SB

32

(FILE 1)

The Greatest Addiction of All

by Jon Gettman, NORML Director

NORML—IZER

Power is the most addictive habit in the world. The moral influence that shaped the American Revolution and inspired our democracy demands that individual citizens challenge the abuse of power by our leaders. Modern politics is founded on the belief that the government's natural tendency to increase its power requires restraint. Conservatives are inspired by the belief that governmental power needs to be kept minimal in order to preserve individual liberty. Liberals are inspired by the belief that individual rights require protection from authoritarians throughout society.

The War on Drugs is really a war between two opposing ideologies about the management of our society. It is a struggle between authoritarians driven by their craving for ever-increasing power and patriots driven by the love of their democratic heritage.

Marijuana reform will eventually prevail because it is true to the principles that give our society its greatest strength. It will gain support from a diverse coalition of Americans because they abhor abuse of power in their name. When they understand how the War on Drugs has been the excuse for a steady increase in the power of the government to invade their privacy, whether they use drugs or not, they will demand an end to the war.

In the last few years marijuana and other drug use has been exploited by governmental agencies to not only increase their budgets but their authority. And they lie to and mislead the public in order to justify the exceptional steps they wish to take, steps which repudiate the principles upon which our country was founded.

The American Revolution was inspired by a long simmering, deeply felt distrust by the colonists of the men running the English government. They proudly asserted their liberty to exercise their natural rights, which, wrote John Dickinson in a pre-war pamphlet, "are created in us by the decrees of Providence, which establish the laws of our nature. They are born with us, exist with us, and cannot be taken from us by any human power without taking our lives. In short, they are founded on the immutable maxims of reason and justice."

One of these rights was and is held to be a right to privacy. It is this right that is protected by the Fourth Amendment of the United States Constitution which restrains the government from unreasonable search and seizures. However, the anti-drug crusade seeks to have police excused from this restraint as long as they act in "good faith." And the Fourth Amendment would have been quietly circumvented amidst the anti-drug hysteria of September, 1986 had it not been for a few brave conservatives in the Senate, like Robert Packwood, who seek to block the abuse of governmental power, no matter what the excuse.

But this is not the only assault on the Fourth Amendment. The anti-drug movement has secured [illegible] rulings which allow the [illegible] hover over your back yard [illegible] you. They have secured widespread support for forced urine testing. How would George Mason, the father of the Bill of Rights, react to a surprise urine test? "Mr. Mason, take off that wig, we don't want any contaminants in your pee. Now just fill this little bottle and you can go back to writing the Bill of Rights, just as long as you haven't been smoking any of those hemp plants in your garden."

The assertion of a right to be protected from governmental scrutiny precedes the American Revolution. Its advocates were inspired by the tradition of liberty established by the Magna Carta and nurtured by the English Constitution. In an immortal declaration, William Pitt, a man the King's men found to be too reasonable to run the government, said in 1763: "The poorest man in his cottage may bid defiance to all the force of the Crown. It may be frail; its roof may shake; the rain may enter; but the King of England cannot enter; all his forces dare not cross the threshold of the ruined tenement!"

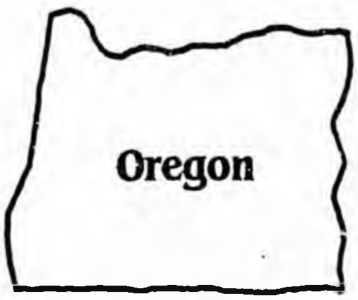
Nearly 200 years later, in 1960, Barry Goldwater wrote **The Conscience of the Conservative**, which "is pricked by anyone who would debase the dignity of the individual human being." Our dignity is debased, by a government that not only seeks to barge into our living rooms and instruct our behavior, but also has dedicated itself to spreading lies about marijuana users and promoting their widespread persecution. Our dignity is debased when Carlton Turner, the President's drug advisor, encourages employers to discriminate against marijuana users by stating the are unfit for work. Our dignity is debased when the National Institute on Drug Abuse releases a story to the press that marijuana causes premature senility without mentioning that it would take the equivalent of 135 joints a day for 40 years to accomplish it, and that 50 joints a day has no effect on the brain.

Conservatism, Goldwater wrote, is guided by "the ancient and tested truths that guided our Republic through its early days (and they) will do equally well for us." Power corrupts, and "the natural tendency of men who possess some power to take unto themselves more power leads eventually to the acquisition of all power."

The 200th birthday of the Constitution is about to be celebrated. We must remember that we, the people, must assert our natural rights so that our society may prosper as our ancestors envisioned.

We believe, as those who brought about the American Revolution, that when faced with tyranny, "submission is a crime." We're not involved in a struggle over whether or not you have a right to smoke marijuana. It's a struggle over how much power we are willing to let the state accumulate at the expense of liberty. The time has come to remind our leaders of this, and begin anew our quest for liberty. ●

Since 1969, enough Americans have been arrested for possession of marijuana to empty the states of:



(pop. 2,633,149)

(pop. 944,038)

(pop. 800,493)

And the cities of:

Fresno, CA (pop. 218,202) **Spokane, WA** (pop. 171,300) **Salt Lake City, UT** (pop. 163,033)
Amarillo, TX (pop. 149,230) **Pueblo, CO** (pop. 101,686) **Casper, WY** (pop. 51,106)
Santa Fe, NM (pop. 48,899) **Redding, CA** (pop. 41,995) **Flagstaff, AZ** (pop. 34,641)

And the towns of:

Piercy, Reynolds, Leggett, Rockport, Cummings, Covelo, Ukiah, Dos Rios, Laytonville, Branscomb, Westport, Longvale, Inglenook, Cleone, Ft. Bragg, Novo, Willits, Casper, Mendocino, Littleriver, Potter Valley, Redwood Valley, Comptche, Albion, Calpella, Navarro, Talmage, Elk, Philo, Manchester, Boonville, Point Arena, Yorkville, Anchor Bay and Gualala, California (pop. 66,783)

In fact, almost 6,000,000 people have been arrested for possession of marijuana.
In 1984 alone, over 419,000 marijuana arrests were reported, *one every minute and a half.*
The government has pledged to continue. If you think enough is enough, get involved.

Join NORML today by sending $25 membership dues, or write or call for free information:

NORML, 2001 S Street, NW, Suite 640, Washington D.C. 20009 • (202) 483-5500

☐ Yes, I want to do my part to end the suffering caused by America's unjust marijuana laws.

☐ Enclosed are my $25 regular membership dues. Please send me my membership package, a copy of the state and federal marijuana laws and a free NORML button.

☐ Enclosed are my $15 low income, student or military membership dues. I understand that I receive all the benefits of a regular membership.

☐ No, I can't join now, but please put this tax-deductable contribution to good use. I'm enclosing:
___$500 ___$250 ___$100 ___$50 ___$25 ___$10
___$ Other

National Organization for the Reform of Marijuana Laws

NAME: ____________________
ADDRESS ____________ APT.#: ______
CITY: ______ STATE: ______ ZIP: ______
TELEPHONE: ( ) ____________
(All information remains strictly confidential.)

☐ Check here if you would like to receive your mail without our logo on the envelope.

MAIL TO:

NORML
2001 S Street, N.W.
Suite 640
Washington DC, 20009

ACTIVIST NEWS

IN THE EYE OF THE STORM

Activist News by Burt Neal, NORML Projects Coordin[illegible]

At the end of September and the beginning of October of the past year, a storm of hurricane strength overcame Washington D.C. This hurricane became known as "Hurricane Hysteria" and she was a tough one to weather. Hysteria's appearance came to no one's surprise; after all, it was a mid-term election year, and the media rarely gives reform supporters a fair shake. In other words, it is always hurricane season. But the fierceness of Hysteria was the shocker. Who would have thought that crack and cocaine, the killers of 700 people last year, (tobacco—350,000 dead), would have been proclaimed by every publication as the number one security threat facing the nation? And let us not forget the opportunistic politicians trampling of the very constitutional rights that our forefathers fought for.

Needless to say, it was a busy time for **NORML** and its activitists. Everyone was on the anti-drug gravy train, and they were all out to expand their powers, increase their funding, and spread their lies while they could. The anti-marijuana forces in the White House and in the National Institute of Drug Abuse quickly began to increase their exaggerations to an eagerly awaiting and amazingly gullible media.

[illegible]

that claimed that excessive mari[illegible] ing could cause brain damage simila[illegible] aging. One government official desc[illegible] "a ticking time bomb." When a repor[illegible] tacted NIDA about the story, he was to[illegible] these new findings should have a grave im[illegible] on the voters of Oregon who were co[illegible] dering a proposal on November's ballot to le[illegible] galize possession and cultivation of cannabis[illegible] the Oregon Marijuana Initiative.

What reporters weren't told was that one group of rats was given the human equivalent of **136 joints a day for 30 to 40 years**, the other the equivalent of 54 joints a day for 30-40 years. **The 136 "J's" a day group suffered the ill effects, the 54 a day group showed no problems.**

Typical. **NORML** wrote the papers that ran the story and sent out a press advisory to the media warning about this and other examples of government exaggerations about marijuana. We know that we did have some impact on the media, but the truly important point is that an organization was out there to point out the falsity of this story.

The press frenzy, which began to deteriorate somewhat in October, came in a distant second to what we witnessed in Congress.

[illegible] refused, he [illegible] possible $1,000 fine.

[illegible] Bill allowed illegally seized evi[illegible] cases, not just [illegible] John Adams [illegible] allowed Brit[illegible]?) Over the [illegible]ense Casper [illegible] military to [illegible] days of en[illegible] t forget the [illegible] million fed[illegible] es to a urine [illegible] basis for sus[illegible]

[illegible] Representatives [illegible] to such inher[illegible] include Rep. [illegible] Rep. John Conyers (MI), [illegible] (MA), Rep. Ron Dellums (CA), [illegible] (CA), Rep. Henry [illegible] Michael Lowry (WA). [illegible] Rep. Edward [illegible]vsabo (MN). [illegible] Stokes (OH). [illegible] Ted Weiss (NY) [illegible] Republican Rep. Philip Crane [illegible] not on this list. [illegible] know your displeasure

[illegible] of the Capi[illegible] Bob Dole intro[illegible] have allowed the [illegible] alcohol, and mental [illegible] State that had de[illegible] deliberate, but [illegible] to recrimina[illegible]

The [illegible] about this amendment [illegible] the activists in the [illegible] contacted their friends [illegible] centers and urged [illegible] their Senators and Governors. NORML sent out a press release and also called [illegible] offices to make them aware of the [illegible]

All these people had one question for their elected representatives: Are you in favor of cutting off our [illegible] alcohol, and mental health grants? [illegible] suggest that you do something about [illegible]

It takes about ten phone calls from constituents about a specific bill before a Representative [illegible] takes notice. Only ten. Not too many of the Senators were in favor of this proposal and they let Sen. Dole know it. The amendment was dropped the next day.

[illegible]

As I am writing, the storm is slowly subsiding. A fair amount of the media is beginning to admit that they exaggerated the drug crisis. And there are even voices of wisdom coming from certain politicians, especially Pat Schroder (D-CO) and Gary Ackerman (D-NY). Perhaps the bravest was Sen. Evans (R-WA), who was absolutely correct when he said that the Senate Bill "belonged in Orwell's 1984, not America in 1986."

America's civil liberties took a beating this hurricane season. Perhaps it's greatest victim was O.M.I. They'll be back next election. But we were able to in some ways deflect some of Hysteria, and thus alter the course of the debate. NORML activists and members were able to make a difference to the temporary situation.

If you think that the work of NORML as described above is important, please help us to help you. Join NORML or make a contribution today. If you want to alter history, become an activist for justice in America. Contact NORML today. Hysteria was a rough storm, but remember, it is always hurricane season during prohibition.

Here is a listing of some of the NORML college chapters around the country:

U Con. NORML
Univ. of Connecticut N. Campus
Middlesex 403
Storrs, CT 06268
Attn: C. McGrattan

V.P.I. & S.U. NORML
Attn: Susan Anderson
Math Dept.
VPI & SU
Blacksburg, VA 24061

Southwestern U.S.L. NORML
Attn: Richard Dafford
USL #43984
Lafayette, LA 70504-3984

Columbia U. NORML
Attn: James Slaughter
423 W. 118th St. #4-G
New York, NY 10027

H.E.M.P.
(Help Educate Missouri's People)
P.O. Box 278
Fremont, MO 63941

CASE IN POINT

● Possession's still legal, eleven years later. ●

BOOZE AND GRASS IN ALASKA

A monthly report on drugs and the law. Written in consultation with Kevin Zeese, NORML Chief Counsel.

BY BOB LABRASCA

The case that gives rise to this column is that of *Hugh Harrison v. State of Alaska*—a case that's not very important in itself.

Harrison, an Alaska state trooper who apparently enjoyed an occasional nip, was transferred in late 1981 to duty in St. Mary's, a "dry" village on the Yukon River. In April '82, he flew a plane in from Nome to St. Mary's carrying a load of beer and vodka. Two days later police searched his home and found 62 liters of beer and 1.75 liters of vodka. He was convicted under the local ordinance of importing alcohol and then appealed, arguing in part that the local law violated his right to privacy under the state constitution.

In August '84, the Alaskan court of appeals affirmed his conviction. In so doing they had to draw some sharp distinctions between Harrison's case and one from 1975 involving a chap named Irwin Ravin. It was the Ravin case that effectively legalized "the possession of marijuana by an adult for personal consumption" in the state of Alaska.

You see, the Alaska Constitution specifically protects the "Right of Privacy." The state proudly guards that right: "Our territory and now state," the Alaska Supreme Court wrote in the Ravin decision, "has traditionally been the home of people who prize their individuality and who have chosen to settle or to continue living here in order to achieve a measure of control over their own lifestyles which is now virtually unattainable in many of our sister states."

In concluding that the state had no right to go rooting through people's domiciles and belongings in search of their personal pot stashes, they stated unequivocally, "We believe this tenet to be basic to a free society. The state cannot impose its own notions of morality, propriety, or fashion on individuals when the public has no legitimate interest in the affairs of those individuals."

So, in response to Harrison's appeal, the appeals judges had to explain why his case was different from Ravin's—and they had no trouble doing that. The Ravin decision, they pointed out, had not affirmed a fundamental right to possess or ingest marijuana; it was the privacy of the home, and implicitly the person, that was at issue, and that privacy wasn't absolute. If marijuana were the cause of a significant public health problem, then the right might have to give way to the public interest. But, "given the evidence of the relative harmlessness of the drug," they told Harrison, "an individual's right of privacy in the home outweighed the government's interest in regulating personal use of marijuana in the home."

Despite the defeat of the Oregon Marijuana Initiative at the polls last fall, some states continue to exercise a more enlightened attitude toward pot.

Alcohol, on the other hand, was far from harmless, they explained, citing these facts among others: Alaska's alcoholism mortality rate in 1975 was 418 percent higher than the national average... one out of every ten Alaskans is an alcoholic (in the rural areas of the state) 77.9 percent of violent crimes and 55.6 percent of property crimes were committed under the influence of alcohol. With a drug problem of that severity ravaging the Alaskan population, the town of St. Mary's had a perfect right to outlaw the importing of booze, regardless of trooper Harrison's lifestyle. (This decision, by the way, did not address Harrison's right to drink in his own home, but only his right to import or sell alcohol. Smuggling and dealing pot are still illegal in Alaska.)

What I find interesting about this is that it's been well over eleven years since *Ravin*, and it's still a matter of law in Alaska that marijuana is relatively harmless. Nobody gets busted there for head stash. If "legal" pot had the potential to provoke a major health problem, it would have done so by now, and the "parents power" antimarijuana lobby would have made its case before the legislature and the courts, and personal possession of grass would be illegal again. In the intervening decade, hundreds of millions of tax dollars (your money and mine) have been spent to try to discover some intolerably deleterious effect of marijuana, and "experts"—who in that much time could have proven clear, arctic air poisonous—are still coming up dry.

I talked with Anchorage attorney Robert Wagstaff, who handled the Ravin case, before putting this column together and heard for the first time the story of how the Alaskan courts became enlightened on this issue. It seems that he and Irwin Ravin, also a lawyer, actually conspired to change the law.

According to a prearranged plan, Ravin got himself busted with some pot in his pocket way back in December 1972. They moved to dismiss the case, and almost three weeks of hearings ensued in which the entire issue of marijuana and health was examined. Nationally-recognized scientists and zealots, from Dr. Lester Grinspoon to Dr. Gabriel Nahas, took the stand, and the current scientific literature on cannabis was entered in the record. A thorough study of that evidence formed the basis of the Supreme Court's *unanimous* decision in Ravin's favor, delivered in May '75.

Despite the passage of time, it's still quite probably the most thorough and rational discussion on marijuana prohibition yet dispensed by a body of judges. (Courts in the lower 48 have universally rejected the pot-privacy argument.) Anyone with an interest in this issue and access to a law library should give it a read-through. It just might make your day.

You'll find it under *Ravin v. State*, 537 P. 2d 494 (Alaska 1975). ●

ILLINOIS

Dennis M. Kleper

7 South Dearborn St., Suite 1412
Chicago, IL 60603
(312) 726-6764

MASSACHUSETTS

Richard B. Modica

27 Lambert St.
Medford, MA 02155
(617) 391-3488

MISSOURI

Henry B. Hine

Pharmacist/Attorney
Drug Defense Practice
St. Louis, MO 63105 (314) 725-8600

NEW MEXICO

David C. Serna, Trial Lawyer

411 10th St. S.W.
Albuquerque, NM 87102
(505) 242-4057

NEW YORK

Michael Kennedy

148 East 78th Street
New York, NY 10021
(212) 737-0400

TEXAS

Gerald Goldstein

Tower Life Bldg., 29th Floor
San Antonio, TX 78205
(512) 226-1463

Joseph A. Connors III

804 Pecan
McAllen, TX 78502-5838
(512) 687-8217

UTAH/WYOMING

Robert W. Horn

50 King St., Suite 201
Jackson Hole, WY 83001
(307) 733-5747

VIRGINIA

Moffitt & Jones

655 S. Washington St.
Alexandria, VA 22314
(703) 684-7900

David Whaley

9 East Franklin St.
Richmond, VA 23219
(804) 643-0147

DISTRICT OF COLUMBIA

NORML — Jon B. Gettman

2001 S. Street NW, Suite 640
Washington, DC 20009
(202) 483-5500

For information about the HIGH TIMES Legal Directory, or to change your current listing, contact Sandy Rosen, HIGH TIMES Magazine, 211 East 43rd Street, New York, NY 10017, (212) 972-8484.

Mike Royko

Legal marijuana —a pot of gold

I've been playing around with a fascinating number—14,000 tons. That's the amount of marijuana—foreign and domestic—that's said to be consumed each year in this country.

Actually, the federal narcs think it might be even higher. A recent raid in northern Mexico turned up 10,000 tons. The narcs were stunned because they thought that Mexico produced only one-fourth that amount.

But for this column's purpose, let's stay with the 14,000-ton figure.

If you break that down, it comes to 448,000,000 ounces.

I'm told that an ounce of marijuana will produce 20 to 40 joints, depending on whether you are frugal and make skinny ones or are self-indulgent and make them stogie-sized.

There's also a waste factor—seeds, twigs, bugs, spillage and so on.

So let's be conservative and figure 20 joints an ounce.

That's just under 10 billion joints a year.

If you divide that by the population of this country, it comes to about 40 joints for every man, woman and child.

Now, we can assume that millions of little toddlers and pre-schoolers don't smoke it. We can even assume that most kids in elementary school don't, since most of them don't have the purchase price.

And we can assume that millions of old codgers in nursing homes or two-room flats don't use it.

So who's doing all this grass-smoking? Recent studies say that teenagers are smoking less and less pot. So the biggest users are the age groups that range from young adults to middle-agers.

And they're a huge part of the population. If they aren't the majority, they're not far from it.

That tells us something obvious: There's a great demand in this country for marijuana.

As any Harvard economist—or dry-goods salesman—will tell you, when there's a great demand for something that isn't hard to supply, somebody is going to supply it.

Obviously, it's happening. Whether you live in a big city, a suburb or a small town, you can easily buy marijuana. If you aren't sure where to get it, just ask the nearest teenager.

So I have a simple question: If so many Americans want and use marijuana, if they are already getting it so easily, if they insist on spending billions of dollars a year on it, why are we screaming at Mexico, why are hordes of narcotics agents floundering around in futile attempts to find it, why are the police and courts still wasting time and money trying to put dealers in jail for selling it?

It ought to be obvious by now that the politicians in Washington can talk all they want about stamping it out, but they can't do it. It's become one of this country's biggest cash crops. It's a big part of Mexico's economy.

So maybe it's time to give up trying to stamp it out and consider legalizing it, thereby controlling it.

If it were legal, we wouldn't have gun-crazy dealers spraying Florida and other big import states with machine-gun bullets. They wouldn't be bribing politicians in this and other countries. In other words, it would be taken out of the hands of the criminal dope dealers, who are quickly becoming some of the world's wealthiest creeps.

It would allow the narcs to stop wasting their time trying to stop it, which they can't do, and would let them concentrate on chasing far more harmful drugs, such as heroin and cocaine.

And, best of all, it could be taxed. A $10 or $20 an ounce federal tax would bring in more than $5 billion or $10 billion a year. And every local government could slap on a little tax of its own.

Who would sell it? Private enterprise, I suppose. The day it became legal, we'd see nationwide pot franchises springing up.

And we could stop feuding with Mexico, since our own needy farmers could grow enough to meet all local demands.

Why, they'd probably wind up dealing in marijuana futures on the Board of Trade.

The sale could be regulated just as we now regulate the sale of booze. TV and radio advertising of pot would be banned, just as we've banned the advertising for hard liquor and cigarettes. Minimum age limits would be set.

Sure, it would be impossible to enforce the laws 100 percent. But the fact that teenagers find ways to buy beer doesn't prevent the rest of us from drinking it.

And, yes, I'm aware that marijuana isn't good for us, although scientists still aren't sure what the effects really are.

However, the scientists do know a lot more about the effects of even the finest scotches, the most elegant gins, the most regal cognacs. Even if you pay $5 a shot and tip the bartender a deuce, they will still quiver your liver and strain your brain.

So it might be time for us to stop pretending that we can do something to stop marijuana from being sold and consumed. In a country where the citizens—and even illegal aliens—have unlimited freedom of movement and where there is almost no control of its own borders, we can't do it.

Then why not try to at least regulate it and let our own farmers and businessmen make a buck.

Are we ready for a McJoint?

Alaska State Legislature

COMMITTEES

Committee on Community and Regional Affairs
Committee on Transportation
Special Committee on Oil and Gas
Special Committee on Fisheries
Finance Sub-committee on Fish and Game

District 5

Kenai	Sterling
Soldotna	Anchor Point
Homer	Point Graham
Seldovia	English Bay
Kachemak	Nikolaevsk
Kasilof	Halibut Cove
Ninilchik	Clam Gulch

Representative Andre Marrou

THE NEW PROHIBITION ?

Some people think that Libertarians favor drugs. This is not so. Libertarians no more favor drugs than they favor guns.

Rather they have taken a look at history and have seen from past experience that outlawing substances (like drugs) or inanimate objects (like guns) simply does not work.

When you attempt that, you don't get rid of such things; you simply drive the use of them underground. Thereby you set up a black market, wherein people deal in the illegal substance or inanimate object, making much money at high prices by providing common citizens with what their leaders have decided is illegal.

For example, during America's "noble experiment" with prohibition from 1919 to 1933, the efforts of Congress to get rid of alcoholic beverages simply did not work. Instead, the underground provided both good and bad alcoholic substances to the American people, thus profiting greatly. The main effect of prohibition was to establish the Mafia in the United States, and it has grown stronger ever since. After seeing for fourteen years that the American public was simply not obeying the law, Congress then repealed the Constitutional amendment which had prohibited alcoholic beverages.

18th century

Similarly, another substance was outlawed in Sweden for 70-odd years, from about 1775 to about 1850. Many of the arguments that we now hear against various illegal substances were advanced against that substance back then. A black market developed in that substance, and an underground market was established, which thrived for the better part of a century by providing the common person with this substance. Believe it or not, that substance was coffee.

What about children

Whether a substance or an inanimate object is good or bad for individual persons is not, repeat not, properly for the government to decide. Rather, it is for each individual person to decide whether he/she would benefit from the use of a substance or inanimate object.

As you may have noticed, the Ten Commandments in the Bible do not mention substances. Instead, the Ten Commandments refer to actions by human beings.

This, in essence, is what Libertarians believe-- that human actions are what should be considered in judging a person, not whether that person partakes of a certain substance or utilizes a given inanimate object.

If we were to outlaw the most dangerous inanimate object in our society, the object that results in the most deaths to our populace, the object that kills the most Americans every year, then we would outlaw automobiles. Obviously, the problem is not with the automobiles, but with the drivers behind the wheels--in other words, the problem is with actions of human beings, not in which objects they use to perform those actions. The same idea applies to substances.

The only two groups who adamantly favor outlawing drugs in our society are: the far-right wing religionists, who consider that certain drugs are "demons" and are thus immoral and sinful; the other group is the underworld, which profits greatly by dealing in these drugs. The common person in the street really does not care whether the drugs are legal or illegal, so long as he/she is protected from violent or coercive acts of other human beings, whether or not they use drugs or inanimate objects.

In sum, the outlawing of drugs is tantamount to the outlawing of guns. Outlawing guns will not stop murders, and outlawing drugs will not stop, nor has it stopped, the drug problem.

Supreme Court of the United States. Regents of the University of California v. Allan Bakke. *Ruling #76-811*, 1978.

Thibaut, J. W., & Walker, L. *Procedural Justice: A Psychological Analysis*. New Jersey: Erlbaum Publishers, 1975.

United States Commission on Civil Rights. *Statement on Affirmative Action*, 1977. Clearinghouse Publications 54.

Walster, E., Berscheid, E., & Walster, G. W. New directions in equity research. In L. Berkowitz & E. Walster (Eds.), *Advances in Experimental Social Psychology*, 1976, 9, 1-42.

Discriminatory Decision Making at the Legislative Level

An Analysis of the Comprehensive Drug Abuse Prevention and Control Act of 1970

Ruth D. Peterson*

This paper is an analysis of the Comprehensive Drug Abuse Prevention and Control Act of 1970. Consistent with value-conflict perspectives, previous research on the social origins of drug legislation suggests that coercive laws occur when the behavior of minority and other subordinate groups become threatening. Liberalizing drug legislation is enacted when the interests of dominant groups seem juxtaposed to existing punitive legislation. The present analysis explores the process of legislative decision making when both subordinate *and* superordinate groups engage in drug-related behaviors which run counter to dominant norms and values. To do so, a detailed analysis of the congressional committee hearings and floor debates which preceded enactment of the 1970 Act was conducted. This analysis revealed that Congress did not pass a strictly coercive drug control policy at the risk of stigmatizing superordinate groups. Nor did it choose to liberalize drug penalties across the board. Congress perceived that strictly liberal policies might undermine both the instrumental goal of reducing illicit drug activity, and the symbolic goal of expressing general societal disapproval of illicit drug use. Instead, the legislation that emerged from congressional debates contained both liberal and coercive provisions reflecting the requirements of dealing with two targeted populations: young middle and upper class white drug users who became identified as victims of drug traffickers; and large-scale and professional drug dealers who became identified as enemy deviants—the true source and symbol of the drug problem. Liberal, and essentially discriminatory, provisions permitted the protection of the former from stigmatization as criminal felons. Coercive, but apparently nondiscriminatory, provisions provided the threat and potential for severe punishment of the latter. The discriminatory features of the 1970 Act are identified and explicated. And, the implications of the Act's provisions for race- or class-based decisions in the application of sanctions are discussed.

INTRODUCTION

An important tenet of American criminal justice is the assumption of equality

* Department of Sociology, University of Iowa—Iowa City.

before the law. Ideally then, both lawmaking and law enforcement are class- and color-blind. Laws are based on general and universalistic criteria, and are applied without regard to the social background of those subject to its effects. Legal scholars have long attempted to assess the degree to which justice is exercised in a manner consistent with these legal ideals. The most prominent body of research along these lines considers the role of race, class, and other status characteristics of offenders on arrest, prosecutorial, and judicial decisions. However, scholars also recognize that discriminatory lawmaking represents another way in which the reality of the administration of American justice may depart from our ideals of equality before the law. Legislators may criminalize or assign penalties to behaviors that are common only to certain segments of the population (e.g., the lower classes or minorities), fail to criminalize or assign only slight penalties to harmful behaviors that are common among preferred segments of the population, or allocate resources such that certain groups are more likely than others to be the targets of law enforcement activities (Kleck, 1981). Legislation containing such features is discriminatory not only in its construction, but may also have discriminatory consequences at the level of law enforcement. As Kleck (1981, p. 801) suggests, discriminatory decisions at the legislative level may "reveal far more about why blacks and lower-class persons are overrepresented in arrest, court, and prison data than studies of processing within the criminal justice system."

Although discrimination is not always an explicit concern, there is a fairly substantial body of literature which examines the social origins of criminal legislation. Most such studies are posed as tests of the relative merits of value-consensus versus conflict models of law. In brief, although there are several variants of consensus theory (e.g., Durkheim, 1964; Freidmann, 1959; Bohannon, 1965), the basic argument is that criminal laws grow out of the societal mores, and are expressions of "those societal values which transcend the immediate interests of individuals or groups" (Chambliss, 1969, p. 8). Criminal law, therefore, represents the codification of values and customs that are widely shared in society and that reflect common interests.

In contrast, conflict viewpoints hold that criminal laws are expressions of the interests of the more powerful segments of society. Some conflict theorists draw largely upon the works of Marx and regard criminal laws as expressions of ruling class interests. Thus, for example, Quinney (1975, p. 291) argues that "Criminal law is an instrument that the state and dominant ruling class use to maintain and perpetuate the existing social and economic order." This theme is also echoed in the works of Chambliss (1973, 1974), and Taylor et al. (1973, 1975). A more moderate conflict perspective (Quinney, 1970; Chambliss and Seidman, 1971) views laws as reflecting and symbolizing the victory of one interest group over that of others, but no single set of interests is assumed to underlie all criminal legislation.

Research on the enactment of theft (Hall, 1952), vagrancy (Chambliss, 1964), sexual psychopath (Sutherland, 1950), prostitution (Roby, 1969, 1972), alcohol (Sinclair, 1962; Gusfield, 1963), and drug laws (Becker, 1963; Musto, 1973; Bonnie & Whitebread, 1974) suggests that conflicts of interest rather than consensus of values are the prime factors underlying much contemporary lawmaking. (In many instances too, the interests involved are race and class based.) Importantly, most of the research upon which this conclusion is based has a common feature: the legislation under consideration usually involves a single and fairly uniform type of behavior that is engaged in characteristically by an identifiable but subordinate segment of the population (Galliher & Pepinsky, 1978). Such a bias in the choice of legislation may have permitted only a limited understanding of the role of conflict in legislative decision making. If neither the interests nor the values of dominant populations are being called into question, it is not surprising that the laws which emerge reflect and symbolize their interests at the expense of less powerful and less reputable populations. Importantly too, we are unable to specify on the basis of such research the kinds of circumstances that will give rise to one or the other forms of discriminatory legislation (e.g., legislation favoring the privileged or aimed at controlling subordinates).

A more complete understanding of the role of conflicts of interests and values in lawmaking requires examination of proposed changes that could affect dominant as well as subordinate interests (Hagan, 1980; Hopkins, 1975). What happens, for example, when both subordinate and superordinate groups are believed to engage in behavior which runs counter to dominant values and norms? Are solutions sought which preserve intact dominant values regardless of the groups affected? Or, do lawmakers attempt to differentiate the various populations and their behavior? If the latter, how are such distinctions made, justified, and presented in the form of a general law?

The purpose of this paper is to address the above and related questions by examining passage of the Comprehensive Drug Abuse Prevention and Control Act (CDAPCA) of 1970. This act presents a unique opportunity to investigate the above questions because it deals with behaviors that (1) are complex and varied, (2) involve both subordinate and superordinate population segments, and (3) potentially place into conflict dominant values and dominant interests. In analyzing the 1970 Act particular attention will be given to any discriminatory features in the construction of the legislation, and to the potential of the legislation for permitting discrimination at the law enforcement level. Before turning to our analysis of the 1970 legislation, a brief review of the previous literature on federal drug control may help to put the present legislation in the appropriate historical perspective.

PREVIOUS LITERATURE ON FEDERAL DRUG CONTROL

Research on the enactment of federal drug laws supports the view that such laws reflect discriminatory decision making (along race and class lines) at the legislative level. Consistent with conflict viewpoints, most explanations of federal drug control have viewed the laws as instruments of social conflict stemming from profound tensions among socioeconomic, ethnic, and racial groups. When such tensions are high, and use of a particular drug is associated with an identifiable and threatening group, legislation is enacted to control the undesirable behavior, and/or as a symbolic expression of hostile attitudes toward the particular group.

Musto (1973) and others (Reasons & Purdue, 1981; Helmer, 1975) demonstrate how the Harrison Narcotic Act of 1914 was linked to fear of opium smoking among the Chinese during a period when Chinese workers represented a labor surplus and an economic threat to working class Americans. This perceived threat resulted in antagonism against the Chinese, and, "along with this prejudice came a fear of opium smoking as one of the ways in which the Chinese were supposed to undermine American society" (Musto, 1973, p. 6). Musto adds that passage of the Harrison Act was also associated with fear of cocaine use by blacks in southern states. Because of the euphoric and stimulating properties of this drug, "The South feared that Negro cocaine users might become oblivious of their prescribed bounds and attack white society" (Musto, 1973, p. 6).

Similarly, researchers (Musto, 1973; Bonnie & Whitebread, 1974) have documented an association between the passage of the Marihuana Tax Act of 1937 and the threats posed by marihuana-smoking Mexican immigrants under conditions of economic depression in the 1920s and early 1930s. Mexican immigrants had been welcomed as a source of cheap farm labor during the economic boom in the early 1920s. With the onset of the Great Depression the Chicano and Mexican labor force became an unwelcome surplus in regions devastated by unemployment. Under these circumstances, the use of marihuana became a symbol of evil and users were depicted as capable of the most violent crimes under its influence (Reasons & Purdue, 1981). In short, the prohibition of opium and cocaine use under the Harrison Narcotic Act, and marihuana use under the Marihuana Tax Act was aimed at controlling the perceived threats posed by the noted ethnic and racial populations. In addition, the respective laws were symbolic gestures to indicate the superiority of Anglo culture over Oriental, black, and Chicano culture in times of great concern about these threatening groups.

Social research on federal drug legislation since the Marihuana Tax Act is not as extensive or as systematic. However, available literature continues to emphasize economic or social tensions between different segments of society. For example, Susman (1975), the National Parole Institutes (1964), and Glaser (1974) note that following World War II, drug use became concentrated in large cities, among younger persons, persons from the lowest socioeconomic classes, and particularly, among poor slum-dwelling blacks, Puerto Ricans, and Mexican-Americans. Further, among these "outsiders," drug addiction increasingly became associated with other types of illegal behavior (crime and delinquency). In this context Congress enacted the most severe criminal sentences ever imposed for drug use and abuse (see the pre-1970 penalty structure summarized in Table 1).

While the research cited above is clearly suggestive of racial and ethnic discrimination in the making of criminal drug laws, it is noteworthy that under certain circumstances even the drug-related behavior of affluent socioeconomic groups (e.g., middle class whites) may be subject to punitive legislation. Federal drug legislation enacted during the 1960s (The Federal Drug Abuse Control

Amendments of 1965 and 1968) are cases in point. The most distinctive feature of drug use during this period was the consumption of new types of drugs (including LSD and other hallucinogens) by middle class youth in communities and on college campuses. Although the use of dangerous drugs was not concentrated among traditional "social inferiors," Greenberg (1974, p. 190) argues that "the rationale behind the legislation [of the 1960s] was not the control of drug abuse, but the deliberate harassment and supression of an emerging minority group felt to be politically dangerous and morally disruptive." Gusfield (1975) adds that drug use among youth in the 1960s was related to major cultural issues, especially the "moral revolution," which touched off new debates about hedonism, sexuality, individual and public responsibility, and personal ambition. Thus, for Gusfield, the labeling of the new drugs of the 1960s as illicit served to maintain the condemnation of drug users and reinforced the legitimacy of those values threatened by cultural change.

In sum, legal prohibition of drugs or an upgrading of drug penalties is likely to occur when groups (most often minority and low-income groups) threaten powerful interests or challenge dominant cultural values. In Gusfield's (1963) terms, the threats posed are those of "enemy deviants." Importantly, Greenberg's (1974) and Gusfield's (1975) analyses indicate that the drug-related behavior of dominant segments of the population may be subject to punitive legislation if that behavior symbolizes a challenge to the legitimacy of important social values. It is also noteworthy, however, that the penalties enacted in the latter types of cases are likely to be much less severe than those which apply to crimes involving substances (e.g., heroin, cocaine) presumably used by traditional minorities. For example, compare the pre-1970 narcotics and marihuana penalties with the pre-1970 penalties for dangerous drugs in Table 1. It is even possible that a decline in prohibition will occur when the undesirable activity is associated with important segments of society. Although drug penalties are seldom lowered, analyses (Galliher et al., 1974; Galliher & Basilick, 1979; Glaser, 1974) of liberalizing trends in marihuana legislation at the state level emphasize a feature that is more or less a "corollary of the conflict perspective's claim regarding the use of drug laws for minority oppression. The conclusion is that consensus on lenient penalties is most easily achieved if the drug in question is not associated with a threatening minority" (Galliher & Basilick, 1979, p. 295).

Considering the population groups separately, then, it is possible to interpret legal changes which emerge to control the drug-related behavior of both subordinate and superordinate groups within the conflict frame of reference, and as reflecting discriminatory lawmaking. In the case of subordinate groups, the legislation which emerges attempts to protect dominant values and powerful interests by applying coercive reform when the behavior of minority and low-income groups become threatening. On the other hand, drug control laws tend to be liberalized when the interests of dominant groups seem juxtaposed to more punitive existing legislation. A variant on the latter theme is to criminalize the undesirable conduct, but to impose relatively light penalties mainly as a way of reaffirming the legitimacy of values threatened by the drug-related activities of reputable populations.

The questions that provide the impetus for the present analysis remains, however. What happens when a perceived drug crisis simultaneously involves the behavior of both subordinate and superordinate groups? How does a legal system, which is supposed to be blind to race and class considerations in lawmaking and enforcement, deal with the conflicting interests posed by a diverse population of drug offenders? Does Congress differentially weight the threats posed by each group and construct a law that applies to all, but which is more or less coercive or liberal depending upon the relative seriousness of the threats posed? Or, does the legislature attempt to tailor the law to meet the requirements of "substantive justice" for the various populations? If the latter, what is the system's mechanism for differentiating among populations, and justifying the resulting law in universalistic terms? Discovering the answers to these questions is the subject of the following discussion.

METHODOLOGY

To explore the (1) possible discriminatory features of the 1970 federal drug act and (2) the process through which a general law is developed to accommodate a variety of specific concerns, a detailed analysis of the congressional committee hearings and floor debates which preceded the law's enactment was conducted. In total, Senate and House hearings yielded approximately 2000 pages of testimony from more than 118 witnesses representing the Administration, local and state law enforcement (e.g., mayors, police commissioners, etc.), various medical and scientific fields (e.g., pharmacists, physicians, drug manufacturers, psychiatrists), agencies administering to people with drug problems, and a smattering of educators, civil libertarians, and the like. In addition to committee hearings, there were eight days (six in the Senate, two in the House) of floor debates on various versions of the proposed drug legislation.

The congressional records from these debates and hearings were examined in detail to discover Congress' views of its mission in light of the variety of population groups likely to be affected by the legislation; Congress' justification of provisions, if any, that distinguish among offenders on the basis of social criteria, such as race, ethnicity and class; and any hidden agendas, symbolic or instrumental, of the lawmakers. Obviously, there are shortcomings in relying solely upon an examination of congressional records in analyzing legal changes. As Galliher and Basilick (1979, p. 286) note, "complete understanding of any legislation, including drug laws, requires consideration of both triggering events and historical foundations." Such factors may be revealed in a variety of sources, including news reports and interviews with key informants. Thus, for a comprehensive understanding of changes in legislation, it would be desirable to provide a very broad data base. However, when the "political drama" of debates and hearings is complex and detailed (as it is in this case) they may provide sufficient evidence of structural conflicts that underlie the legislation. In addition, in analyzing the process of lawmaking, it is inappropriate simply to take the legislation at face value. The statutes may not reflect congressional (or public) intent regarding the punishment of offenses or offenders. However, hidden agends, symbolic and instrumental, may be revealed in the process of hammering out specific provisions of the legislation. Thus, systematic analysis of congressional debate should provide a useful way of discovering (1) what types of offenders (offenses) are actual and symbolic targets of the legislation and (2) how Congress distinguished (and justified such distinctions) among offenders from different social backgrounds in constructing a law that is general in content, tone, and message. More generally, the present analysis provides a case study of the dynamics of the criminal lawmaking process as it occurs in the legislature. Unfortunately, as Gibbons (1982) points out, such detailed study is an important omission in analyses of the creation of law in modern societies.

BACKGROUND OF THE 1970 ACT

Like previous drug legislation, the CDAPCA was a response to a perceived drug crisis. During the late 1960s and early 1970s, public and political concern about drugs reached near crisis proportions (Lidz and Walker, 1980). Several factors seemed to characterize the period. First, as noted above, by the end of the 1960s, new patterns of drug use, abuse, and trafficking were evident among middle and upper class white youth. In part, such drug use stood as a symbol of youth's disaffection with the legal system, Vietnam War policies, and general societal values (Lidz and Walker, 1980; Gusfield, 1975; Greenberg, 1974). Second, there was a presumed increase in opiate use among traditional drug-using populations (i.e., minorities and members of the lower classes). Third, concommitant with the rising and/or presumed increase in drug use was an increase in street crime which increasingly became associated with drug use. The presumption was that addicts committed crimes of theft to support their drug habits, and committed acts of violence while under the influence of drugs. In addition to these drug-using populations, of course, were the suppliers of drugs—manufacturers, distributors, and major and small dealers who sold drugs for profit. Although drug trafficking is racially and ethnically stratified, (Ianni, 1974), traffickers cut across a variety of race, ethnic, and class lines.

In short, unlike in previous legislation, dealing with the drug problem in 1970 meant (1) dealing with a variety of kinds of offenses and offenders and (2) addressing the symbolic challenge to the legitimacy of existing norms and values posed by drug using and pushing among reputable population groups, and the perceived threats to life and property posed by traditional drug using populations. We turn now to our analysis of the process through which the legislature accommodated within a general law the illicit drug behavior and related activites of diverse population segments, while preserving at least in appearance, the ideals of equality and justice, and symbolizing societal disapproval of undesirable drug use.

PROVISIONS OF THE 1970 ACT

The 1970 Act made broad sweeping changes in the structure of federal drug control. The new law consolidated nearly all existing federal drug legislation, and changed the basis of federal drug control from Congress' powers to tax and to control imports to the power of Congress to regulate interstate commerce. In addition, and most importantly for our purposes, the 1970 Act established a new and more complex penalty structure for federal drug offenses (see Table 2) which tied the penalties both to the type of crime (e.g., sale or possession) and the type of substance involved.[1]

Major impetus for new drug legislation came from the White House.[2] Echoing the characteristics of the drug problem described above, on July 14, 1969 President Nixon sent a message to Congress in which he argued that the abuse of drugs had "grown from essentially a local police problem into a national threat to the personal health and safety of millions of Americans" (Congressional Quarterly, 1969, p. 57-A). To cope with this growing menace the President outlined a ten-point program, including proposals for a complete revision of current inadequate and outdated drug laws.

With several exceptions, the Administration's bill as submitted to Congress maintained the same penalties that were in effect under the Narcotics Control Act of 1956 and the Drug Abuse Control Admendments of 1968. As outlined in Title V of S.2637, the original bill would have altered earlier penalties by (1) eliminating minimum mandatory sentences for first-offense possession cases only; (2) providing for special first-offender treatment in unlawful possession cases; (3) requiring that in the application of special penalties for sale to minors, the recipient must be at least three years the junior of the distributor; (4) treating possession with intent to sell in the same manner as sale; (5) separating and extending penalty provisions for the professional criminal engaged in the business of supplying drugs to others for profit; and (6) providing civil penalties for industries which violate certain laws. Significantly, mandatory minimum penalties for offenses other than first-offense possession were retained, as were the specific penalty ranges for most offenses.

Importantly, the penalty provisions that were eventually enacted into law were substantially less severe than those originally proposed by the Administration and those effective prior to the 1970 Act. Especially noteworthy were (1) the wholesale elimination of mandatory minimum penalties; (2) the reduction of maximum sentences for traditional drug offenses; (3) the reduction of first-offense possession, and distribution of small amounts of marihuana for no remuneration, to misdemeanors; (4) the provision of special first-offender treatment for possessors; and (5) the elimination of provisions denying offenders the right to probation and parole or to have their sentences suspended. In only two areas were the 1970 penalty provisions more severe than earlier federal drug penalties. Under the 1970 Act, two new categories of offenders were singled out for especially harsh treatment—those engaged in a continuing criminal enterprise,[3] and the dangerous special drug offender.[4] Even with these tough provisions, however, the bulk of defendants were likely to be processed under statutes that permitted lower penalties than they may have received under earlier laws. (See Table 2 for a summary of penalties under the 1970 Act.)

EXPLAINING THE 1970 PENALTY REDUCTIONS

Analysis of congressional debates surrounding the enactment of the 1970 Act suggests that the noted penalty structure did in part represent discriminatory lawmaking (i.e., the construction of penalties that would minimize any possible negative consequences that might accrue from the criminal drug activities of a preferred segment of the population—white middle class youth). It would be a misrepresentation, however, to conclude that serving the interests of the middle and upper classes by protecting their sons and daughters from criminalization as felons was Congress' only goal in enacting the provisions of the 1970 Act. Congress also sought to (1) underscore societal disapproval of illicit drug use—whether that characteristic of subordinate or superordinate populations and (2) provide a coercive approach to drug control in dealing with certain conventional types of offenders. Thus Congress distinguished among drug offenders in such a way that permitted the simultaneous achievement of all of these goals. Refocusing the drug problem on the consequences of pushing drugs rather than on their use was the major mechanism by which the distinctions were made and justified. By redefining the problem in this way, Congress was able to develop a law directed at "saving" users and punishing pushers, whatever their respective social backgrounds. Once constructed, such a law would not appear to represent a class-based drug policy, but would provide the vehicle for dealing less harshly with more affluent offenders, the bulk of whom could be conceived as users rather than pushers. (Congress recognized that middle class youth often sold drugs, but profit making was not seen as the major goal of such activity.) Concepts suggested in Gusfield's analyses (1963, 1967) of alcohol prohibition are instructive here.

In discussing the role of the Temperance Movement in the prohibition of alcohol, Gusfield (1963) discerned two types of reform efforts. Assimilative reform is possible when the object of the reform is someone that can be pitied or helped. The sick or repentant deviant is viewed as continuing to hold allegiance to dominant social norms and values. However, because of moral weakness or personal circumstances the individual has slipped into the depths of evilness. The task is to convert and salvage the deviant through benevolent goodwill and humanitarian efforts (to treat or rehabilitate him/her). It is therefore not necessary to apply extreme sanctions to such deviants.

In contrast, coercive reform emerges when the object of the reformer's efforts cannot be pitied or helped; when he or she is an enemy deviant. Enemy deviants reject the reformer's values and do not want to change. They engage in the undesirable behavior for personal pleasure and in defiance of dominant social norms and values. Coercive reformers turn to repressive control mechanisms to deal with the enemy deviant and to reaffirm the dominance of their way of life.

Recall that in previous periods, the targets of federal drug legislation were users perceived as enemy deviants in the sense that Gusfield describes. Recall too, that such users were presumed to be primarily from minority backgrounds.

In the politics of deviance defining surrounding the enactment of the 1970 legislation, a new type of enemy deviant emerged, and users of drugs were redefined as sick or misguided. That is, although (1) middle class youth were largely responsible for the increase in drug use during the period and (2) addicts were seen as responsible for drug-related property and violent crimes, pushers emerged as the designated source and symbol of the drug problem in congressional debate. Congress portrayed pushers, particularly large-scale suppliers and dealers, as evil forces corrupting otherwise innocent youth, and as ultimately responsible for the drug-related criminal activities of addicts who are motivated to steal by the high cost of drugs, and who commit acts of violence while under the influence. (The previous attitude was that users created the market for illicit drugs.) In a sense, major drug dealers became scapegoats for the entire drug problem, bearing the brunt of concern over changes in the distribution of drug use, and the threats to legitimacy symbolized in youthful drug use and other protest activity. For their part, youthful middle class drug offenders could be perceived as innocent victims in need of protection from criminal stigmatization rather than punishment.

Addicts were regarded as sick and their treatment emphasized. However, in our assessment, addicts continued to be viewed as belonging to low income or minority population segments, and their designation as "sick" (rather than as enemies) was coincident to the necessity of defining users (whatever their backgrounds) as less culpable in order to protect youthful offenders from severe treatment in the criminal justice system. Indeed, references to addicts in congressional discussion suggest that the class and ethnic biases that prevailed in earlier conceptions of the drug problem were still prevalent in 1969 and 1970. Apparently though, in the absence of economic competition from such groups, and, in the face of perhaps an even greater peril (the subjection of middle class white youth to severe criminal penalties), the drug use and related activities of subordinate populations did not become the central focus of drug control. Indeed, such groups could essentially be ignored, and the lawmaking process focused on two alternative categories of offenders: middle and upper class youth and major drug dealers whatever their social backgrounds.

PROTECTING THE "CREAM OF AMERICAN YOUTH"

The most notable feature of congressional discussion over the 1970 Act was the great emphasis placed upon dealing with the rising tide of drug use among middle and upper class youth. The following statements of the problem by Representatives Dwyer of New Jersey and Sisks of California were typical. (These statements also reflect the still prevalent race and class biases in conceptions of the drug problem.) First, Congresswoman Dwyer:

> There is no longer an easy victim or an obvious seller to whom we can shake an accusing finger. On the contrary, the patterns of use and "pushing" are changing rapidly. In the past, most heroin was used by male, urban ghetto dwellers. Now many young, suburban men and women are using this drug.
>
> In years past, marihuana was considered prevalent only among populations of disadvantaged individuals—such as the Mexican American community—and among jazz musicians and the like. Now marihuana smokers penetrate the middle and upper income families as well (United States Congress—1970f, p. 33306)

And, Representative Sisks:

> The insidious menace of drug abuse is growing at an alarming rate across our Nation. It knows no particular geographic boundary nor does it prey on any one particular socioeconomic group. While the uninformed may equate drug abuse with the ghetto and minorities, studies show that it is a problem that has touched the sons and daughters of some Members of Congress as well as other leading members of the business, industrial, and political community of these United States (United States Congress, 1970)

Congress adopted the stance taken by President Nixon that, stopping this epidemic of drug use among the "cream of American youth" was of the highest priority. However, it was frequently noted that the then present cure was in many ways worse than the disease. Members of Congress believed, and cited newspaper reports and arrest statistics as evidence, that one consequence of youthful drug use was the turning of the tools of law enforcement (traditionally used to keep "social inferiors" in line) upon the children of the dominant middle class. Such punishment was not regarded as appropriate for this class of drug offenders. Referring to the innocence of drug-using upper status youth, Senator Dodd of Connecticut summarized the views of the majority of his colleagues:

> What concerns me the most is that thousands of these people arrested for one drug offense or another are not hardened criminals leading lives of lawbreaking and violence. They are not even the hardened drug addicts that used to be the main problem in the slums and ghettos of our larger cities. They are college students, often children of parents who suffer from no lack of opportunity in the economic and educational sense. Quite often they are young people on the road to professional careers as lawyers and teachers. Indeed, today, there are even cases of young school teachers, college professors and ministers being arrested on drug charges.
>
> . . .
>
> Our reaction has often been to do little more than increase the penalties for drug violations. We make new criminals out of a large number of people whose only lawbreaking has been in connection with drug use in response to some personality inadequacy or weakness or disenchantment with the way of life that exists in America today.
>
> . . .
>
> I think we must be most cautious in processing this new legion of drug and narcotic offenders through our present criminal justice system.
>
> We must be careful that we do not send too many to our so-called "correctional institutions" where it is now obvious they will get worse rather than better (United States Senate, 1969, pp. 2-4).

This theme was echoed repeatedly throughout committee hearings and floor debates in both houses of Congress.

Education and research aimed at prevention of drug abuse, and rehabilitation for those who had fallen prey to their own illness, weakness, or gullibility, were the agreed-upon long-run answers to the drug problem. However, something had to be done immediately before even more of the, otherwise innocent, "cream of American youth have their futures and careers ruined because of an arrest for marihuana. . . " (United States Congress, 1970b, p. 993).

To solve the problem, some legislators called for decriminalization or legalization of those drug offenses most often committed by middle class youth; primarily, possession of marihuana. For a variety of reasons, the majority of Congress found this solution unacceptable. Chief among the reasons was a concern for preservation of the expressive functions of the law as a statement of proper values. It was argued that having some penalty, however lenient, would be a signal to young people that the controlled drugs are dangerous and that society does not approve of their use. On the other hand, in the words of Administration spokesperson Ingersoll, legalization of marihuana, or further reduction in the marihuana penalties, "would place the government in a position of implicit toleration of the abuse of the drug which we do not want to do" (United States House of Representatives, 1970b, p. 114).

Congress also went to some lengths to emphasize the instrumental value of maintaining a possession offense. Referring to the testimony of witnesses from law enforcement, legislators argued that eliminating the possession offense would seriously handicap law enforcers in apprehending and arresting (1) addicts who were otherwise criminals (those who support their habit through theft or perpetrate violence upon law abiding citizens) and (2) professional traffickers—those most culpable of drug law violators. Captain Mueller of the Chicago Police Department stated the case regarding the addict criminal:

> Many of these addicts that are arrested for possession are criminals; they are a menace to themselves and to society, and we are fortunate to get them before the court with the possession charge, and not implying that that is all they are guilty of. To support their habit they may be doing other things: I do believe that addicts are sick people, and as a result of their illness they become criminals, and anything that can be done to reduce the number of criminals we would greatly appreciate [United States Senate, 1969, p. 484].

The argument for retaining the possession offense in enforcing the law against traffickers was twofold. First, it was noted that the relative ease of proving possession as compared to more serious drug offenses, sometimes renders possession the only basis of incarcerating traffickers and big time users. Second, it was argued that the possession penalty could be used as vehicle in building cases against major traffickers. By holding out the threat of imprisonment for possession, prosecutors and police can extract information from individuals and turn them into useful informants that provide a convenient first rung up the ladder to big dealers. (See Sonnenreich et al., 1973 for an elaboration of this idea.)

Although Congress was not amenable to decriminalizing possession offenses (even for marihuana), there was virtually no opposition to lowering penalties for such crimes. One of the stated advantages of this approach was the protection of youth from the throes of the criminal justice system. Youthful offenders were perceived as those most likely to be hurt by stiff possession penalties.[5] By reducing such penalties and providing special first-offender treatment (which, upon expungement of records essentially negates the conviction), the negative effects upon this class of offenders would be minimized. At the same time, the expressive and law enforcement advantages of having a possession offense would be preserved.

Reduction of possession penalties was also viewed as one way of dealing with the rebellion and alienation of youth. Congress was aware that in the eyes of American youth the entire legal system suffered a very serious credibility gap, owing to (1) youth's recognition that drug laws, particularly possession laws, are either unenforceable or only selectively enforced; (2) the perceived hypocrisy of adult authority systems that penalize illegal use of some mood-altering substances (e.g., drugs) and not others (e.g., alcohol); and (3) the perception of drug laws, especially those related to marihuana, as inherently unjust. Representative Koch of New York summarized the implications for law enforcement:

> To be operative the law requires an implicit trust of its validity by the people—and when this trust breaks down, so does the law. And no amount of penalty can hold up a law that is unjust or deemed to be unjust by the population. Basically, this is what has happened in the pot revolution on our campuses. The students have experimented with pot and their experience has not corresponded with the description used by those who enacted the severe penalty in the law. So, the force of the penalties as a deterrent has crumbled, the use of marihuana has soared, and the law is clearly no longer effective in providing what restrictions over the use of marihuana may in fact be needed [United States Senate, 1969, p. 563].

Members of Congress and Administration spokespersons argued that the new penalty structure (with its lower possession penalties) would increase the credibility, and thereby, the enforceability of the law.

In a more general sense too, the reduction of penalties for possession may have been symbolic: intended as a concession to youth, and others, disaffected with the Vietnam War, law enforcement, "the Establishment," those over 30, traditional values, and other features of American life. As Rosenthal (1977, p. 69) notes, "reducing the penalties for possession of drugs and transfers of small gifts was perhaps the simplest way to make concessions to the dissatisfied; it was certainly simpler, for example, than ending the War."

In short, in its own eyes, with one provision Congress was able to (1) minimize the danger of involving the "cream of American youth" in the criminal justice system; (2) symbolize the disdain of Americans for illegitimate and nonmedical use of drugs; (3) remove or reduce one possible source of alienation of American youth; and (4) provide a handhold against the criminal addict, and pushers who are difficult to arrest because of their insulation from street traffic. Further, these goals had been achieved largely without dissension or division of opinion among the ranks of Congress, and with the approval of civil libertarians and representatives from the fields of law enforcement, medicine, and various scientific communities.

Since protecting and appeasing middle and upper class youth seemed to be the prime objective of legislators in reducing possession penalties, and since Congress believed marihuana to be the main drug of abuse among these youth, a question arises regarding why harsher penalties were not imposed for possession of drugs regarded as more dangerous (e.g., heroin). Although there was substantial disagreement on the relative and absolute harmfulness of marihuana compared to other drugs, Congress did distinguish between marihuana and other substances in deciding to treat the distribution of small amounts of marihuana (but not other substances) for no remuneration as a misdemeanor. Further, since opiate drugs and cocaine were presumed to be used primarily by drug offenders from subordinate populations, stiffer penalties for possession of these drugs would not have placed middle class youth at any additional risk of criminalization. Still Congress chose not to rely upon the distinction between marihuana and other types of drugs in setting penalties for possession offenses. There are a number of possible explanations.

First, Congress may have anticipated that youthful offenders might occasionally use more dangerous substances than marihuana. Thus, they could be faced with the greater penalties if the law was administered evenhandedly. Second, prescribing the same penalty for possession of any controlled substance may simply have reflected the symbolic nature of the possession offense. Since Congress intended that federal law enforcement efforts be concentrated on illegal suppliers rather than possessors, the level of the possession penalty, whatever the substance, was not very important, so long as it was high enough to indicate disapproval of nonmedical use of drugs.

A third possibility is that by keeping penalties very light for possession of dangerous drugs (e.g., stimulants, depressants, other hallucinogens), Congress avoided a collision course with the drug industry. In congressional hearings, the drug industry was relatively silent on the question of criminal penalties. Still, it was clear that the industry was very much opposed to the attachment of severe penalties for possession of widely used medicants. Like all other parties, they welcomed the severe punishment of those (i.e., pushers) who would induce drug abuse by others, particularly if they did so for profit.

Fourth, the across-the-board penalties for possession may have been Congress' way of handling the problem of the addict. Although Congress clearly believed that narcotic addicts were responsible for the large increases in property and violent crime in the nation, most did not take as hard a line as Chicago Police Captain Mueller presented earlier. As indicated, and despite their presumed social backgrounds, in the social context surrounding the enactment of the 1970 Act, addicts were seen as victims of "pushers" or their deprived social conditions, and as sick people in need of intensive rehabilitation rather than punishment. Maintenance of a possession offense provided sufficient legal resources for arrest of the addict; and removal of mandatory penalties (see the discussion below) provided sufficient flexibility to permit judges to steer the addict into rehabilitation. Finally, the relatively "soft" penalties for possession of even the most dreaded of controlled substances (e.g., the addictive narcotics) may have been a compromise strategy aimed at facilitating the maintenance of a repressive approach to drug control, while conceding a minor victory to those who would have protested too loudly against a strictly law enforcement approach to the problem.[6]

The reduction of possession penalties was one answer to dealing with the drug involvement of upper status youth. The elimination of mandatory penalties for most traditional drug crimes was another. Doing so, however, was justified mainly on law enforcement grounds. Representative Bush of Texas aptly summarized the wishes of Congress to eliminate mandatory minimum penalties for drug offenses:

> The bill eliminates mandatory penalties, except for professional criminals. Contrary to what one might imagine, however, this will result in better justice and more appropriate sentences
>
> Philosophical differences aside, practicality requires a sentence structure which is generally acceptable to the courts, to prosecutors, and to the general public. H.R. 18583 [the original House version of the bill that was eventually enacted] does this in several ways. Elimination of the mandatory minimums is one, and, and at the other end of the scale, severe maximums with mandatory minimums for the true professional is another. In between, penalties are graduated and flexible to cover the type of offense and type of offender.
>
> As a result, we will undoubtedly have more equitable action by the courts, with actually more convictions where they are called for, and fewer disproportionate sentences [United States Congress, 1970f, p. 33314].

In sum, in the name of achieving greater law enforcement, more equitable justice in courts, and preserving traditional American values of fitting the punishment to the crime and the criminal, Congress eliminated almost all mandatory penalities during a major drug crisis. In the meantime, the combination of discretionary penalty provisions, the reduction of first offense possession and selling of small amounts of marihauna to misdemeanors, and the provision of special first-offender treatment including expungement of records after a period of good behavior, facilitated the protection of middle and upper class youth from criminal stigmatization, and provided a symbolic offering of appeasement to the alienated among them.

DEALING WITH PUSHERS

As indicated, in the politics of deviance defining during the late 1960s and early 1970s, pushing drugs rather than drug use became the *sine qua non* of the drug problem. Pushers, especially large-scale dealers, were regarded as evil, corrupters of youth, and as ultimately responsible for the drug-related crimes of addicts. Throughout legislative debates, stress was placed on cracking down on this menace to society. Thus, in addition to the liberalizing provisions of the 1970 Act, the bill included a number of features geared toward control of this target population of "enemy deviants." Before proceeding, it should be noted that unlike users, pushers were not differentiated along race and class lines. While it is generally recognized that drug trafficking is racially and ethnically stratified (Ianni, 1974), the only relevant distinctions made in Congress were those between white middle class youth and other users, between users and pushers, and between small- and large-scale dealers.

Among the most coercive features of the Act are the enforcement provisions, and the extreme penalties provided for new categories of drug offenders (i.e., the continuing criminal enterprise and dangerous special drug offender provisions). These features of the 1970 Act are discussed below. Presently, we explain briefly why Congress did not regard the elimination of mandatory minimum penalties and the reduction of maximum penalties for traditional trafficking offenses as counterproductive to cracking down on major federal drug dealers.

We have already indicated that the elimination of mandatory penalties was viewed as necessary for the protection of middle class youth from the negative consequences of criminal drug control. In addition, this could be justified on the grounds that discretionary sentences would facilitate, rather than hinder, punishment of serious drug offenders because the resulting sentences would be more acceptable to the courts and prosecutors.

The reduction in maximum penalties for trafficking offenses is not as easy to explain. Such reductions were not the subject of controversy in either house of Congress. Nonetheless, we would not interpret the penalty reductions for pushers as an indication that Congress was in any way softening its attitude toward traffickers. To the contrary, the altered penalty structure did not reduce substantially the possibility of spending a large portion of one's life behind bars for distributing a controlled substance. One could still be imprisoned for as many as 15 years for first-offense distribution of heroin, where previously the maximum jail term was 20 years. Also, by imposing a mandatory special parole term onto the term of imprisonment received for trafficking, Congress extended the right of the state to intervene in the offender's life after release from prison. Also, the special parole term is not a substitute for regular parole; it begins after regular parole expires. In the case of parole revocation while serving a term of special parole, the original prison sentence is increased by the period of the special parole term, and time spent on parole does not diminish the penalty. Clearly, these provisions indicate that Congress was not "softening" its attitude toward the drug trafficker.

The features of the 1970 legislation which most clearly reveal Congress' coercive approach to traffickers are the provision of special extreme sanctions for those engaged in a continuing criminal enterprise (professional traffickers) and for dangerous special drug offenders. Persons found guilty of the continuing enterprise provision are subject to a mandatory penalty of from ten years to life imprisonment without the possibility of parole, probation, or suspended sentence. Dangerous special drug offenders could receive an additional 25 years of imprisonment for the violation of an offense that might otherwise net only a few years of confinement. Significantly, amendments establishing these offenses were passed overwhelmingly despite strong arguments questioning their constitutionality. Conversely, proposals attempting to eliminate or modify these amendments were defeated soundly.

Opponents questioned the necessity of these provisions, and in the case of professional traffickers, the wisdom of mandatory penalties in light of their questionable efficacy as law enforcement tools. However, opponents' main objections were to the imposition of these very severe penalties without full due process of

law. Representative Eckhardt of Texas summarized the position of those opposed to the continuing criminal enterprise provision:

> It is extremely important that minimum mandatory penalties be taken out. This is one of the recommendations of the American Bar Association's Committee studying the questions of criminal process. The argument, of course, is quite simple, and that is this: when the jury is confronted with a case in which if it finds the defendant guilty, the penalty must automatically be 10 years or more it may hold the accused not guilty because, under the circumstances, it feels that the mandatory penalty is too high.
>
> . . .
>
> The other difficulty is that the maximum penalty involved here is life. Given a situation in which someone is considered anathema in the community for reasons other than those involved in the offense and in which he can be got out of the way for life on the basis of passing marihuana cigarettes and maybe buying a $50 stash and distributing it, that man, because he is thought to have engaged in other activities that cannot be proven and perhaps are not true, can be removed from society for life by the judge issuing the sentence [United States Congress, 1970g, p. 33627].

Proponents of the measure (Representative Hunt of New Jersey, for example) countered as follows:

> There is nothing wrong with imposing a mandatory sentence on a hard headed pusher. Mitigating circumstances should not apply to a person of this nature. The only way you can handle narcotics and get rid of the situation is to incarcerate those main pushers and help those who have unfortunately become addicted [United States Congress, 1970g, p. 33629].

Congressman Poff of Virginia proposed the special dangerous drug offender provision of the 1970 Act as a complement to the continuing criminal enterprise section. The rationale was to give prosecutors the option of approaches, and to strengthen the statutes against possible constitutional attack. In Poff's words:

> With a maximum additional sentence of 25 years for offenders falling within the purview of this amendment, we can accomplish much today in assuring that society is rid of devastatingly evil forces who reap the fruits of drug traffic [United States Congress, 1970g, p. 33630].

Significantly, proposals attempting to eliminate or modify these amendments were defeated soundly, while the amendments establishing the offenses were passed overwhelmingly despite the arguments questioning their constitutionality. Following the adoption of the Poff Amendment, Representative Ryan summarized the sentiments of the opposition:

> Perhaps most perilous, an amendment has been adopted today for the sentencing of so-called dangerous special drug offenders which simply refutes the very basics of due process which have marked ours as a system of rule by law and not by arbitrary men.
>
> . . .
>
> But let me be blunt and say that this amendment is a subterfuge designed to allow the Government to incarcerate the defendants whom it cannot prove beyond a reasonable doubt have engaged in the past acts which will be taken into account in the hearing. This hearing, disguised as a procedure for sentencing is in fact, an unconstitutional trial on the issues of guilt, which only need be proved by a preponderance of the information and which is divested of the rules of evidence which attend a trial [United States Congress, 1970g, p. 33661].

In brief, Congress seemed quite eager to enact coercive measures to deal with the presumed source and symbol of the drug problem. Indeed, in their enthusiasm to punish traffickers, the legislators enacted amendments that bordered on being unconstitutional in violation of due process guarantees, and which at the very least failed to provide the defendant with a reasonable chance to establish his/her innocence. It should be noted that the difficulty of establishing proof that defendants are professional traffickers or especially dangerous could result in minimal use of the above two provisions (Sonnenreich et al., 1973). If so, then, despite the severity of the prescribed penalties, the provisions may be more symbolic than instrumental, providing a public statement and sound warning that society takes a dim view of drug trafficking and will not tolerate such activities.

ENFORCEMENT: THE NO-KNOCK PROVISION

Also indicative of Congress' intent to maintain a coercive approach to the drug problem are the enforcement powers and supplementary civil sanctions entrusted to the United States' Attorney General. King (1972, p. 318) has summarized the provisions most directly related to criminal law enforcement:

> The Department of Justice may use Treasury funds to hire informers, pay for incriminating information, and make purchases of contraband substances, with any sum or sums the Attorney General "may deem appropriate." All property connected in any way with a violation of the Act, . . . such as raw materials, equipment, packing and shipping containers, and aircraft, vehicles, or vessels used for transportation, are subject to seizure by the Attorney General and forfeiture to the United States. And in addition to the powers usually conferred on federal law enforcers, drug agents may act as compliance inspectors, make arrests for any offense against the United States, seize on sight any property they regard as contraband or forfeitable, and execute search warrants at any time of the day or night, with the controversial "no-knock" procedures if a judge has authorized it."

These and other enforcement provisions led King to conclude that the "proponents of 'soft' attitudes toward drug abuse have been routed, and the new federal drug police force has been given every armament and prerogative that could conceivably be conferred on a peacetime domestic agency" (King, 1972, p. 319).

To carry out the provisions of the Act, the Bureau of Narcotics and Dangerous Drugs was authorized to add at least 300 agents to its existing enforcement staff for the following year. An annual appropriations of $6 million dollars for the purpose of staffing beginning in fiscal 1971 was also authorized.

Enforcement provisions of the law met with little opposition in either House of Congress. The no-knock provision was an exception. In fact, the provision of no-knock authority was probably the most controversial provision of the entire bill (Sonnenreich et al., 1973). Proponents of no-knock argued that it was necessary to avoid quick disposal of controlled substances by suspects, and to avoid placing officers in danger of physical harm. They also noted that no-knock authority was provided for by common law or statutory law in at least 32 states, had withstood Constitutional tests, and, that in places where no-knock was available it had neither been overused or abused.

In contrast, the many opponents of no-knock argued, that such a provision was: unnecessary, already available in the law, subject to easy abuse especially in an era of considerable concern about drug abuse, and, a bad precedent to set in a free society that values the sanctity of privacy. However, as in the case of the provisions discussed above, the main arguments against no-knock authority had to do with its questionable constitutionality. Senator Ervin of North Carolina, the most adamant opponent of no-knock, argued the case:

> Mr. President, when we pray the Lord's Prayer, we make this petition to the Almighty. "Lead us not into temptation." I think that this petition impliedly commands us not to lead others into temptation. And yet we have a Senate bill that will lead the law enforcement officers . . . to make false affidavits in order to obtain search warrants which would enable them to enter the private homes of American citizens like thieves in the night without notice and without warning.
>
> One of the strangest things is why the representatives of a free society are always trying to convert that free society by legislation into a police state. That is precisely what is being attempted on this occasion. My associates and I are attempting to save one of the basic freedoms of the American people, the right not be disturbed in their homes by an unreasonable search and an unreasonable seizure [United States Congress, 1970c, pp. 1159, 60].

Proposals by Senator Ervin to strike this provision of the bill were defeated soundly in the Senate, and no-knock authority was included as a provision of the 1970 Act. As with the continuing enterprise and the dangerous special drug offender provisions, Congress was willing to risk possible constitutional violations to achieve more coercive drug control.

SUMMARY AND CONCLUSIONS

On October 27, 1970, President Nixon signed into law the Comprehensive Drug Abuse Prevention and Control Act. That Act made significant changes in the federal approach to drug control, including establishment of a new and more complex set of penalties for violations of federal drug laws. Significantly, the new legislation was enacted during a period when public concern about drugs was high, and when Congress and the Administration believed that drug abuse, and its consequences (primarily street crime, violence, drug-related deaths, etc.), were on the increase. Further, for the first time in the history of federal drug control, drug use among superordinate as well as subordinate segments of the population was viewed as a significant part of the problem.

Throughout the twentieth centruy, Congress had responded to apparent changes in the levels and distributions of drug use simply by increasing criminal penalties (or establishing them where none existed to cover a particular type of drug use). In the present case, this rather straightforward but coercive solution would have placed higher status groups at risk of criminal stigmatization and its presumed negative consequences. On the other hand, the simple lowering of penalties, as state courts have done in the face of greater drug use by reputable population segments, would have implied societal toleration or approval of drug use, and may have undermined the instrumental goals of reducing illicit drug use and associated problems (e.g., street crime and violence) by all segments of the community. The dynamics of the process through which Congress constructed a general law that would (1) deal with the drug-related behaviors of both subordinate and superordinate groups and (2) communicate societal disapproval of illicit drug use was the major focus of this discussion.

To address this question, a detailed analysis of congressional committee hearings and floor debates on the pending legislation was conducted. Our review of the congressional materials has led to the following general conclusions. First, Congress did not choose a strictly coercive approach to drug control at the risk of stigmatizing middle and upper status white offenders. Nor did it choose to liberalize across the board federal drug penalties in light of the rise in drug crimes among superordinate population segments. Instead, Congress redefined the drug problem as one of pushing drugs rather than using them, and developed a law oriented toward "saving" users (especially upper status youth) and punishing pushers, whatever their social backgrounds. Thus, in enacting the 1970 penalty provisions, Congress was concerned primarily with two target populations: young middle and upper class drug users, and hardcore traffickers and professional drug criminals. The former required protection from the criminal justice system; the latter required both the threat and actuality of severe punishment.

The penalties and other provisions that emerged from congressional debate reflect the compromises reached to deal with these two distinct populations. The reduction of penalties for first-offense possession and for distribution of small amounts of marihuana for no remuneration to misdemeanors; removal of mandatory minimum penalties; and the provision of special first-offender treatment, all served to minimize the possibility of subjecting middle and upper class youth to harsh penalties, and their presumed negative consequences. On the other hand, retention of a possession offense (albeit with very lenient penalties); the relatively minor reductions in maximum penalties for trafficking offenses; provisions of mandatory special parole terms; provision of extreme sanctions for two new offense categories of questionable constitutionality; and the supplementary criminal enforcement provisions provided the coercive policies required for handling (and warning) the second targeted population—major drug traffickers.

Although the downgrading of federal drug penalties was clearly motivated by the desire to protect upper status youth from criminal stigmatization, Congress was unwilling to liberalize penalties at the cost of effective law enforcement. Thus, the downgrading of all penalties, even for possession, was justified partially in terms of providing better justice and more efficient law enforcement. For example, the elimination of mandatory penalties was justified on the grounds that in so doing the punishment of serious drug offenders would be furthered (more certain) rather than hindered.

Some provisions of the 1970 Act were as much symbolic as they were instrumental. For example, retention of a possession offense within the federal code was, in large part for the purpose of indicating a lack of acceptance of indiscriminate or nonmedical use of controlled substances. Also, the reduction of penalties for possession was in part a symbolic gesture to youth believed to be alienated from the legal system and society in general. Congress hoped that in making such a concession the credibility of law enforcement would be restored; and, one source of youth's disaffection with the American way of life removed.

In short, the above findings would seem to establish that penalty, and certain other provisions of the 1970 Act were a result of compromises which permitted Congress to (1) maintain a coercive approach to the drug problem for the purpose of dealing with one target population—major traffickers; (2) protect middle and upper class youth from stigmatization as criminal felons; (3) provide a symbolic gesture (an offer of appeasement) to disaffected youth believed to be alienated from the criminal justice system, and society in general; and (4) express congressional and societal condemnation of indiscriminate and nonmedical use of controlled substances.

Regarding discrimination, our examination of the statute and the decision-making process suggests that the discriminatory aspects of the legislation are limited to those provisions which minimize the consequences of criminal drug behavior for upper status youth. As indicated, in congressional debate legislators were very explicit that protection of this class of offenders was a major goal. Distinctions among drug offenders were made on the basis of their age, class, and social status. And, it was often suggested or implied that the same kinds of penalties ought not be applied to the "cream of American youth" as had been applied to conventional and less reputable types of drug users. Importantly too, the legitimacy of the above distinction was never called into question.

While race, class, and ethnic bias is apparent in Congress' characterizations of the nature of the drug problem, drug users from subordinate populations would seem to be beneficiaries, albeit unintended, of the more lenient penalties for possession offenses. An alternative scenario is possible, however. Since the downgrading of federal drug penalties was motivated almost exclusively by the desire to protect upper status youth from criminal stigmatization, the substitution of discretionary for mandatory penalties actually may have increased the likelihood of race- or class-based decisions in the application of sanctions. No longer would convicted defendants from different social backgrounds be subject to the same minimum penalties for illegal possession of drugs. Thus, in the face of persistent biases in the perception of drug users, and, in light of the presumed connection between drug use among conventional offenders and street crime, minorities and low-income defendants convicted of possession could be the recipients of substantially more severe sentences (e.g., imprisonment versus probation or fines) than their youthful upper status counterparts.

Discriminatory decision making was not evident in congressional discussions related to dealing with drug-trafficking. There were no references to the racial, ethnic, or class composition of this offender group. Indeed, the only major distinction drawn was that between small-scale and major dealers, with the latter types of offenders essentially becoming the scapegoats for the entire drug problem. Again, I would caution the reader that the absence of discriminatory intent does not mean that the law will be applied in an unbiased fashion.

With the provision of discretionary penalties, and especially during eras in which politicians and the public call for a crackdown on drug traffickers, minority and low-income defendants could indeed bear the brunt of state social control of drugs. Particularly telling would be a situation in which minorities, who are generally confined to the lower levels of the drug trade, receive sentences for trafficking that are significantly more severe than those received by their counterparts with majority status. Elsewhere (Peterson & Hagan, 1984) we have attempted to assess the role of race and class in sentencing decisions during periods prior to and following the passage of the 1970 Act. Our findings there, as well as in the present research, suggest that discrimination in the law is more complicated than a simplistic application of conflict notions of legal decision making might suggest. More generally, our research suggests that studies examining the role of power, status, and class in legislative decision making, followed by, or in combination with, studies of the role of such variables in the application of the law will make possible a greater understanding of (1) the process of legislative decision making, (2) the extent to which people of different race, class, and ethnic backgrounds are protected and/or punished equally in our justice system, and (3) the relative merits of Kleck's (1981) argument that legislative decision making may have more to do with differential patterns of arrest, court, and prison statistics than criminal justice processing. To understand the complexity of interests involved in lawmaking, it is also suggested that future research consider laws that are complex, and that have implications for the interests and values of a variety of population segments, including upper status groups.

REFERENCE NOTES

1. Under the 1970 Act, abusable substances are classified into five schedules based upon their dangerousness and potential for abuse. Restrictions and penalties are downgraded as one moves from controlled substances in Schedule I (e.g., hardcore illicit narcotics such as heroin, and the hallucinogens—including marihuana and LSD—for which there is no currently accepted medical purpose) to those in Schedule V (e.g., all the exempt narcotic preparations—e.g., cough syrups—which may be sold over the counter without a prescription).
2. Cracking down on drug abuse and trafficking and related street crime was a major part of the Nixon Administration's law and order agenda.
3. The continuing criminal enterprise provision is aimed at the importer of controlled substances and high-level drug dealers who command a drug distribution network. Specifically, a person is considered to be engaging in a continuing criminal enterprise if she or he (1) commits a felony which is part of a continuing series of drug offenses, (2) acts in concert with at least five other persons to commit these offenses, (3) commands some organizational or supervisory position with respect to the group, and (4) obtains substantial income from the enterprise. Notably, this is the only offense under the 1970 Act which involves a mandatory sentence and which does not permit suspended or probated sentences.
4. A defendant who is over 21 years of age and has been convicted but not yet sentenced for a drug felony can be declared a dangerous special drug offender in a separate judicial hearing prior to sentencing. A dangerous special drug offender is defined as one who (1) has been previously convicted on two or more occasions of a felony violation of the federal or state drug law and who has been sent to prison for one or more of those offenses, unless more than five years has lapsed between the present offense and defendent's release from prison or the defendant's commission of the last previous offense, or (2) has been guilty of deriving a substantial source of income from a pattern of dealing in drugs and manifests special skill or expertise in that dealing; or (3) in relation to his/her violation, is involved in a conspiracy with three or more other persons to deal in controlled substances and the defendant acted, or agreed to act, to direct such conspiracy or to give or receive a bribe, or to use force in connection with such dealing. Notably, the government only has to establish that one is a special drug offender by a preponderance of the *information* rather than by the usual and more stringent beyond a reasonable doubt standard.
5. In one sense, maintaining penalties for possession offenses may have been of purely symbolic significance. Congress members and witnesses emphasized on a number of occasions that federal enforcement efforts (money and personnel) had never been, and should not be, expended on small time users or even small time pushers (e.g., addicts who sold limited quantities of drugs to supply their own habits). Dealing with such offenders had always been left to state and local authroties despite the offenses being violations of federal drug laws as well. By contrast, federal efforts have been, and it was noted should be, concentrated on the major illegal suppliers of drugs.
6. Some members of Congress were displeased with the overwhelmingly law enforcement focus of the entire bill. They preferred a research, education, and rehabilitation approach to the drug problem. Senator Hughes of Iowa was perhaps the most adamant supporter of a health rather than a law enforcement orientation to dealing with drugs. On the floor of the Senate, Hughes proposed a number of amendments that would have placed more emphasis on research, prevention, and rehabilitation. Most of these proposals were defeated by a large margin, but some concessions were granted. These were contained in "Title I—Rehabilitation Programs Relating to Drug Abuse" of the 1970 Act and consist of several amendments to the Community Mental Health Centers Act. Our point is, however, that the relatively "soft" penalties for possession of even the most dreaded of controlled substances (e.g., the addictive narcotics) may have been a compromise strategy aimed at facilitating the maintenance of a repressive approach to drug control, while conceding a minor victory to those like Senator Hughes, who would have been very displeased with a strictly law enforcement approach to the problem. If this is the case, then the penalty structure only coincidently benefited the addict.

REFERENCES

Becker, H. S. *The Outsiders*. New York: Free Press, 1963.

Bohannan, P. The differing realms of the law, in D. Black, and M. Milesk (Eds.), *The Social Organization of Law*. New York: Seminar Press, 1965, pp. 306–317.

Bonnie, R. J., & Whitebread, C. H. *The Marihuana Conviction*. Charlottesville, Virginia: University of Virginia Press, 1974.

Chambliss, W. J. A sociological analysis of the law of vagrancy. *Social Problems*, 1964, 12, 46–67.

Chambliss, W. J. *Crime and the Legal Process*. New York: McGraw-Hill, 1969.

Chambliss, W. J. Functional and conflict theories of crime. *MSS Modular Publications*. New York, Module 1973, 17, 1–23.

Chambliss, W. J. The State, the law and the definition of behavior as criminal or delinquent, in D. Glaser (Ed.), *Handbook of Criminology*. Indianapolis, Indiana: Bobbs-Merrill.

Chambliss, W. J., & Seidman R. *Law, Order and Power*. Reading, Massachusetts: Addison-Wesley, 1971.

Congressional Quarterly Almanac. *President Nixon's Message on Drug Abuse*. 91st Congress—First Session, 1969, 25, 57-A.

Durkheim, E. *The Division of Labor in Society*. Glencoe, Illinois: Free Press, 1964.

Friedmann, W. *Law in a Changing Society*. London: Stevens and Sons, 1959.

Galliher, J. F., McCartney, J. L., & Blum, B. Nebraska's marijuana law: a case of unexpected legislative innovation. *Law and Society Review*, 1974, 8, 441–455.

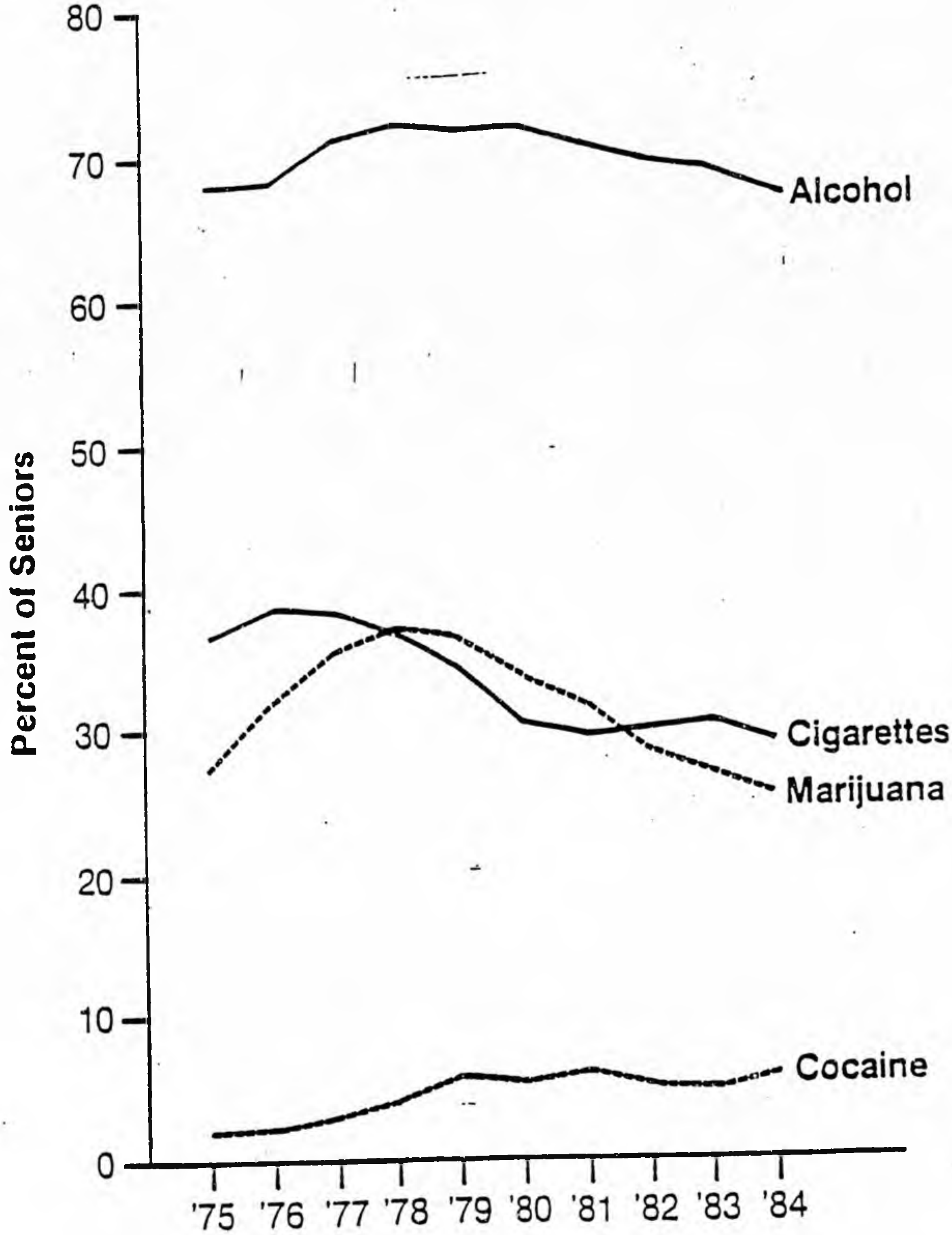
Galliher, J. F., & Basilick, L. Utah's liberal drug laws: Structural foundations and triggering events. *Social Problems*, 1979, 26, 284–297.

Galliher, J. F., & Pepinsky, H. E. A meta-study of social origins of substantive criminal law, in Krohn,

M. D., and Akers, R. L. (Eds.), *Crime, Law, and Sanctions: Theoretical Perspectives*, Beverly Hills: Sage Publications, 1978, pp. 27–38.
Gibbons, D. C. *Society Crime and Criminal Careers*. Englewood Cliffs, New Jersey: Prentice-Hall, 1982.
Glaser, D. Interlocking dualities in drug use, drug control, and crime, in J. Inciardi and C. Chambers, (Eds.), *Drugs and the Criminal Justice System*. Beverly Hills, California: Sage Publications, 1974.
Greenberg, S. M. Compounding a felony: Drug-abuse and the American legal system, in J. Inciardi, and C. Chambers, (Eds.), *Drugs and the Criminal Justice System*. Beverly Hills, California: Sage Publications, 1974.
Gusfield, J. R. *Symbolic Crusade*. Urbana: University of Illinois, 1963.
Gusfield, J. R. Moral passage: The symbolic process in public designations of deviance. *Social Problems*, 1967, 15, 175–188.
Gusfield, J. R. The (F)utility of knowledge?: The relation of social science to public policy toward drugs. *The Annals*, 1975, 417, 1–15.
Hagan, J. The legislation of crime and delinquency: A review of theory, method, and research. *Law and Society Review*, 1980, 14, 603–628.
Hall, J. *Theft, Law and Society*. Indianapolis, Indiana: Bobbs-Merrill, 1952.
Helmer, J. *Drug Use and Minority Oppression*. New York: Seabury Press, 1975.
Hopkins, A. On the sociology of criminal law. *Social Problems*, 1975, 22, 608–619.
Ianni, F. *The Black Mafia*. New York: Simon and Schuster, 1974.
King, R. *The Drug Hang-Up: America's Fifty-Year Folly*. New York: W. W. Norton Company, 1972.
Kleck, G. Racial discrimination in criminal sentencing: A critical evaluation of the evidence on the death penalty. *American Sociological Review*, 1981, 46, 783–804.
Lidz, C. W., & Walker, A. L. *Heroin, Deviance and Morality*. Beverly Hills: Sage Publications, 1980.
Musto, D. F. *The American Disease: Origins of Narcotic Control*. New Haven: Yale University Press, 1973.
National Parole Institutes. *The Control and Treatment of Narcotic Use*. Publication VII. The National Council on Crime and Delinquency, 1964.
Peterson, R. D., & Hagan, J. Changing conceptions of race: Towards an account of anomalous findings of sentencing research. *American Sociological Review*, 1984, 49, 56–70.
Quinney, R. *The Social Reality of Crime*. Boston: Little, Brown, 1970.
Quinney, R. *Criminology*. Boston: Little, Brown, 1975.
Reasons, C. The politics of drugs: An inquiry in the sociology of social problems. *Sociological Quarterly*, 1974, 15, 381.
Reasons, C. E., & Purdue, W. D. *The Ideology of Social Problems*. Sherman Oaks, California: Alfred Publishing, Co., 1981.
Roby, P. A. Politics and criminal law: Revision of the New York State penal law on prostitution. *Social Problems*, 1969, 17, 83–109.
Roby, P. A. Politics and prostitution: A case study of the revision, enforcement and administration of the New York State penal laws on prostitution. *Criminology*, 1972, 9, 425.
Rosenthal, M. P. The legislative response to marijuana: When the shoe pinches enough. *Journal of Drug Issues*, 1977, 7, 61–77.
Sinclair, A. *Prohibition: The Era of Excess*. Boston: Little, Brown, 1962.
Sonnenreich, M. R., Roccograndi, A. J., & Bogomolny, R. L. Commentary on the federal controlled substances act, in National Commission on Marihuana and Drug Abuse, *Drug Use in America: Problem in Perspective*. Washington, D.C.: United States Government Printing Office, 1973, pp. 169–239.
Susman, R. M. Drug abuse, Co[illegible]ress and the fact-finding process. *The Annals*, 1975, 417, 16–26.
Sutherland, E. H. The sexual psychopath laws. *Journal of Criminal Law, Criminology and Police Science*, 1950, 40, 543–554.
Taylor, I., Walton, P., & Young, J. *The New Criminology*. London: Routledge and Kegan Paul, 1973.
Taylor, I., Walton, P., & Young, J. *Critical Criminology*. London: Routledge and Kegan Paul, 1975.
Timberlake, J. H. *Prohibition and the Progressive Movement 1900–1920*. Cambridge, Massachusetts: Harvard University Press, 1963.

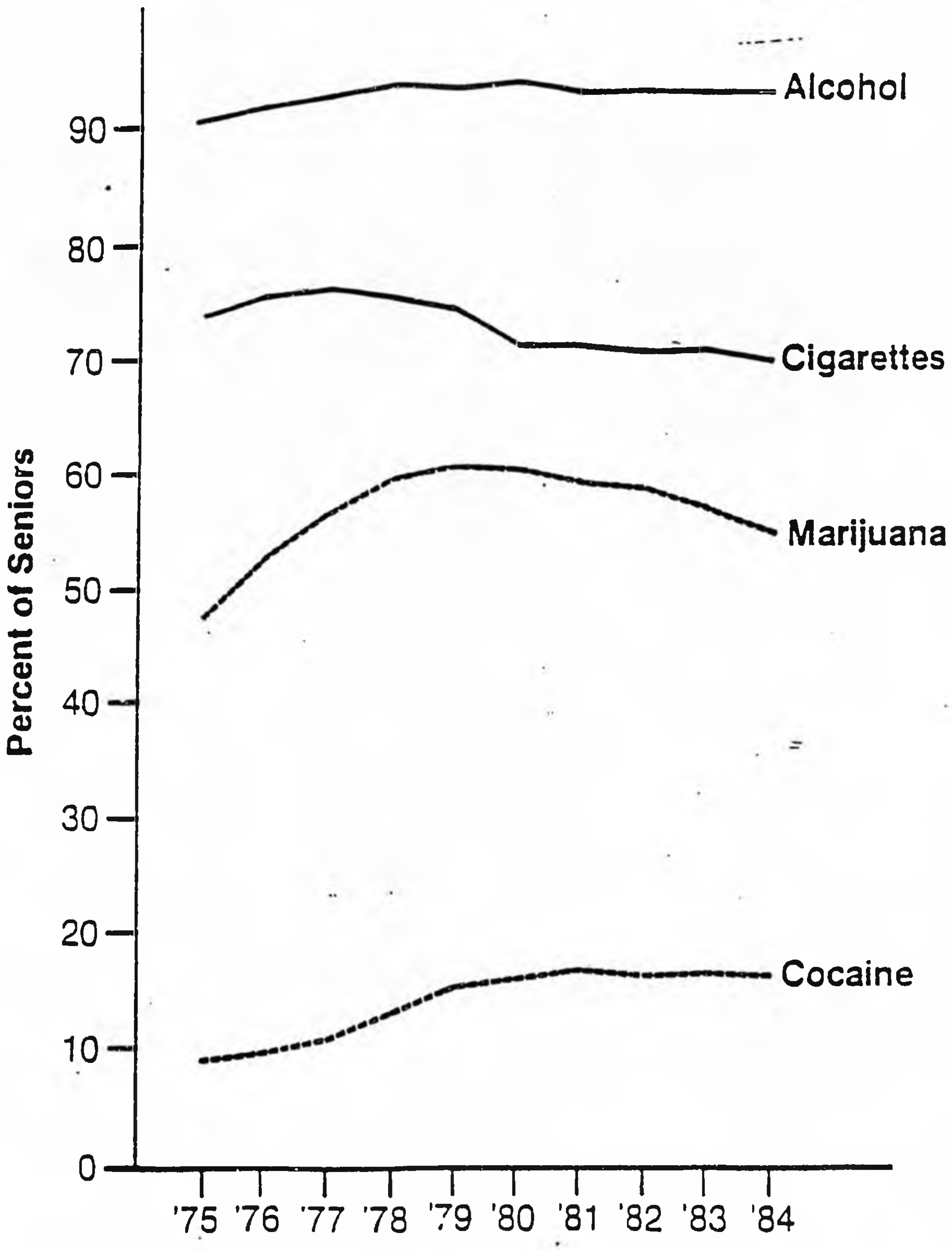
United States Congress. Act of November 2, 1951, Public Law 255—82nd Congress, Chapter 666 – 1st Session, H.R. 3490, 1951.
United States Congress. Narcotic Control Act of 1956, Public Law 728—84th Congress, Chapter 629—2nd Session, H.R. 11619, 1956.
United States Congress. Drug Abuse Control Amendments of 1965, Public Law 89-74, 89th Congress, H.R. 2, 1965.
United States Congress. Act of October 24, 1968, Public Law 90-639, 90th congress, H.R. 14096, 1968.
United States Congress. Comprehensive Drug Abuse Prevention and Control Act of 1970a. Public Law 91-513, 91st Congress, H.R. 18583, 1970a.
United States Congress. Congressional Record—Senate. Vol. 116 (daily ed. January 24, 1970b).
United States Congress. Congressional Record—Senate. Vol. 116 (daily ed. January 26, 1970c).
United States Congress. Congressional Record—Senate. Vol. 116 (daily ed. January 27, 1970d).
United States Congress. Congressional Record—Senate. Vol. 116 (daily ed. January 28, 1970e).
United States Congress. Congressional Record—House. Vol. 116 (daily ed. September 23, 1970f).
United States Congress. Congressional Record—House. Vol. 116 (daily ed. September 24, 1970g).
United States Congress. Congressional Record—Senate. Vol. 116 (daily ed. October 5, 1970h).
United States Congress. Congressional Record—Senate. Vol. 116 (daily ed. October 6, 1970i).
United States Congress. Congressional Record—Senate. Vol. 116 (daily ed. October 7, 1970j).
United States Congress. Congressional Record—House. Vol. 116 (daily ed. October 14, 1970k).
United States House of Representatives. *Controlled Dangerous Substances, Narcotics and Drug Control Laws*. Hearings before the Committee on Ways and Means, "Legislation to regulate controlled dangerous substances and amend narcotics drug laws," 91st Congress—2nd Session. Washington, D.C.: United States Government Printing Office, 1970a.
United States House of Representatives. *Part 1—Drug Abuse Control Amendments—1970*. Hearings before the Subcommittee on Pubic Health and Welfare of the Committee on Interstate and Foreign Commerce, House of Representatives, 91st Congress—2nd Session on H.R. 11701 and H.R. 13743. Washington, D.C.: United States Government Printing Office, 1970b.
United States House of Representatives. *Part 2—Drug Abuse Control Amendments—1970*. Hearings before the Subcommittee on Public Health and Welfare of the Committee on Interstate and Foreign Commerce, House of Representatives, 91st Congress—2nd Session on H.R. 11701 and H.R. 13743. Washington, D.C.: United States Government Printing Office, 1970c.
United States Senate. *Narcotics Legislation*. Hearings before the Subcommittee to Investigate Juvenile Delinquency of the Committee of the Judiciary, 91st Congress—1st Session. Washington, D.C.: United States Government Printing Office.

Current Use: Cocaine, Marijuana, Alcohol and Cigarettes Among High School Seniors



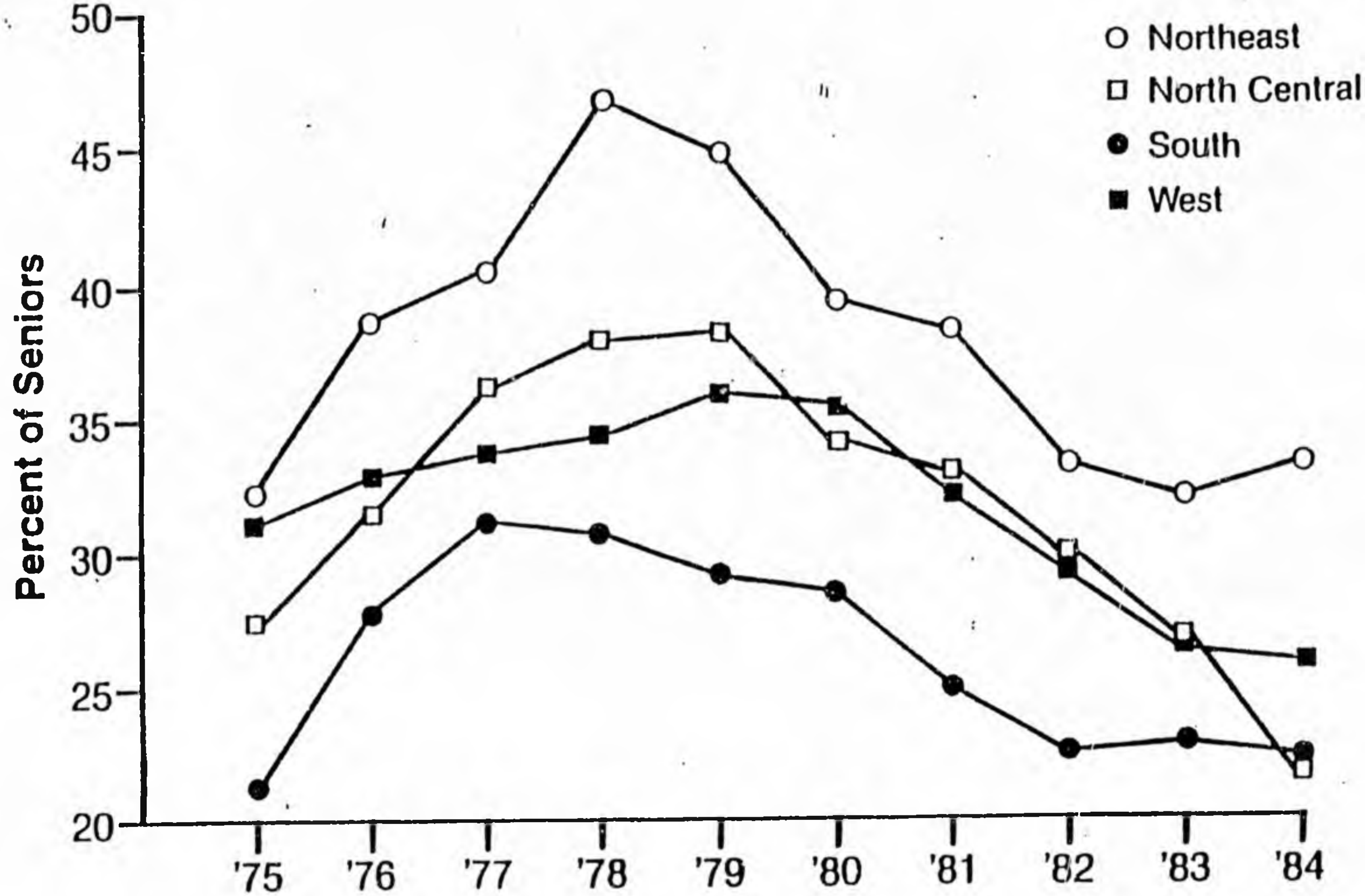
Note: Current use is defined as use at least once in past 30 days.
Source: NIDA. Monitoring the Future Study.

Lifetime Use: Cocaine, Marijuana, Alcohol and Cigarettes



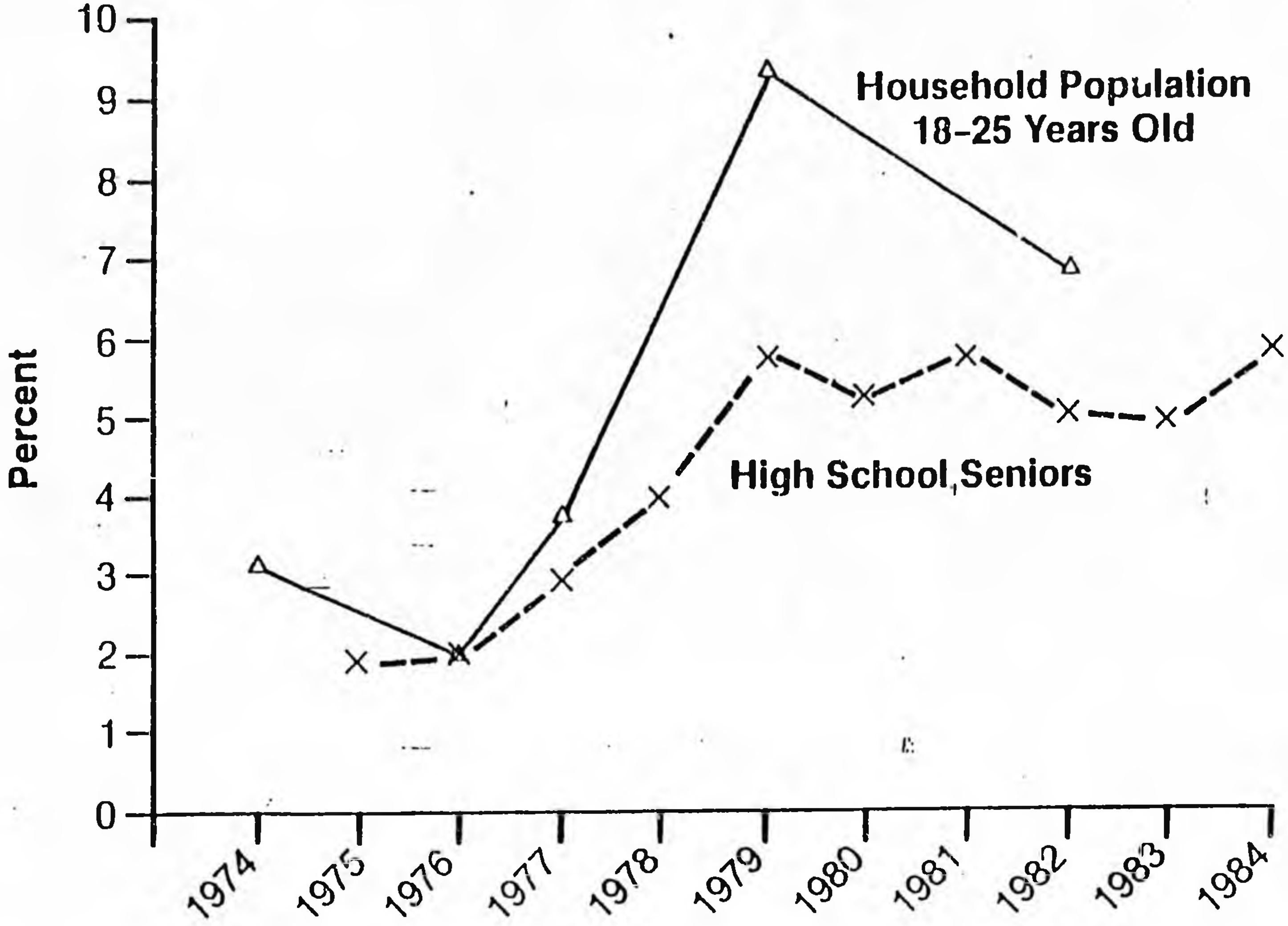
Source: NIDA, Monitoring the Future Study.

Current Use: Marijuana
Among High School Seniors According to Region



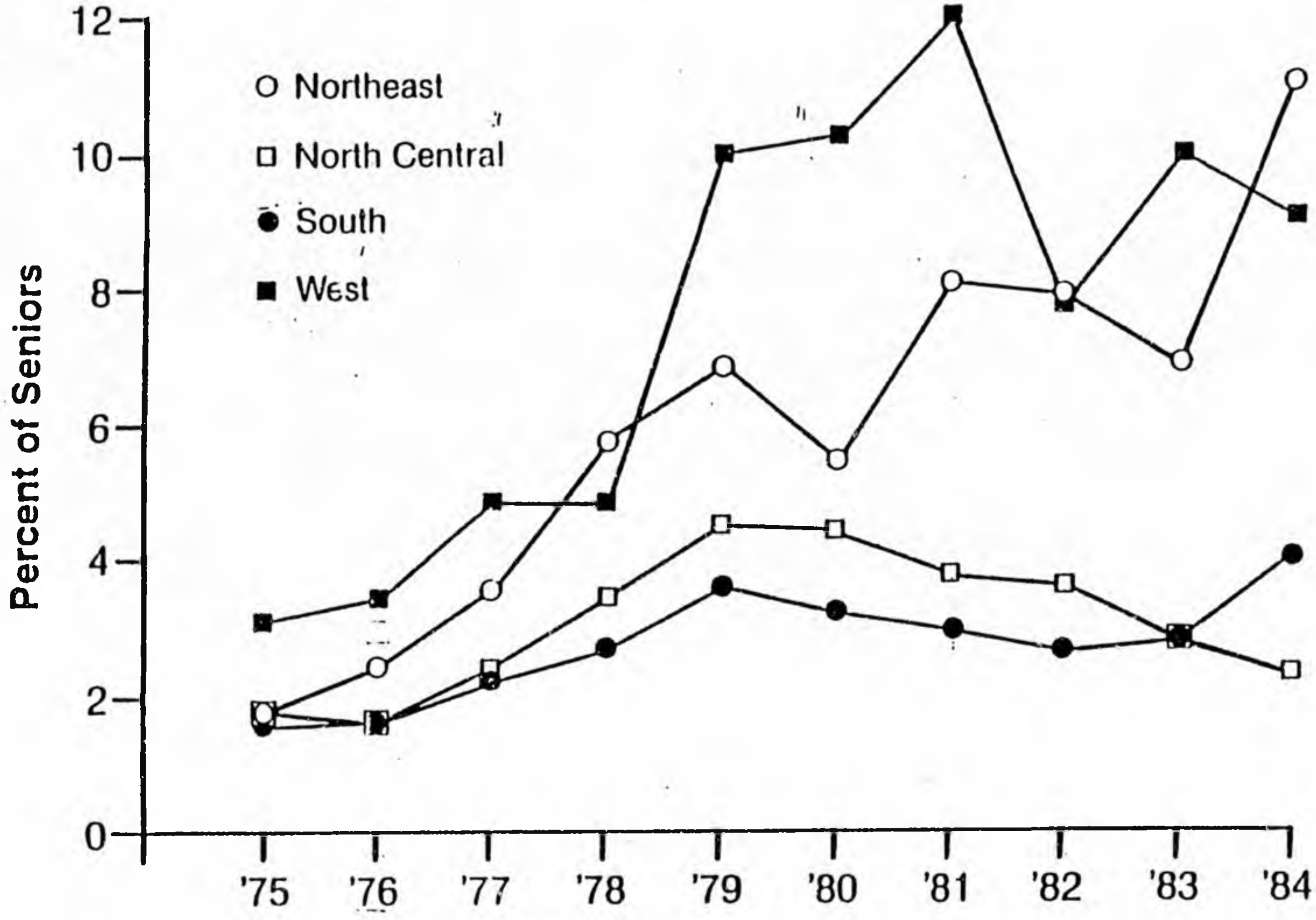
Note: Current use is defined as use at least once in past 30 days.
Source: NIDA, Monitoring the Future Study.

Current Cocaine Use, U.S. Household Population and High School Seniors, 1974–1984



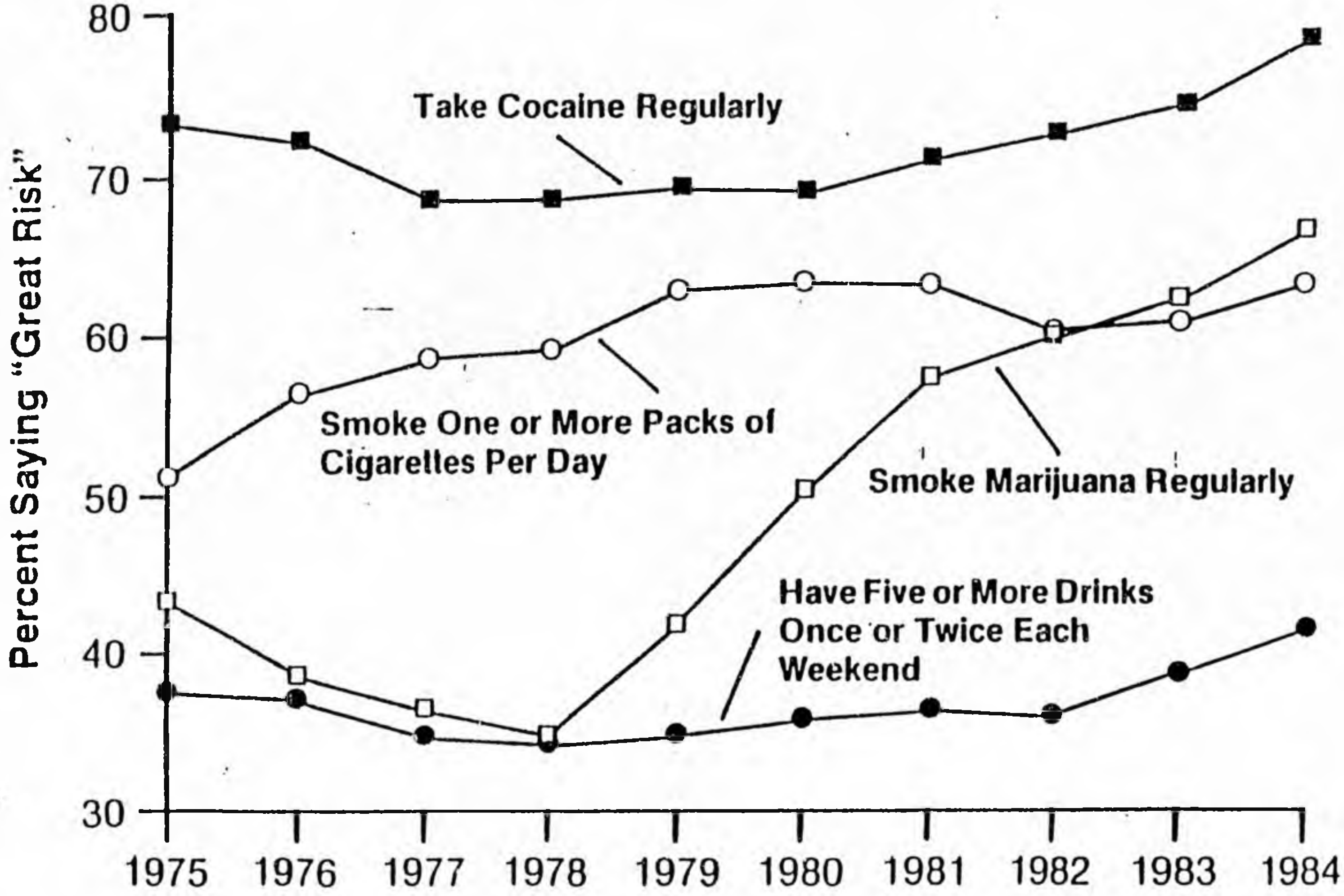
Source: NIDA, Data from the National Survey on Drug Abuse, 1982 and Student Drug Use in America, 1984.

Current Use: Cocaine
Among High School Seniors According to Region



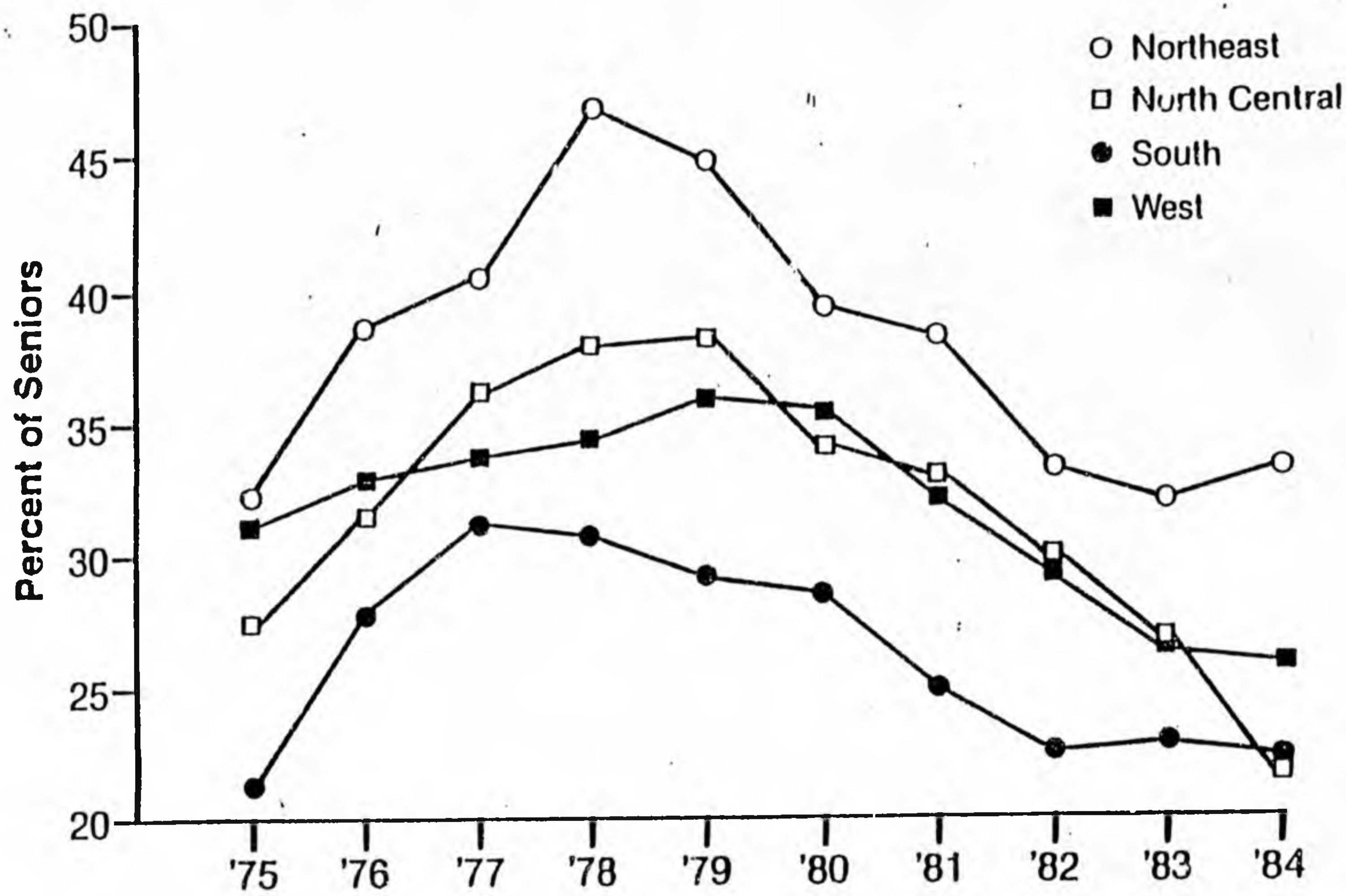
Note: Current use is defined as use at least once in past 30 days.
Source: NIDA, Monitoring the Future Study.

Perceived Harmfulness of Drugs as Reported by High School Seniors



Source: NIDA, Monitoring the Future Study

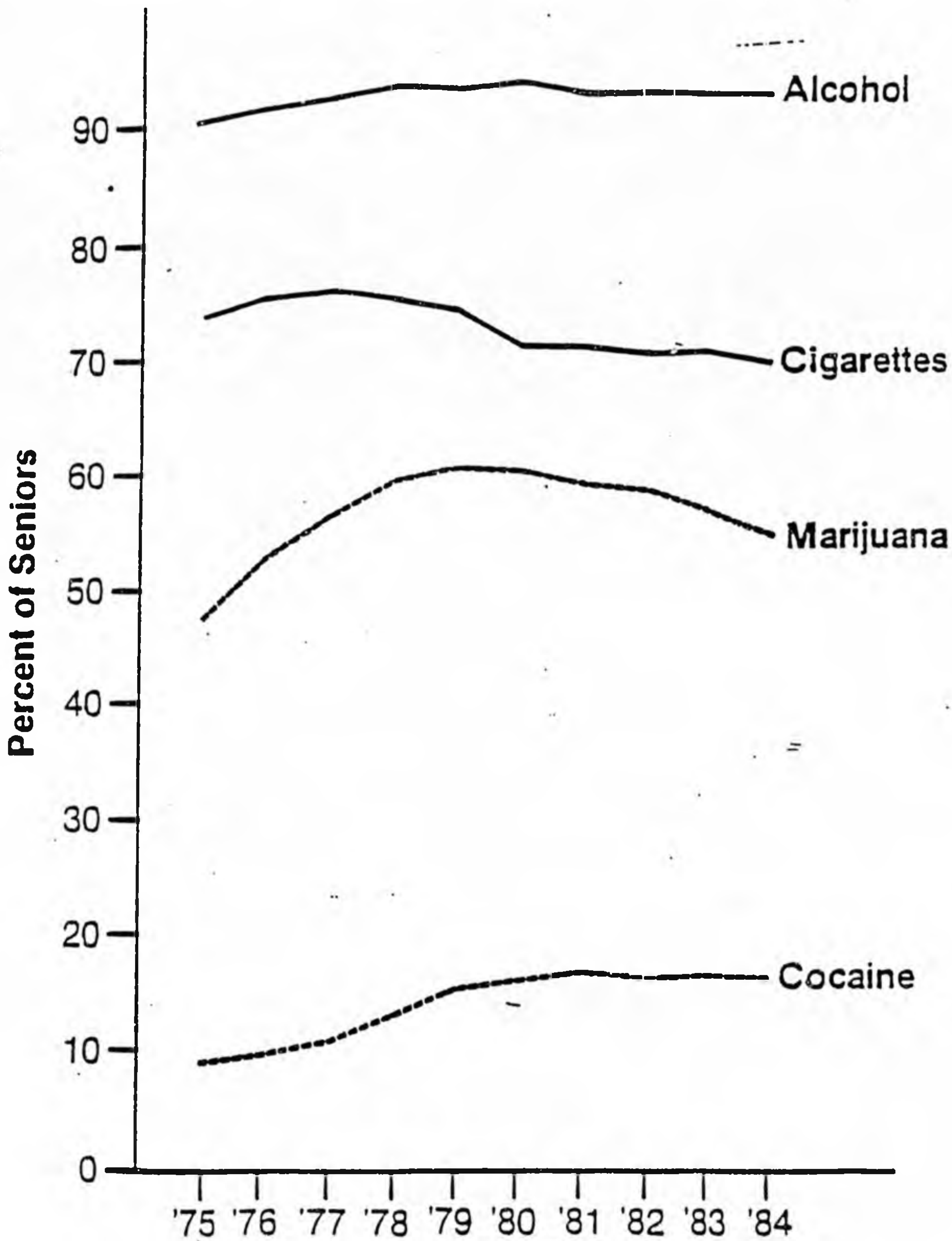
Current Use: Marijuana Among High School Seniors According to Region



Note: Current use is defined as use at least once in past 30 days.

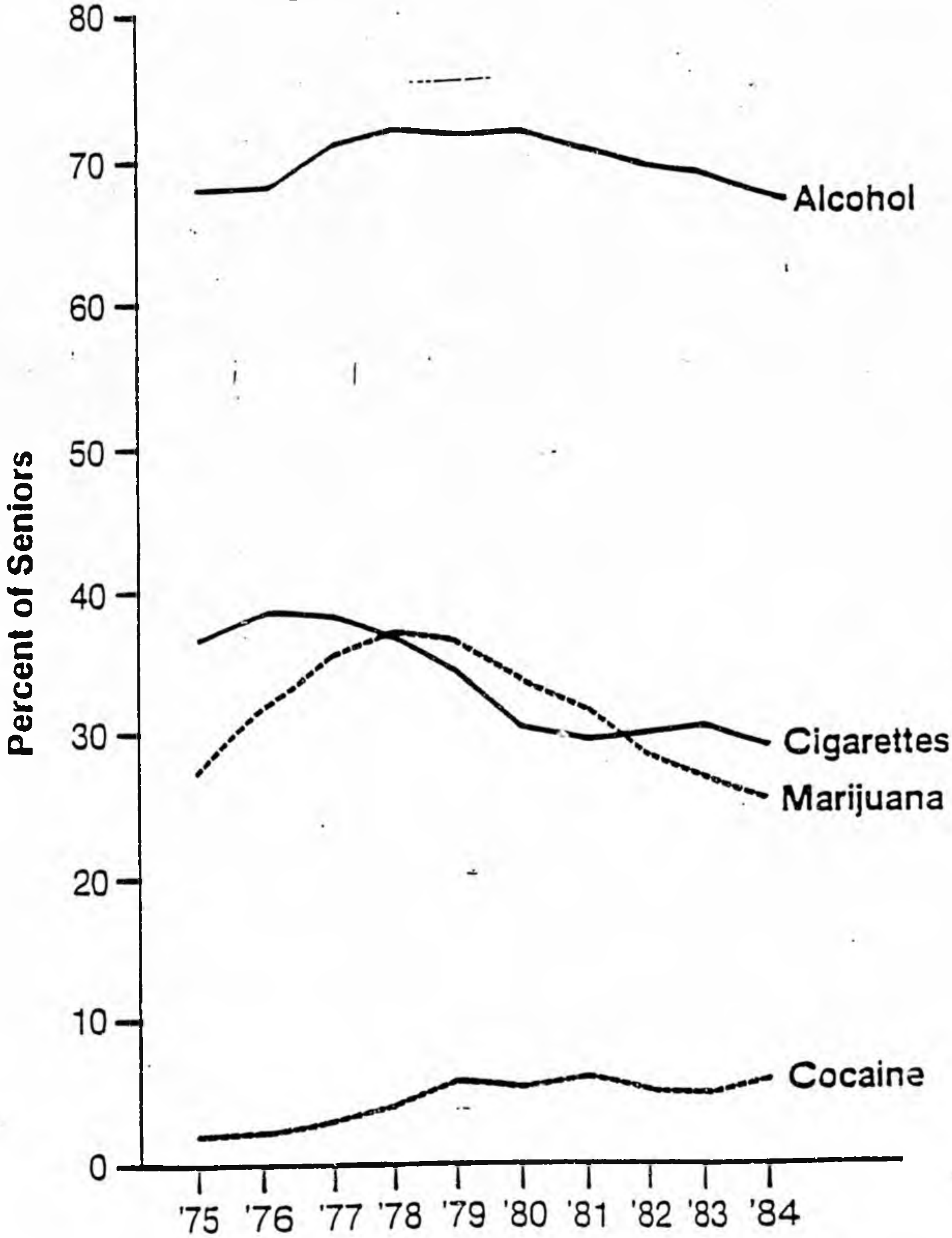
Source: NIDA, Monitoring the Future Study.

Lifetime Use: Cocaine, Marijuana, Alcohol and Cigarettes



Source: NIDA, Monitoring the Future Study.

Current Use: Cocaine, Marijuana, Alcohol and Cigarettes Among High School Seniors



Note: Current use is defined as use at least once in past 30 days.
Source: NIDA. Monitoring the Future Study.

HHS NEWS

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES

FOR IMMEDIATE RELEASE
Monday, Jan. 7, 1985

Contact: Claire del Real
(202) 245-6343

HHS Secretary Margaret M. Heckler today released the tenth annual survey of drug abuse among high school seniors, and she said the survey "shows significant progress on a broad front against the specter of drug abuse by our youth."

The survey shows that "more students are recognizing the dangers of drugs, more are saying they disapprove of drug use, and more are making the personal choice against drugs," Secretary Heckler said.

In many instances, the survey showed the lowest usage of illicit drugs since the survey was initiated ten years ago, including daily use of marijuana.

But at the same time, Mrs. Heckler said illicit drug use among American youth is still "much too high," and she cited figures showing that cocaine use remained at the level reached in 1981.

The high school survey, conducted each year since 1975 by the University of Michigan Institute for Social Research, is primarily funded by the National Institute on Drug Abuse, an HHS agency. It measures illicit drug use by questioning 16,000 seniors in 140 public and private schools throughout the country. The primary investigator for the survey is Dr. Lloyd Johnston of the University of Michigan.

- MORE -

Highlights from the new survey, which covers the class of 1984, included:

-- Current use (used at least once in the past 30 days) of illicit drugs among seniors dropped to 29 percent in 1984, down from 33 percent in 1983 and from a peak of 39 percent in 1978 and 1979. The 29 percent level is the lowest since the survey began. Mrs. Heckler said this level "is still far too high," but she called the long term trend of reduced drug abuse "strong and positive."

-- Only 5 percent of seniors used marijuana daily, less than half the 11 percent found in the peak year of 1978. The 5 percent finding was also the lowest ever recorded by the survey.

-- Other measures of marijuana use also declined. Current use of marijuana dropped to 25 percent in 1984 from 27 percent in 1983. This is approximately one-third lower than the peak level of 37 percent in 1978. However, 55 percent of the senior class of 1984 still reported having used marijuana at some time in their lives.

-- Cigarette smoking by the seniors also declined to the lowest level ever recorded by the survey, with less than 19 percent smoking half a pack or more a day. Disapproval of smoking a pack or more of cigarettes a day rose to 73 percent, the highest level yet measured by the survey.

-- The prevalence of "binge" drinking (five or more drinks in a row within two weeks prior to the survey) declined to 39 percent in 1984 from 41 percent in 1983.

- MORE -

-- Daily use of alcohol among seniors declined to 5 percent in 1984, compared with the peak level of 7 percent in 1979.

"Increasingly, students are resisting the temptations and the pressures to use drugs," Mrs. Heckler said. "Increasingly, I believe, they are taking control."

However, Secretary Heckler cited cocaine as a remaining "disturbing area."

Current use of cocaine rose to 6 percent in 1984 from 5 percent in 1983. While statistically this measure does not represent a significant increase, Mrs. Heckler said, it does mean that "cocaine use is still at the level it reached in 1981."

The survey shows moderate declines in cocaine use in the west and north central regions of the country, with a slight increase in the south and an increase in current use from 7 percent in 1983 to 11 percent in 1984 for the northeastern region.

However, Mrs. Heckler also pointed to figures in the survey showing increased awareness of cocaine's dangers, compared with a lower perception of the dangers five years earlier.

###

NOTE: Attached are tables now available from the survey.

TABLE 6

Trends in Lifetime Prevalence of Sixteen Types of Drugs

AMONG HIGH SCHOOL SENIORS

	Class of 1975	Class of 1976	Class of 1977	Class of 1978	Class of 1979	Class of 1980	Class of 1981	Class of 1982	Class of 1983	Class of 1984
	Percent ever used									
Approx. N =	(9400)	(15400)	(17100)	(17800)	(15500)	(15900)	(17500)	(17700)	(16300)	(15900)
Marijuana/Hashish	47.3	52.8	56.4	59.2	60.4	60.3	59.5	58.7	57.0s	54.9
Inhalants[a]	NA	10.3	11.1	12.0	12.7	11.9	12.3	12.8	13.6	14.4
Inhalants Adjusted[b]	NA	NA	NA	NA	*18.7*	*17.6*	*17.4*	*18.0*	*18.8*	19.0
Amyl & Butyl Nitrites[c]	NA	NA	NA	NA	11.1	11.1	10.1	9.8	8.4	8.1
Hallucinogens	16.3	15.1	13.9	14.3	14.1	13.3	13.3	12.5	11.9	10.7
Hallucinogens Adjusted[d]	NA	NA	NA	NA	*18.6*	*15.7*	*15.7*	*15.0*	*14.7*	13.3
LSD	11.3	11.0	9.8	9.7	9.5	9.3	9.8	9.6	8.9	8.0
PCP[c]	NA	NA	NA	NA	12.8	9.6	7.8	6.0	5.6	5.0
Cocaine	9.0	9.7	10.8	12.9	15.4	15.7	16.5	16.0	16.2	16.1
Heroin	2.2	1.8	1.8	1.6	1.1	1.1	1.1	1.2	1.2	1.3
Other opiates[e]	9.0	9.6	10.3	9.9	10.1	9.8	10.1	9.6	9.4	9.7
Stimulants[e]	22.3	22.6	23.0	22.9	24.2	26.4	32.2	35.6	35.4	NA
Stimulants Adjusted[e,f]	NA	NA	NA	NA	NA	NA	NA	*27.9*	*26.9*	27.9
Sedatives[e]	18.2	17.7	17.4	16.0	14.6	14.9	16.0	15.2	14.4	13.3
Barbiturates[e]	16.9	16.2	15.6	13.7	11.8	11.0	11.3	10.3	9.9	9.9
Methaqualone[e]	8.1	7.8	8.5	7.9	8.3	9.5	10.6	10.7	10.1	8.3
Tranquilizers[e]	17.0	16.8	18.0	17.0	16.3	15.2	14.7	14.0	13.3	12.4
Alcohol	90.4	91.9	92.5	93.1	93.0	93.2	92.6	92.8	92.6	92.5
Cigarettes	73.6	75.4	75.7	75.3	74.0	71.0	71.0	70.1	70.6	69.7

NOTES: Level of significance of difference between the two most recent classes:
s = .05, ss = .01, sss = .001.

NA indicates data not available.

[a]Data based on four questionnaire forms. N is four-fifths of N indicated.

[b]Adjusted for underreporting of amyl and butyl nitrites (see text).

[c]Data based on a single questionnaire form. N is one-fifth of N indicated.

[d]Adjusted for underreporting of PCP (see text).

[e]Only drug use which was not under a doctor's orders is included here.

[f]Adjusted for overreporting of the non-prescription stimulants. Data based on three questionnaire forms. N is three-fifths of N indicated.

Source: NIDA, monitoring the Future Study, 1984.

TABLE 7

Trends in Annual Prevalence of Sixteen Types of Drugs

AMONG HIGH SCHOOL SENIORS

	Class of 1975	Class of 1976	Class of 1977	Class of 1978	Class of 1979	Class of 1980	Class of 1981	Class of 1982	Class of 1983	Class of 1984
	Percent who used in last twelve months									
Approx. N =	(9400)	(15400)	(17100)	(17800)	(15500)	(15900)	(17500)	(17700)	(16300)	(15900)
Marijuana/Hashish	40.0	44.5	47.6	50.2	50.8	48.8	46.1	44.3	42.3	40.0
Inhalants[a]	NA	3.0	3.7	4.1	5.4	4.6	4.1	4.5	4.3	5.1
Inhalants Adjusted[b]	NA	NA	NA	NA	*9.2*	*7.8*	*6.0*	*6.6*	*6.7*	7.9
Amyl & Butyl Nitrites[c]	NA	NA	NA	NA	6.5	5.7	3.7	3.6	3.6	4.0
Hallucinogens	11.2	9.4	8.8	9.6	9.9	9.3	9.0	8.1	7.3	5.5
Hallucinogens Adjusted[d]	NA	NA	NA	NA	*12.8*	*10.6*	*10.1*	*9.3*	*9.3*	7.3
LSD	7.2	6.4	5.5	6.3	6.6	6.5	6.5	6.1	5.4	4.7
PCP[c]	NA	NA	NA	NA	7.0	4.4	3.2	2.2	2.6	2.3
Cocaine	5.6	6.0	7.2	9.0	12.0	12.3	12.4	11.5	11.4	11.6
Heroin	1.0	0.8	0.8	0.8	0.5	0.5	0.5	0.6	0.6	0.5
Other opiates[e]	5.7	5.7	6.4	6.0	6.2	6.3	5.9	5.3	5.1	5.2
Stimulants[e]	16.2	15.8	16.3	17.1	18.3	20.8	26.0	26.1	24.6	NA
Stimulants Adjusted[e,f]	NA	NA	NA	NA	NA	NA	NA	*20.3*	*17.9*	17.7
Sedatives[e]	11.7	10.7	10.8	9.9	9.9	10.3	10.5	9.1	7.9	5.6
Barbiturates[e]	10.7	9.6	9.3	8.1	7.5	6.8	6.6	5.5	5.2	4.9
Methaqualone[e]	5.1	4.7	5.2	4.9	5.9	7.2	7.6	6.8	5.4	3.3
Tranquilizers[e]	10.6	10.3	10.8	9.9	9.6	8.7	8.0	7.0	6.9	5.1
Alcohol	84.8	85.7	87.0	87.7	88.1	87.9	87.0	86.8	87.5	86.3
Cigarettes	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NOTES: Level of significance of difference between the two most recent classes:
s = .05, ss = .01, sss = .001.

NA indicates data not available.

[a]Data based on four questionnaire forms. N is four-fifths of N indicated.

[b]Adjusted for underreporting of amyl and butyl nitrites (see text).

[c]Data based on a single questionnaire form. N is one-fifth of N indicated.

[d]Adjusted for underreporting of PCP (see text).

[e]Only drug use which was not under a doctor's orders is included here.

[f]Adjusted for overreporting of the non-prescription stimulants. Data based on three questionnaire forms. N is three-fifths of N indicated.

Source: NIDA, monitoring the Future Study, 1984.

TABLE 8

Trends in Thirty-Day Prevalence of Sixteen Types of Drugs

AMONG HIGH SCHOOL SENIORS

	Percent who used in last thirty days									
	Class of 1975	Class of 1976	Class of 1977	Class of 1978	Class of 1979	Class of 1980	Class of 1981	Class of 1982	Class of 1983	Class of 1984
Approx. N =	(9400)	(15400)	(17100)	(17800)	(15500)	(15900)	(17500)	(17700)	(16300)	(15900)
Marijuana/Hashish	27.1	32.2	35.4	37.1	36.5	33.7	31.6	28.5	27.0	25.2
Inhalants[a]	NA	0.9	1.3	1.5	1.7	1.4	1.5	1.5	1.7	1.3
Inhalants Adjusted[b]	NA	NA	NA	NA	3.1	2.7	2.3	2.5	2.7	2.7
Amyl & Butyl Nitrites[c]	NA	NA	NA	NA	2.4	1.8	1.4	1.1	1.4	1.4
Hallucinogens	4.7	3.4	4.1	3.9	4.0	3.7	3.7	3.4	2.8	2.6
Hallucinogens Adjusted[d]	NA	NA	NA	NA	5.5	4.4	4.4	4.3	3.8	3.6
LSD	2.3	1.9	2.1	2.1	2.4	2.3	2.5	2.4	1.9	1.5
PCP[c]	NA	NA	NA	NA	2.4	1.4	1.4	1.0	1.3	1.6
Cocaine	1.9	2.0	2.9	3.9	5.7	5.2	5.8	5.0	4.9	5.8
Heroin	0.4	0.2	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.3
Other opiates[e]	2.1	2.0	2.8	2.1	2.4	2.4	2.1	1.8	1.8	1.8
Stimulants[e]	8.5	7.7	8.8	8.7	9.9	12.1	15.8	13.7	12.4	NA
Stimulants Adjusted[e,f]	NA	NA	NA	NA	NA	NA	NA	10.7	8.9	8.3
Sedatives[e]	5.4	4.5	5.1	4.2	4.4	4.8	4.6	3.4	3.0	2.3
Barbiturates[e]	4.7	3.9	4.3	3.2	3.2	2.9	2.6	2.0	2.1	1.7
Methaqualone[e]	2.1	1.6	2.3	1.9	2.3	3.3	3.1	2.4	1.8	1.1
Tranquilizers[e]	4.1	4.0	4.6	3.4	3.7	3.1	2.7	2.4	2.5	2.1
Alcohol	68.2	68.3	71.2	72.1	71.8	72.0	70.7	69.7	69.4	67.2
Cigarettes	36.7	38.8	38.4	36.7	34.4	30.5	29.4	30.0	30.3	29.3

NOTES: Level of significance of difference between the two most recent classes:
s = .05, ss = .01, sss = .001.

NA indicates data not available.

[a]Data based on four questionnaire forms. N is four-fifths of N indicated.

[b]Adjusted for underreporting of amyl and butyl nitrites (see text).

[c]Data based on a single questionnaire form. N is one-fifth of N indicated.

[d]Adjusted for underreporting of PCP (see text).

[e]Only drug use which was not under a doctor's orders is included here.

[f]Adjusted for overreporting of the non-prescription stimulants. Data based on three questionnaire forms. N is three-fifths of N indicated.

Source: NIDA, monitoring the Future Study, 1984.

TABLE 9

Trends in Thirty-Day Prevalence of Daily Use of Sixteen Types of Dru

AMONG HIGH SCHOOL SENIORS

	Percent who used daily in last thirty days									
	Class of 1975	Class of 1976	Class of 1977	Class of 1978	Class of 1979	Class of 1980	Class of 1981	Class of 1982	Class of 1983	Class of 1984
Approx. N =	(9400)	(15400)	(17100)	(17800)	(15500)	(15900)	(17500)	(17700)	(16300)	(15900)
Marijuana/	6.0	8.2	9.1	10.7	10.3	9.1	7.0	6.3	5.5	5.0
Inhalants	NA	0.0	0.0	0.1	0.0	0.1	0.1	0.1	0.1	0.1
Inhalants Adjusted	NA	NA	NA	NA	0.1	-0.2	0.2	0.2	0.2	0.2
Amyl & Butyl Nitrites[c]	NA	NA	NA	NA	0.0	0.1	0.1	0.0	0.2	0.1
Hallucinogens	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Hallucinogens Adjusted[d]	NA	NA	NA	NA	0.2	0.2	0.1	0.2	0.2	0.2
LSD	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1
PCP[c]	NA	NA	NA	NA	0.1	0.1	0.1	0.1	0.1	0.1
Cocaine	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.2	0.2	0.2
Heroin	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Other opiates[e]	0.1	0.1	0.2	0.1	0.0	0.1	0.1	0.1	0.1	0.1
Stimulants[e]	0.5	0.4	0.5	0.5	0.6	0.7	1.2	1.1	1.1	NA 0.5
Stimulants Adjusted[e,f]	NA	NA	NA	NA	NA	NA	NA	0.7	0.8	0.1
Sedatives[e]	0.3	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	
Barbiturates[e]	0.1	0.1	0.2	0.1	-0.0	0.1	0.1	0.1	0.1	0.0
Methaqualone[e]	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0
Tranquilizers[e]	0.1	0.2	0.3	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Alcohol	5.7	5.6	6.1	5.7	6.9	6.0	6.0	5.7	5.5	4.8
Cigarettes	26.9	28.8	28.8	27.5	25.4	21.3	20.3	21.1	21.2	18.7

NOTES: Level of significance of difference between the two most recent classes:
s = .05, ss = .01, sss = .001.

NA indicates data not available.

[a] Data based on four questionnaire forms. N is four-fifths of N indicated.

[b] Adjusted for underreporting of amyl and butyl nitrites (see text).

[c] Data based on a single questionnaire form. N is one-fifth of N indicated.

[d] Adjusted for underreporting of PCP (see text).

[e] Only drug use which was not under a doctor's orders is included here.

[f] Adjusted for overreporting of the non-prescription stimulants. Data based on three questionnaire forms. N is three-fifths of N indicated.

Source: NIDA, monitoring the Future Study, 1984.

ERRATUM

Please note the following correction to "Crime as Commonsense Theory" by Clayton A. Hartjen, which appeared on pages 435-452 of the Feburary 1981 issue of CRIMINOLOGY:

> Page 438, the sentence beginning on line 6 in the second paragraph should read: "The 'deep structure' of a language is the set of rules (or grammar) that underlies the sounds or symbols of experienced language."

As for the relationship between marijuana use and other deviant behaviors, the general scenario was presented to us many decades ago by Harry J. Anslinger, the director of the Federal Bureau of Narcotics from its inception in 1930 through the 1950s:

> In the earliest stages of intoxication the will power is destroyed and inhibitions and restraints are released; the moral barricades are broken down and often debauchery and sexuality results. While mental instability is inherent, the behavior is generally violent. An egotist will enjoy delusions of grandeur, the timid individual will suffer anxiety, and the aggressive one often will resort to acts of violence and crime [Anslinger and Tompkins, 1953: 21-22].

While Anslinger's position on marijuana has been viewed by many as either politically motivated or as the ravings of a madman, the spectre of a relationship between marijuana, crime, and violence periodically reemerges. Furthermore, the vast majority of the studies which have focused on any relationship between drug use and crime have typically singled out the impact of heroin use on street crime. Data sets do exist on users of marijuana which document that if any relationship does exist it is generally limited to the subculture and marketplace circumscribing the distribution and sale of the drug (Johnson, 1973; Pottieger and Inciardi, forthcoming). Nevertheless, any agenda for marijuana decriminalization research should address itself to the many studies which have touched upon this issue in order that more thorough documentation can be provided. A similar approach might be structured for a resolution of the marijuana-heroin progression hypothesis.

Turning to an alternative area for research, the impact of arrest and conviction on cohorts of marijuana users remains unstudied. An overview of the FBI's *Uniform Crime Reports* suggests that there have been almost three million marijuana-related arrests during the 1972-1978 period. What proportion of these arrests involve simple possession vs. sales, and what proportion represent misdemeanors or lesser crimes in those jurisdictions where marijuana has been decriminalized, is not known. However, what is clear is that the number of marijuana arrests annually is almost one-half million; and furthermore, the *proportion* of arrests involving marijuana has become more or less stabilized. This becomes a crucial issue when one considers that, as has been pointed out elsewhere, as soon as arrest patterns and rates for a given crime have become stabilized, they will remain at that level for many years to come (Inciardi, 1978). From this perspective it is suggested that almost one-half million persons (or perhaps slightly less, since some individuals experience multiple arrests) will be confronted with criminal justice processing during the next few years as a result of marijuana use. This suggests a whole range of research questions:

- Of some 1/2 million arrests each year, what proportion are possession arrests?
- How many *persons* are arrested for possession of a quantity of marijuana which would not involve criminal processing in a decriminalized state?
- How many of the possession arrests involve first offenders *of any type?*
- How many personal and occupational disruptions occur as a result of these arrests?

An interesting study which might address these questions could involve a follow-up of matched samples of marijuana users who are, and who are not, arrested. With such an effort, one could easily measure the impact of the marijuana prohibition on a user's finances, family, and career.

The other side of this question relates to the economic costs of enforcing the marijuana laws. Again, these data are not readily available. Even rough estimates cannot be structured since the activities of so many agencies impact on marijuana enforcement activity. Research in this behalf could estimate the cost of a single marijuana arrest in a given jurisdiction by examining the budgets and activities of local, county, and state police, municipal and state court and correctional agencies, and diversion programs. A

study of this order would begin to give us some indication of the economic burden imposed by the marijuana statutes.

DECRIMINALIZATION, PUBLIC OPINION, AND SOCIAL POLICY

Shifting to an alternative area of inquiry, the beginnings of the epidemic of marijuana use during the 1960s occurred at a time when *any* possession of the drug was a felonious offense under federal and *all* state laws. The "movement" toward decriminalization began in 1973 with Oregon, followed by Colorado, Alaska, Ohio, and California in 1975, Maine and Minnesota in 1976, Mississippi, North Carolina, and New York in 1977, and Nebraska in 1978. But as Dr. Eric Josephson (1980) of the Center for Socio-Cultural Research on Drug Use at Columbia University has pointed out, this "movement" has become stalled, and for a variety of reasons. He suggests that further progress has not been made because of the failure of the U.S. Congress to pass legislation that would decriminalize marijuana under federal statutes, because the issue has not been salient enough throughout the nation as a whole to result in concerted action in favor of decriminalization, because the lobbying on behalf of marijuana law reform has not demonstrated the power and influence necessary for repeal, and because marijuana is a drug favored by youth.

Within the context of Josephson's observations, it seems clear that the lack of further movement toward decriminalization can be tied primarily to the images of the drug and its users which have been nurtured in American drug mythology since the beginning decades of the twentieth century.

Descriptions of marijuana as a "weed of madness" appeared as early as the mid-1800s, and were brought before a national audience during the 1920s. In a New York *Times* article datelined Mexico City, July 5, 1927, and headlined "Mexican Family Go Insane," for example, the following report was offered.

> A widow and her four children have been driven insane by eating the Marihuana plant, according to doctors, who say that there is

no hope of saving the children's lives and that the mother will be insane for the rest of her life.

The tragedy occurred while the body of the father, who had been killed, was still in a hospital.

The mother was without money to buy other food for the children, whose ages range from 3-15, so they gathered some herbs and vegetables growing in the yard for their dinner. Two hours after the mother and children had eaten the plants, they were stricken. Neighbors, hearing outbursts of crazed laughter, rushed to the house to find the entire family insane.

Examination revealed that the narcotic marihuana was growing among the garden vegetables.

Combined with this image of the drug as a creator of madness, a more formal crusade was organized and pursued by Harry J. Anslinger and his Federal Bureau of Narcotics during the 1930s, who targeted marijuana as the "assassin of youth." Using *American Magazine* as his national forum, Anslinger initiated a series of reports in 1937 aimed at shocking the American public. For example:

> The sprawled body of a young girl lay crushed on the sidewalk the other day after a plunge from the fifth story of a Chicago apartment house. Everyone called it suicide, but actually it was murder. The killer was a narcotic known to America as marijuana, and to history as hashish. It is a narcotic used in the form of cigarettes, comparatively new to the United States and as dangerous as a coiled rattlesnake [Sloman, 1979: 34].

And in terms of crime:

> An entire family was murdered by a youthful addict in Florida. When officers arrived at the home, they found the youth staggering about in a human slaughterhouse. With an ax he had killed his father, mother, two brothers, and a sister. He seemed to be in a daze. . . . He had no recollection of having committed the multiple crime. *The officers knew him ordinarily as a sane, rather quiet young man; now he was pitifully crazed.* They sought the reason. The boy said he had been in the habit of smoking something which youthful friends called "muggles," a childish name for marijuana [Sloman, 1979: 63].

The end product of these moral enterprises has been well documented. By the 1940s, a body of literature had begun to develop which stereotyped marijuana users as sex-crazed maniacs, degenerate street criminals, and members of the "living dead." The drug reportedly ravaged the human body; it destroyed morality; users were sexually violent and criminally aggressive, and in general were weak and ineffective members of society; marijuana "addiction" was contagious since users had a mania for perpetuating the social anathema of drug taking; and finally, once addicted, the user entered a lifetime of slavery to drugs. Furthermore, the erroneous conception was typically emphasized that marijuana, like heroin, was an addicting narcotic, and that such drug use was concentrated almost exclusively among criminals and other social outcasts.

By mid-century, after marijuana had become outlawed throughout the nation, it then became associated with the "Beats" of America's bohemian underground.

Beat, as a slang term, originated in *harlem jive,* the jargon of the black musician of the 1920s and 1930s. With a meaning of "exhausted and worn out," beat was descriptive of a part social, part literary phenomenon of the late 1940s and 1950s initiated by the postwar disaffected and a cult of west coast writers. They were of a genertaion that was trying to make sense of a postwar world, a world that seemed to offer no respite, only an eternal state of war and chaos. Reality, as the Beats viewed it, was a state of consciousness where nature, history, and humanity could not be controlled; where the worship of reason had fallen into obscurity; where progress was both a false concept and an illusion; and where the future and past were of little value.

The Beats believed that the path to harmony in a chaotic world could not be had by the more traditional consolations of success and achievement which demanded a feigning of beliefs, feelings, and virtues, and a relentless obligation to the prevailing social forms and customs. Many Beats, in their attempt to more readily attain the success of setting themselves right with nature, pursued their "true" reality through an effort of the mind and rejected the perceived discontinuities of life in organized society. For most, however, their conceptual reality of the irrational properties of everyday existence was escaped through the sensation of a drug, and high frequency/long duration marijuana and hashish use became a pervasive part of Beat life (Inciardi, 1972).

The chief spokesmen of the Beat movement were Allen Ginsberg, Jack Kerouac, William Burroughs and Lawrence Ferlinghetti, but the most celebrated of these was Ginsberg, whose writings were so charged with obscenity that they brought awkward attention to the movement that was national in scope. The best known of Ginsberg's works was *Howl*, written, for the most part, while he was under the influence of drugs. In its 75 lines of inelegant poetry aimed at dismaying the middle class, *Howl* condemned American society and suggested a new set of values that were almost totally antisocial. And it was from this context that Ginsberg again emerged during the early 1960s making the rounds on Capitol Hill lobbying for the legalization of marijuana (Viorst, 1979: 57-59). Understandably, legalization of the drug could be viewed as nothing more than the radical politics of the time, and Ginsberg's appearance in the midst of the issue did much to confirm the persisting images of the marijuana user.

As the 1960s grew more mature, the nonconformist notions of the tiny minority of Beats in the 1950s emerged as the common social currency of the new youth movement. And the new counterculture contained a variety of types. It included what social critic Norman Mailer called the "philosophical psychopaths" who had found a need to throw off the political and social restraints of their generation. They lived immoderately and for the moment, congregated in communes, spoke a special avant garde language, experimented with sex, and smoked marijuana. It included the political activists whose radical perception of society's horrors were communicated in a manner that was attractive to the existing adolescent propensity to rebel. And finally, it included the tens of thousands of "plastic" or weekend "hippies" and "heads" whose social schizophrenia placed them partially in the straight world and partially in this "new underground"; they were children of two cultures, never wholly in phase with either, and not believing fully in the values and mores of either.

Concomitant with the rise of the counterculture was a revolution in the technology and handling of drugs which had begun at mid-century and served to designate the sixties as a "new chemical age." Recently compounded psychotropic agents were enthusiastically introduced and effectively promoted, with the consequence of exposing the national consciousness to an impressive catalogue of chemical temptations which could offer fresh inspiration as well as simple and immediate relief from fear, anxiety, tension, frustration, and boredom. Exploiting the new hallucinogenic, stimulant and sedative drugs that emerged during this period, the new counterculture also became the new drug culture, and the image of the marijuana user was further denigrated.

It was not until the 1970s that the nation had become conscious of the fact that marijuana use went well beyond the "dangerous and criminal classes." In 1965, less than ten million persons were estimated to have used marijuana, but by the mid-seventies this figure had more than tripled, and a large and rapidly expanding segment of the American population had become the target of legal concern.

The initial surge of decriminalization statutes which did occur appeared, for the most part, in those states where marijuana use was most prevalent, and the movements toward decriminalization emerged primarily as an attempt to implement anti-marijuana statutes of reduced severity that were more likely to produce arrests and convictions. In the main, however, public attitudes toward marijuana use and users continued to reflect much of the stigma that had been originally attached to the drug, and the decriminalization movement remained stalled.

With the onset of the 1980s, the growing number of users within the youthful population at all class and social levels drew much attention away from the former images of the marijuana user, but the depiction of the drug as an "assassin of youth" seemed to reemerge. Currently, articles in the popular media present aspects of marijuana use in an alternative, but still problematic, context. A segment of contemporary literature, for example, emphasizes (but fails to document) that most new recruits to marijuana are younger than their counterparts of a decade ago.

Such articles focus on how marijuana smoking has become a major part of many 10-year-olds' daily routines, and that their involvement with the drug has served to destroy their family relationships and coping skills (for example, Brynner, 1980). This type of rhetoric, however, often serves only to incite parents into hysterical antidrug behavior and further stimulate intergenerational disaffection.

The research issue which must address this phenomenon is three-fold in nature. *First,* in those areas where marijuana use rates among youth are said to be high, data on the incidence, prevalence, and pattens of use of marijuana are critical. *Second,* accurate documentation is also warranted as to the extent to which family relationships and coping skills are, or are not, being impacted by marijuana use. And *third,* whether or not the findings of these studies portray marijuana use among youth in a negative light, a public education campaign seems appropriate which places reliable data, untainted by melodrama and demagoguery, before both parents and youth.

EPILOGUE

As a final note, perhaps the most crucial variable in a marijuana decriminalization research agenda relates to the possible benefits of marijuana as a substitute drug. There is an indication that at least within some populations of college students, the nature of drug use has changed over the last ten years. While more students are using drugs now than those of a decade ago, current student drug use has become more focused. Marijuana and alcohol are the primary, and typically the *only,* drugs of abuse, while narcotics, sedatives, stimulants, and hallucinogens are rarely seen. As such, while marijuana and alcohol use may be more prevalent now, the use of the more debilitating drugs may have become less significant.

Research that would target this issue could be readily undertaken as a part of the much needed impact evaluations of marijuana use in those states where the drug has already been decriminalized. Of the eleven states that have reduced the penalties for the possession of marijuana, the effects of the new legislation have been examined only in the states of Oregon (Drug Abuse Council, 1978), California (California Health and Welfare Agency, 1977), and Maine (State of Maine, 1979), and these studies are beset with a variety of severe shortcomings (see Cuskey et al., 1978). In short, the range of variables employed to describe marijuana use were extremely limited, age categories were too broadly defined, actual patterns of use were not examined, questions regarding the onset of marijuana use were not addressed, the effects of decriminalization on the use of other drugs was not approached, nor were the effects of the new law examined in terms of the behavior of users, the agencies of social control, public attitudes, and the wider society as a whole. In short, while these studies did attempt to determine if marijuana use did increase subsequent to decriminalization, they accomplished little else. And among those cohorts where marijuana use did increase, it is not known whether such usage was a substitute for other more dangerous and debilitating drugs.

As research descriptive of the health consequences of marijuana use continues, findings suggest that the drug is neither the "devil drug," "weed of madness," or "assassin of youth" that was alleged by some, nor the totally innocuous substance that was suggested by others. Indeed, marijuana does have its effects on immediate memory and intellectual performance in ways that impair thinking, reading comprehension, and verbal and arithmetic problem solving; acute intoxication has a clear impact on motor skills; it has its effects on circulation, the immune system, and the reproductive cycle; furthermore clinical studies have demonstrated that the drug effects lung functioning—in fact, one study suggests that smoking as few as four "joints" per week decreased vital lung capacity to the same extent as smoking as many as 100 conventional cigarettes during the same period of time (Pollin, 1979). These effects should not be ignored, nor should they be overstated. What is important, however, is that they be further examined within the cost/benefit or cost/cost paradigm suggested, in order that more informed decisions regarding decriminalization or continued prohibition be entertained.

REFERENCES

ANSLINGER, H. J. and W. F. TOMPKINS (1953) The Traffic in Narcotics. New York: Funk and Wagnalls.

BRYNNER, E. C. (1980) "New parental push against marijuana." New York Times Magazine (February 10): 36-38, 43-51.

California Health and Welfare Agency (1977) A First Report of the Impact of California's New Marijuana Law. Sacramento: State Office of Narcotics and Drug Abuse.

CUSKEY, W. R., L. H. BERGER, and A. H. RICHARDSON (1978) "The effects of marijuana decriminalization on drug use patterns: a literature review and research critique." Contemporary Drug Problems (Winter): 491-532.

Drug Abuse Council (1978) "Marijuana survey—State of Oregon." Washington, DC: Drug Abuse Council News Release (January 4).

INCIARDI, J. A. (1978) "The Uniform Crime Reports: some considerations on their shortcomings and utility." Public Data Use 6 (November): 3-16.

——— (1972) "Patterns of drug use among village 'beats'." Int. J. of Addictions 7 (4): 649-653.

JOHNSON, B. D. (1973) Marijuana Users and Drug Subcultures. New York: John Wiley.

JOSEPHSON, E. (1980) "Marijuana decriminalization: assessment of current legislative status." Presented at the Technical Review on Methodology in Drug Policy Research, Decriminalization of Marijuana, National Institute on Drug Abuse, March 20-21, Rockville, MD.

POLLIN, W. (1979) Health Consequences on Marijuana Use. Rockville, MD: National Institute on Drug Abuse.

POTTIEGER, A. E. and J. A. INCIARDI (forthcoming) "Drug use and crime on the college campus." Chemical Dependencies.

SLOMAN, L. (1979) Reefer Madness: The History of Marijuana in America. Indianapolis: Bobbs-Merrill.

State of Maine (1979) An Evaluation of the Decriminalization of Marijuana in Maine. Augusta: Department of Human Services.

VIORST, M. (1979) Fire in the Streets: America in the 1960's. New York: Simon & Schuster.

James A. Inciardi is Professor and Director, Division of Criminal Justice, University of Delaware. He has extensive teaching, research, field, and clinical experience in the areas of substance abuse and criminal justice. Dr. Inciardi was the director of the National Center for the Study of Acute Drug Reactions at the University of Miami School of Medicine, Vice President of Resource Planning Corporation, and Associate Director of Research at the New York State Narcotic Addiction Control Commission. He is currently editor of Criminology: An Interdisciplinary Journal *and has published more than 70 books and articles in the areas of substance abuse, medicine, criminology, and criminal justice.*

ration, and Associate Director of Research at the New York State Narcotic Addiction Control Commission. He is currently editor of Criminology: An Interdisciplinary Journal *and has published more than 70 books and articles in the areas of substance abuse, medicine, criminology, and criminal justice.*

ALCOHOLISM AND OTHER ALCOHOL-RELATED PROBLEMS AMONG CHILDREN AND YOUTH

☐ Alcohol is America's No. 1 drug problem among youth. In 1985, an estimated 4.6 million adolescents aged 14 through 17 experienced negative consequences of alcohol use (e.g., arrest, involvement in an accident, impairment of health or job performance). (NIAAA. Projection of data in Alcohol and Health Monograph 1, Alcohol Consumption and Related Problems 1982, p. 85, updated with Bureau of the Census 1985 Population Projections.)

☐ Alcohol is over twice as popular among college students as the next leading drug, marijuana, and over five times as popular as cocaine. Ninety-two percent of college students reported using alcohol in a twelve-month period compared to 42 percent who had used marijuana and 17 percent who had used cocaine. (Institute for Social Research, University of Michigan, Ann Arbor, MI, Drug Use Among American High School Students and Other Young Adults, 1985.)

☐ Only 42 percent of fourth graders know that alcohol is a drug, compared to 81 percent who consider marijuana a drug; the percentage of students considering alcohol a drug drops with age to 28 percent in the upper grades. (Weekly Reader Publications, A Study of Children's Attitudes and Perceptions About Drugs and Alcohol, Middletown, CT, Apr. 25, 1983.)

☐ The earlier in life a child starts using any dependence-producing drug, the more likely he or she is to experience dependence and other health problems, and go on to other dependence-producing drugs. (Robert L. DuPont, "Substance Abuse," Journal of the American Medical Association, Vol. 254, #16, Oct. 25, 1985, p. 2336.)

☐ Lower expectations for the future, alienation and boredom are associated with drinking among children in all socio-economic groups. (Nancy P. Gordon & Alfred McAlister, "Promoting Adolescent Health," Adolescent Drinking: Issues and Research, New York: Academic Press, 1982, p. 205.)

☐ Approximately 10,000 young people aged 16–24 are killed each year in alcohol-related accidents of all kinds, including drownings, suicides, violent injuries, homicides and injuries from fire. (US DHHS; NIAAA, Public Health Service, "Questions and Answers: Teenage Alcohol Use and Abuse," Prevention Plus: Involving Schools, Parents and the Community in Alcohol and Drug Education, Publication No. CADM 841256, Rockville, MD, 1983, p. xiii.)

☐ Alcohol-related highway deaths are the number one killer of 15- to 24-year-olds. (US DHHS National Center for Health Statistics, Public Health Service, Health, United States, 1980, Pub. No. (PHS) 81-1232, December 1980.)

☐ It takes less alcohol to produce impairment in youth than in adults. Younger drivers in fatal crashes have lower average blood alcohol concentrations (BACs) than older drivers. Blood alcohol concentration is the amount by weight of alcohol in a volume of blood, and is typically expressed as percent weight by volume. A BAC of .05 percent is equal to 50 mg of alcohol per deciliter of blood (approx. 3.5 fluid oz). ("Blood Alcohol Concentrations among Young Drivers, 1983," Morbidity and Mortality Weekly Report (MMWR),33:699-701, 1984.)

☐ Drivers 16–24 years old represent 20 percent of licensed drivers and less than 20 percent of total miles driven, and yet account for 42 percent of all fatal alcohol-related crashes. (US DOT Fatal Accident Reporting System, 1982. DOT No. HS-806-566, 1984 (h).)

☐ Of 27,000 New York public school students, grades 7 through 12, 11 percent described themselves as being "hooked" on alcohol, with 13 percent admitting to attending classes while "high," "drunk" or "stoned" on alcohol. (New York State Division of Alcoholism and Alcohol Abuse, Drug and Alcohol Survey, 1983.)

☐ Nearly 100,000 10- and 11-year-olds reported getting drunk at least once a week in 1985. Over 185,000 sixth graders have used hard liquor by age 10. Alcohol use at least once a week by sixth graders more than doubled from 1983 to 1984. (Ronald Adams and Thomas Gleaton, Parents' Resource Institute for Drug Education, PRIDE—Drug Usage Prevalence Questionnaire, 1985.)

☐ About one-third of fourth-graders (9-year-olds) said children their age pressured others to drink beer, wine or liquor; the figure increased to nearly 80 percent by high school. (Weekly Reader Publications, A Study of Children's Attitudes and Perceptions About Drugs and Alcohol, Middletown, CT, 1983.)

☐ Alcoholics are more likely than non-alcoholics to have an alcoholic father, mother, sibling or distant relative. Almost one-third of any sample of alcoholics had at least one parent who was also alcoholic. (Alcoholism: An Inherited Disease, US DHHS, Pub. No. (ADM) 85-1426, 1985, p. 3.)

☐ Children of alcoholics have a four times greater risk of developing alcoholism than children of non-alcoholics. There are 28.6 million children of alcoholics in the U.S. today, 6.6 million of whom are under the age of 18. (Children of Alcoholics Foundation, Children of Alcoholics: A Review of the Literature, 1985, Introduction and p. 2.)

☐ While no one is predestined to become an alcoholic, genetic factors may increase or decrease the level of vulnerability toward alcoholism. (Marc A. Schuckit, M.D., "Genetics and the Risk for Alcoholism," Journal of the American Medical Association, Vol. 254, Nov. 8, 1985, p. 2616.)

☐ At present, first drinking usually occurs around age 12, in contrast to age 13–14 in the 1940s and 1950s. (Gordon and McAlister, Adolescent Drinking: Issues and Research, p. 204.)

☐ Nearly a third of high school seniors have said that most or all of their friends get drunk at least once a week. (L.D. Johnston, P.M. O'Malley and J.G. Bachman, Use of Licit and Illicit Drugs by America's High School Students, 1975-1984, US DHHS Pub. No. (ADM) 85-L394, Washington, D.C., Supt. of Docs., US Govt. Print. Off., 1985.)

☐ Up to half of heavier youthful drinkers also use marijuana at least once a week, and a third of the youth who use marijuana more than once a month also are classed as heavier drinkers. (Research Triangle Institute, Economic Costs to Society of Alcohol and Drug Abuse and Mental Illness: 1980, RTI/2734/00-OIFR, June, 1984, p. 114.)

☐ Many surveys suggest that the best predictor of the drinking habits of adolescents is the attitude and behavior of their parents with regard to alcohol use. Adolescent heavy drinkers tend to come either from homes where one or both parents are heavy drinkers, or from homes where both are abstainers. (Gordon & McAlister, Adolescent Drinking: Issues and Research, p. 206.)

☐ Annual surveys of 17,000 high school seniors aged 17 and 18 years old consistently show that 85 percent of the participants have had at least one drink in the preceding year and that more than 66 percent have consumed at least one drink in the preceding month. Forty percent of seniors have participated in the "party drinking syndrome," that is, consumed five or more drinks on one occasion, at least once in the preceding two weeks. Thirty percent did so on two or more occasions, and 20 percent did so three or more times in the designated two-week period. In response to a related question, only a third of the seniors thought there was great risk in this type of binge drinking. (Johnston, O'Malley and Bachman: Drugs and American High School Students: 1975–1983.)

☐ A child will see alcohol consumed an average of 75,000 times on TV before he or she is of legal drinking age. (Dr. Thomas Radecki, Chairman of the National Coalition on Television Violence and psychiatrist with the University of Illinois School of Medicine, 1983.)

☐ Adolescents and young adults more heavily exposed to alcohol ads on TV and in magazines are more likely to perceive drinking as attractive, acceptable and rewarding than are those who have been less exposed. The heavily exposed group in a recent study was more likely to engage in drinking liquor—31 percent vs. 15 percent—than was the less exposed group. (C. Atkins and M. Block, Content and Effects of Alcohol Advertising, Bureau of Alcohol, Tobacco and Firearms, US Govt., Washington, D.C., Report of Michigan State University Study, 1981.)

☐ Drinking differences between boys and girls is diminishing. The number of young female drinkers has been increasing more rapidly than the number of young male drinkers. Girls also tend now to experiment with a wider variety of substances. (Robert H. Coombs, David K. Wellisch and Fawzy I. Fawzy, UCLA School of Medicine, Los Angeles, CA, Drinking Patterns and Problems among Female Children and Adolescents: A Comparison of Abstainers, Past Users and Current Users, Am. J. Drug Alcohol Abuse, II (3 & 4) pp. 315–348 (1985).)

☐ It is estimated that increasing federal excise taxes on beer, the favorite alcohol beverage among youth, would reduce alcohol-related motor vehicle fatalities by 55 percent among 18- to 20-year-old young men and by 45 percent among 18-to 20-year-old young women. (Henry Saffer, Kean College of New Jersey and National Bureau of Economic Research; and Michael Grossman, City University of New York Graduate School and National Bureau of Economic Research, Effects of Beer Prices and Legal Drinking Ages on Youth Motor Vehicle Fatalities, November 1985.)

☐ Alcoholism is a chronic, progressive and potentially fatal disease characterized by tolerance and physical dependency or pathologic organ changes, or both. All are the direct or indirect consequences of the alcohol ingested. (National Institute on Alcohol Abuse and Alcoholism (NIAAA), Fourth Special Report to the U.S. Congress on Alcohol and Health, ed. John R. DeLuca, DHHS Pub. No. (ADM) 82-1080, 1981, p. 36.)

☐ Alcoholism is one of the most serious public health problems in the United States today. Among the 18.3 million adult "heavier drinkers" (those consuming more than 14 drinks per week) 12.1 million have one or more symptoms of alcoholism, an increase of 8.2 percent since 1980. (NIAAA, Department of Biometry and Epidemiology, Working Paper: Projections of Alcohol Abusers, 1980, 1985, 1990, prepared by John Noble, 1985, pp. 5 and 6.)

☒ One out of three American adults—56 million Americans—say that alcohol abuse has brought trouble to their families. This is about four times the number of families that say that other drugs have troubled their homes. (P. Regans, ABC News/Washington Post Poll, Survey #0190, May 1985.)

Founded in 1944, NCA is the nation's nonprofit voluntary health organization established to prevent and reduce problems of alcohol abuse and alcoholism. NCA's network of 184 state and local affiliates conduct similar activities in their areas and provide information and referral services to families and individuals with a drinking problem.

NATIONAL COUNCIL ON ALCOHOLISM INC
12 West 21st Street, New York, NY 10010 • (212) 206-6770
1511 K Street, N.W., Washington, D.C. 20005 • (202) 737-8122

TABLE 1

Total Marijuana and Drug Arrests Since 1965

Year	Total Drug Arrests	Total Marijuana	Percent Marijuana
1965	60,500	18,815	31.1
1966	75,900	31,119	41.0
1967	121,500	61,843	50.9
1968	198,900	95,870	48.2
1969	283,600	118,903	41.2
1970	415,600	188,682	45.4
1971	492,000	225,828	45.9
1972	527,400	292,179	55.4
1973	628,900	420,700	66.9
1974	642,080	445,600	69.3
1975	601,300	416,100	69.2
1976	609,700	441,100	72.3
1977	642,700	457,600	71.2
1978	628,700	445,800	70.9
1979	559,600	391,600	70.1
1980	580,900	405,600	69.8
1981	559,900	400,300	71.5
1982	676,000	455,600	67.4
1965-82	8,309,180	5,312,639	63.9

Source: FBI Uniform Crime Reports 1965-1983

THE PRECEDING DOCUMENT(S) MAY NOT FILM LEGIBLY BECAUSE OF POOR QUALITY OF THE ORIGINAL.

TABLE 2

How do people rank the severity of crime?

severity score	offense
72.1	Planting a bomb in public, killing 20 people
52.8	Forcible rape resulting in death
43.2	Robbing a victim at gunpoint and shooting victim to death
35.6	Intentionally injuring victim resulting in death
25.9	Focible rape
24.9	Arson causing $100,000 damage
19.5	Smuggling heroin into country
10.5	Stealing property worth $10,000 from outside a building
9.6	Breaking into a home and stealing $1000
7.2	Signing someone else's name to a check and cashing it
6.9	Stealing property worth $1000 from outside a building
4.6	Carrying a gun illegally
1.4	Smoking marijuana
0.3	Vagrancy
0.2	Playing hooky

Source: Excerpts from Report to the Nation on Crime and Justice, U.S. Department of Justice 1983, citing The National Survey of Crime Severity, 1977.

TABLE 3

Marijuana Arrests Compared With Other Crimes - 1982

Crime	Number of Arrests
Larceny - Theft	1,368,100
Burglary	527,100
Marijuana	455,600
Aggravated Assault	313,150
Vandalism	245,700
Weapons Offenses	193,500
Robbery	157,630
Motor Vehicle Theft	129,100
Forgery and Counterfeiting	97,300
Rape	33,600
Murder	21,810
Arson	20,500
Embezzelment	9,000

Source: Compiled from FBI Uniform Crime Report, 1983

TABLE 4

Estimated Number of People Arrested for Marijuana - 1982

Year	455,600
Each month	37,967
Each week	8,762
Each day	1,248
Each hour	52

Source: FBI Uniform Crime Report, 1983

TABLE 5

Marijuana Arrests - Possession and Sale

Total Marijuana Arrests	Total Possession	Total Sale/Cultivation
455,600	68,340 ([illegible]5%)	387,260 ([illegible]5%)

Source: FBI Uniform Crime Report, 1983

LIFETIME PREVALENCE TRENDS IN MARIJUANA USE, 1962 - 1982

YEAR	'62*	'67*	'71	'72	'74	'76	'77	'79	'82
AGE:									
12 - 17			14%	14%	23%	23%	28%	31%	27%
18 - 25	4%	13%	39%	48%	53%	53%	60%	68%	64%
26 - 34	2%	3%	19%	20%	30%	36%	44%	48%	56%
Adults 18+	2%	5%	15%	16%	19%	21%	25%	30%	32%

Source: Based on National Household Surveys on Drug Abuse, 1971-1982, National Institute on Drug Abuse.

*Based on reconstructed data collected in 1977 from Cisin, I., et al., highlights from the National Survey on Drug Abuse: 1978. National Institute on Drug Abuse, 1978.

LIFETIME PREVALENCE TRENDS IN MARIJUANA USE, 1977-1982

Number of Adult Users, 18+

1977 - 36,215,655

1979 - 47,500,000

1982 - 52,543,000

Number of Users, Youth - Ages 12 - 17

1977 - 7,032,506

1979 - 7,300,000

1982 - 6,132,240

Number of Users, Total Population - Age 12+

1977 - 43,248,171

1979 - 54,800,000

1982 - 58,675,240

Source: Based on National Household Surveys on Drug Abuse, 1977 - 1982, National Institute on Drug Abuse.

90% of all persons who have used marijuana are adults.

The above surveys do not include members of the armed forces, people living in college dormitories, group quarters, and institutional populations.

Prepared by Joanne Gampel, M.A.
Director, Council on Marijuana and Health

Alaska Legislature unlikely to ban marijuana use in home

By HAL SPENCER
Daily News reporter

Despite renewed national attention on drug abuse, the 1987 Alaska Legislature likely will just say no to proposals to ban possession and use of marijuana in the home.

Backers of a ban, mostly conservative Republicans, are counting on support from the GOP-controlled Senate, but face an uphill fight in the Democratic-run House. And House Speaker Ben Grussendorf, D-Sitka, last week said nothing to discourage that view.

He observed that the state Supreme Court has spoken on the issue, ruling 12 years ago that a law barring adult Alaskans from possessing and smoking the weed in their homes violated their constitutional right to privacy.

In the case of marijuana use, "I'm not sure we should be telling Alaskans what they can do in their own homes," Grussendorf added.

Possession and use of marijuana in the

See Back Page, MARIJUANA

Daily News file photo/Fran Durner

Rep. Ben Grussendorf

MARIJUANA: Change in Alaska law unlikely

Continued from Page A-1

home became legal after a 1975 Supreme Court case. Irwin Ravin, now a Homer lawyer, argued successfully that his constitutional right to privacy outweighed the state's right to enforce a law barring home-possession or use of what was seen by the court as a relatively harmless drug.

The ruling, however, did not say how much marijuana an adult could possess in the home. In 1982, the legislature answered the question with passage of a misdemeanor law limiting the amount to four ounces. State law also bans buying or selling any quantity of the drug, possession or use outside the home, or any use or possession by juveniles.

Proponents of a new misdemeanor law banning possession or use at home feel it is needed "fundamentally because the state of Alaska is telling people that it is OK to smoke marijuana," said Rep. Terry Martin, R-Anchorage. "That needs to be changed."

The Alaska Association of Chiefs of Police, which recently said recriminalization of marijuana is one of its top priorities, also criticizes what it says is the absurdity of the present law.

"It's illegal to buy or sell it, to carry it into your home. But then the law says it's OK once you get it home. If you can get it home without being caught, you're safe," said Deputy Chief Del Smith of the Anchorage Police Department.

Martin and other proponents believe that public pressure, including new anti-drug sentiment nationally and resolutions from high school students and local governments in Alaska, will help push through a measure that can be tested in the courts.

And they feel that such a law might survive constitutional challenge because, they assert, more is known now about the harmful effects of marijuana.

They note that the Supreme Court considered harmful effects [illegible]

Daily News file photo/Fran Durner

Rep. Fritz Pettyjohn

Daily News file photo/Erik Hill

Rep. Terry Martin

whether the right to privacy should prevail in the case of cocaine possession in the home, and determined it should not.

House Minority Leader Fritz Pettyjohn, R-Anchorage, pointed to the 1978 Supreme Court case, State of Alaska v. Erickson, as an indication that the case for banning marijuana in the home could be re-opened.

"Defendants contend that the reasoning" with respect to marijuana "also applies to the non-commercial use and possession of cocaine, and additionally argue that the constitutional right to privacy guarantees some reasonable access to the drug for personal and social use," the court noted in the Erickson case.

But, the court said, "We think this right must yield when it interferes in a serious manner with the health, safety, rights and privileges of others or with the public welfare. No one has an absolute right to do things in the privacy of his own home which will affect himself or others adversely. ... It seems clear that cocaine is substantially more of a threat to health and welfare" than marijuana, the court said.

That may be, Pettyjohn said, but he and other conservatives contend that marijuana [illegible]

more physically and mentally harmful than it once was, and also is increasingly seen as a gateway to harder drugs.

Martin has introduced a measure to recriminalize home use of marijuana that contains sections asserting that the drug is genuinely "detrimental to the health, welfare and safety of Alaskans." An identical bill was introduced in the Senate by Paul Fischer, R-Soldotna.

"You didn't have this in the old law, which was the reason the Supreme Court was able to say rights to privacy outweighed the state's right to control marijuana possession," Martin said.

The bills assert that THC, "the mind altering substance in marijuana," builds up in the body's fatty tissues and takes weeks to eliminate. The THC, the bills contend, causes moodiness, depression, insomnia, appetite loss, lack of initiative, schizophrenia, illusions, hallucinations and lung cancer. "One marijuana cigarette a day may cause lung cancer in three years," the measures assert, and "The THC content of a marijuana cigarette 10 years ago was 1 percent, but is as high as 10 percent per cigarette today."

Martin said the assertions were gathered from national [illegible] and stu[illegible]

ies.

But Matt Felix, who heads the state Office of Alcoholism and Drug Abuse in Juneau, said evidence of harmful effects hasn't changed much since the Ravin decision. "There has been a lot of new research, but not new evidence. The evidence is that marijuana affects perception, long-term memory, and to a lesser degree, motor skills," he said.

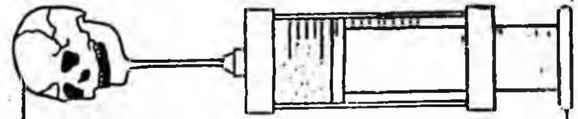
Avrum Gross, a Juneau lawyer who was the attorney general when the high court ruled in the Ravin case, said Martin is engaging in wishful thinking. "The court considered marijuana's harmful effects when it ruled on the issue last time, and the harmful effects haven't changed."

"What the court said was not that marijuana is good but that invasion of privacy is bad," Gross said.

"So some legislators want to ban marijuana. So what else is new?" said Ravin, who was reached at his law office in Homer. There is nothing, he said, that would compel the Supreme Court to change its ruling. "The situation hasn't changed," he said.

Martin said he hoped public pressure might sway lawmakers to pass a new law. He pointed to a national anti-drug campaign that began last year from the White House, and noted that the Anchorage Assembly and the Alaska Association of School Governments, representing 60 state high schools, are among groups that have urged passage of a law banning use and possession of marijuana at home.

One aspect of Martin's proposal that could stir serious opposition is its cost at a time of vastly lower state revenue. The Alaska Department of Law estimates that it would cost about $237,000 to defend and enforce the law the first year. But Martin said new federal funding to combat drug abuse would become available to defray the expense[illegible] Pettyjohn [illegible]

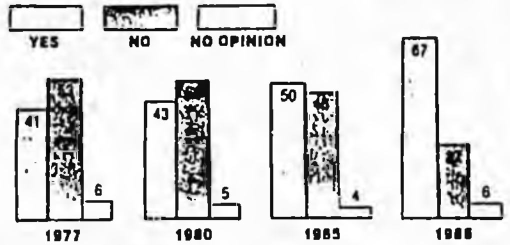


The fight against drugs

Sixty-seven percent of Americans now favor criminal penalties for possession of illegal drugs, compared to 41 percent in 1977, according to a recent Gallup Poll. Forty-three percent of those polled believed abuse of crack and other forms of cocaine to be the most serious drug problem in the U.S., while 34 percent thought that alcohol abuse was the most serious problem. More than 40 percent felt teaching young people about the dangers of drugs should be the government's highest priority in the fight against drug abuse.

CRIMINAL PENALTIES FOR POSSESSION

In percent responding to the question:
Do you think the possession of small amounts of marijuana should be treated as a criminal offense?

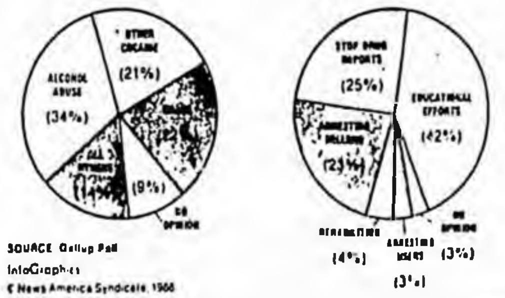


MOST SERIOUS SUBSTANCE PROBLEM

In percent responding to the question: Which one of the following do you think is the most serious problem for society today?

GOVERNMENT PRIORITIES

In percent responding to the question: There are many things that our government is doing to fight drug use. Which one of the following do you think deserves the most money and effort?



SOURCE: Gallup Poll
InfoGraphics
© News America Syndicate, 1986

Anchorage Daily News Jackie Kintzel

nents who consider the cost issue a red herring. "In other states where marijuana is illegal, arrests are incidental to other investigations. In other words, police don't make wholesale arrests for possession of small amounts of marijuana. That would be the situation here, too."

William R. Nix, acting commissioner of the state Department of Public Safety, suggests the cost issue is largely irrelevant.

"Recriminalizing marijuana would not, as some fear, result in wholesale arrest of individuals possessing small amounts of marijuana. The present drug enforcement philosophy of source interdiction recognizes the far greater cost-effectiveness of striking against high-level distributors, and sadly, there is no lack of high level drug dealers in Alaska to occupy the law enforcement efforts of [illegible]

The Drug Trade

Controversy Surrounds The Way the Dutch Treat Heroin Addicts

Liberalized Laws Stress Aid Rather Than Penalties; Other Nations Are Irked

Life Aboard a Junkie Boat

By L. Erik Calonius
Staff Reporter of The Wall Street Journal

AMSTERDAM, the Netherlands—In the Milky Way, a city-financed recreation center here, a scattering of youths are dancing to a rock band. In a darkened auditorium upstairs, perhaps a hundred more are watching an "Our Gang" comedy. Others eat at a cafe or browse among books on politics, handicrafts and pop music.

In one room a young man sits behind a table and sells marijuana and hashish. A small sign before him gives the prices of Colombian, Lebanese, Moroccan and Afghan varieties of both substances. He also sells almonds, cashews, raisins and dried fruits. On this night, he is doing a better business in fruit and nuts: Of the several hundred customers in the big nightspot, only a few are smoking joints.

LAST OF A SERIES

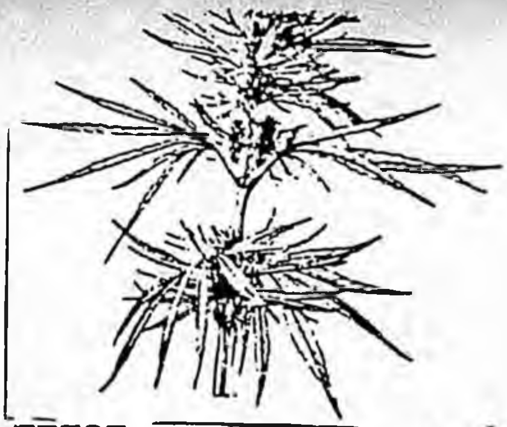
Marijuana has ceased to be a big issue in the Netherlands. Pot has been sold freely in cafes and youth centers since 1978, when the government concluded that the substance was "relatively innocuous" and dropped all criminal penalties for using it. "Cannabis used to be the symbol of the youth culture—it was attractive because it was forbidden," says Eddy Engelsman, who himself grew up in the youth culture of the 1960s and now is the secretary for drug policy of the Dutch Health Ministry. "Our aim was to turn it into an unsensational item."

Idea That Works

The idea seems to have worked: Fewer young people smoke pot in the Netherlands than in several countries that impose criminal penalties for the activity. In a recent study, more than four-fifths of the young people surveyed said they had no interest in smoking marijuana, although it is as easy to buy here as a bar of chocolate. And less than 2%, according to other studies, say they are "regular" users who smoke pot at least once a week.

(The U.S. does not keep comparable statistics. Its most recent survey classifies 11.5% of youths aged 12 to 17 and 27.4% of youths 18 to 25 as "regular" users but defines regular as having smoked pot within a month of being surveyed [illegible]

Liberalization of marijuana hasn't caused any health problems or criminal problems, Dutch officials say. "Because society hasn't defined it as a problem, it isn't a problem," says Peter Cohen, a psychologist and drug adviser to the government.



Exogens]

787.—HEMP.
CANNABIS SATIVUS. F. 393.

Early Renaissance drawing of cannabis

KEVIN B. ZEESE

Legalize marijuana; leave growers alone

WASHINGTON — U.S. marijuana policy is at a crossroads:

The government can continue its futile war against marijuana, a war of escalating violence and unprecedented military law enforcement tactics. Or we can end the violence by regulating and taxing marijuana as a legal commodity.

Prohibition breeds violence, as we saw 60 years ago during alcohol prohibition. Today, marijuana farmers cannot call the police or their insurance agent when their crop is stolen; some have chosen to protect the crop themselves. While violence has been exaggerated, to stop the violence we must stop the marijuana war.

Billions have been spent on enforcement and millions of Americans have been arrested. Cops and cultivators, smugglers and smokers, and more than a few innocent bystanders have been maimed or killed.

Has the government won its war? No. After 15 years of all-out war, the number of people smoking marijuana has tripled, the age of first use has declined, and your child and mine can buy marijuana anywhere in America.

Stepping up the war does not lead to victory, only to more violence. Laws cannot stop marijuana. It is a felony to grow marijuana, yet the U.S. marijuana crop last year was worth $13.9 billion, challenging corn as the USA's largest cash crop.

To stop the violence, we must confront facts: Marijuana prohibition cannot compete with the law of supply and demand. Efforts to crush this burgeoning industry by seizing

Kevin B. Zeese is national director of the National Organization for the Reform of Marijuana Laws.

crops have no impact on the market. At best, 15 percent of the crop is seized, temporarily increasing its price.

Increased prices only make marijuana farming more financially lucrative, attracting more people to grow it and increasing what they will do to protect their crop.

This year, more than 30 states involved National Guard troops in marijuana enforcement. Last week, a federal judge stopped abuses of California's Campaign Against Marijuana Planting after we brought suit, charging that CAMP troops were shooting farm animals, terrorizing people with helicopters, cutting off rural water supplies without notice and using the National Guard to set up roadblocks and conduct warrantless searches of people's homes at gunpoint.

We face a choice: Do we continue down the path of violence and unprecedented military police programs, or should we regulate and tax marijuana as a legal commodity?

We can only end marijuana-related violence by regulating and taxing marijuana. Regulation and taxation can bring it under control, keep the drug away from children, raise $[illegible] billion in new tax revenue, take billions from crime, and fund credible drug education programs.

The government's war against marijuana has failed. It is time for a marijuana truce.

REASON

December 1984

p. 18-20

WORDS OF PEACE ON THE DRUG WAR

It's a sign of changing times indeed: Florida's 4-H Club, in a recent mock legislative session of 200 teenage members, overwhelmingly passed an amendment to legalize marijuana as a cash crop. The farm youth club may have acted only from self-interest—rather than out of principle—but its action may be indicative of a widening strain of rethinking drug prohibition.

An especially noteworthy instance of this was the recent publication of Arnold Trebach's essay "Time to Declare a Drug Truce"—in the *Wall Street Journal*. Trebach, director of the Institute on Drugs, Crime and Justice at American University and author of the 1983 book *The Heroin Solution* (Yale University Press), announced that "we have had enough of drug wars" and that "we can rationally coexist with a good deal of drug use in our society." In any case, "we do *not* have the power to make it go away," noted Trebach. Calling President Reagan's "War on Drugs" a failure, he urged the establishment of "some form of 'drug peace.'"

Trebach pointed out various irrationalities about drug prohibition in addition to its obvious unenforceability. For example, while abuse of (legal) tobacco causes some 300,000 deaths a year, there were only about 1,800 deaths from overdoses of (illegal) heroin and cocaine, and "deaths from marijuana overdose are not estimated because they are virtually nonexistent." Moreover, studies have shown that for alcohol, heroin, and cocaine, only about 1 of 10 users of these substances becomes dependent on them, while 8.5 out of 10 tobacco users develop a dependence. And Trebach also noted that the number of Americans using tobacco has dropped from nearly 43 percent in 1965 to 32 percent last year—without tobacco prohibition.

Trebach proposed that national drug prohibition be repealed in favor of a "states-rights model"—whereby each state would set its own policy on drugs. He suggested that drugs be dispensed under a government-regulated system, as are tobacco, alcohol, and pharmaceutical drugs.

That certainly falls short of an "individual rights-free market model," whereby *individuals* would set their policy on drug use, and market forces, including consumer preferences, would "regulate" purchasing conditions, availability, distribution, etc. But Trebach's specific proposal is perhaps less important than the unconventional wisdom that lies beneath it: the recognition that the war on drugs—which, for federal drug-enforcement efforts, alone, will consume $1.22 billion of taxpayers' money in fiscal year 1985—is not only futile but counterproductive. With decriminalization, Trebach contended, "the drug scene might be characterized only by the naturally [illegible] disorders of a democracy and not [illegible]terrorizing levels of crime and a war against the sometimes destructive personal habits of our neighbors that we cannot control."

officials several directives aimed at reducing cross-subsidization within the airline industry and at making it easier to get licenses for service on nonmajor routes.

There's still a long way to go. The dinosaur-like state airlines are still living off the fat of the taxpayer, and there are still many routes in Europe where heavy regulation makes entrepreneurial airlines untenable. But Ridley may be prescient. The dominos may be toppling, and consumers will benefit as a result.

HOW THE DUTCH TREAT DRUGS

AMSTERDAM—What happens when a nation ends its prohibition of marijuana? In 1978 the Dutch government declared that pot is "relatively innocuous" and decriminalized its use. The result: "Fewer young people smoke pot in the Netherlands than in several countries that impose criminal penalties for the activity," the *Wall Street Journal* recently reported. Though pot has been sold freely throughout the country since decriminalization in 1978, the *Journal* noted, "marijuana has ceased to be a big issue in the Netherlands." Furthermore, according to Dutch officials, no health or criminal problems have resulted from the new pot freedom.

Following its liberalized pot policy, the Dutch government relaxed its heroin policy as well, concentrating on caring for addicts rather than penalizing them. The new policy arose out of several assumptions about heroin use, including the recognition that no matter how vigilant the authorities in trying to prevent heroin importation into the country, some would still get in and some people would still use it. Whatever may be the cause-and-effect relationship between the liberalized policy and heroin use in the Netherlands, it is at least interesting to note that the country has one-third fewer heroin addicts relative to its population than does the United States.

Local authorities in Amsterdam, where heroin use appears to be on the rise, are pushing for even more-radical reforms in the city's heroin policy and are seeking permission from the national government to dispense heroin to addicts on an experimental basis. Addict-related crime, the authorities believe, is increasing, and they suggest that freely dispensed heroin may obviate addicts' need to support their habits by stealing.

The Dutch government remains resistant to Amsterdam's request to further liberalize its heroin policy. But if the city goes ahead with the experiment, the results should be well worth watching: they may provide some indication of what could occur if authorities lifted the heroin ban altogether and allowed individuals to freely buy and sell the substance.

An Analysis of Marijuana Policy

Committee on Substance Abuse and Habitual Behavior

Commission on Behavioral and Social Sciences and Education

National Research Council

National Academy Press
Washington, D.C.   1982

Reprinted and distributed at cost by NORML
with the permission of the National Academy
Press, Washington, D.C.

NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

The National Research Council was established by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and of advising the federal government. The Council operates in accordance with general policies determined by the Academy under the authority of its congressional charter of 1863, which establishes the Academy as a private, nonprofit, self-governing membership corporation. The Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in the conduct of their services to the government, the public, and the scientific and engineering communities. It is administered jointly by both Academies and the Institute of Medicine. The National Academy of Engineering and the Institute of Medicine were established in 1964 and 1970, respectively, under the charter of the National Academy of Sciences.

Available from:

Commission on Behavioral and Social Sciences and Education
National Research Council
2101 Constitution Avenue, N.W.
Washington, D.C. 20418

Printed in the United States of America

NATIONAL RESEARCH COUNCIL

2101 CONSTITUTION AVENUE WASHINGTON, D. C. 20418

OFFICE OF THE CHAIRMAN

June 21, 1982

Dr. William Pollin, Director
National Institute on Drug Abuse
Parklawn Building
Room 10-05
5600 Fishers Lane
Rockville, Maryland 20857

Dear Dr. Pollin:

I transmit, herewith, a report of the National Research Council's Committee on Substance Abuse and Habitual Behavior: "An Analysis of Marijuana Policy" prepared at the request of the National Institute on Drug Abuse.

The Committee on Substance Abuse and Habitual Behavior, composed of 18 experts in the several relevant disciplines, has weighed carefully the available data regarding the costs, risks, and benefits of the major policy alternatives regarding the control of marijuana use and supply. The Committee is clear in pointing to the deficiencies of this body of evidence and cautions about the hazards of formulating policy recommendations based solely or in part thereon. In this regard, I call your attention to the following statement by Louis Lasagna and Gardner Lindzey contained in the Preface to the report:

> The Committee wishes to make clear what it regards as the limits of this report for the selection of policy alternatives. Scientific judgment can estimate the prevalence of different kinds of use, risks to health, economic costs, and the like under current policies and try to project such estimates for new policies. It can come to some conclusions based on those estimates. But selection of an alternative is always a value-governed choice, which can ultimately be made only by the political process.

This caveat notwithstanding, the Committee has derived from its examination of the scientific data a conclusion about the major policy choices facing the nation with respect to marijuana: complete prohibition, prohibition of supply only, and regulatory approaches. Specifically, the Committee concurs with the judgment of the National Commission on Marijuana and Drug Abuse, rendered in 1971, that a policy of prohibition of supply only is preferable to a policy of complete prohibition of supply and use.

What must be understood by the public, the media, and all who read the Committee's report is that its decision to endorse a policy change was not fashioned from scientific information--old or new--alone. Rather it was the analysis of a combination of factors which affect policy decisions, including the cost and efficacy of enforcement practices. Values were necessarily involved in balancing these factors and there are those within the membership and governing bodies of the Academies and the National Research Council who might not have come to the same policy conclusions, after reviewing the same data.

My own view is that the data available to the Committee were insufficient to justify on scientific or analytical grounds changes in current policies dealing with the use of marijuana. In this respect I am concerned that the Committee may have gone beyond its charge in stating a judgment so value-laden, that it should have been left to the political process.

I have one further concern that cannot go unaddressed. I fear that this report, coming as it does from a well-known and well-respected scientific organization, will be misunderstood by the media and the public to imply that new scientific data are suddenly available that justify changes in public attitudes on the use of marijuana. This would be unfortunate at a time when daily use trends by high school students are down significantly. As the Committee's discussion of marijuana's behavioral and health-related effects clearly demonstrates, there is no new scientific information exonerating marijuana. In fact, the review by our Institute of Medicine, published a few months ago, reevaluated existing scientific evidence and concluded, as have others, that marijuana is a harmful drug whose use justifies serious national concern.

I wish to remind you that this is a committee report; the only position that can be inferred with respect to the National Research Council on the issue of marijuana policy is that the National Research Council is satisfied that the Committee was competent to examine the issue and diligent in carrying out its task. Despite my personal disagreement, I believe that the Committee has performed a useful service by illuminating many of the complex issues surrounding this highly controversial subject.

Yours sincerely,

Frank Press

Frank Press
Chairman

COMMITTEE ON SUBSTANCE ABUSE AND HABITUAL BEHAVIOR

LOUIS LASAGNA (Chair), Department of Pharmacology and Toxicology, University of Rochester School of Medicine and Dentistry
HOWARD S. BECKER, Department of Sociology, Northwestern University
PETER DEWS, Department of Psychiatry and Psychobiology, Harvard University
JOHN L. FALK, Department of Psychology, Rutgers University
DANIEL X. FREEDMAN, Department of Psychiatry, University of Chicago
JEROME H. JAFFE, Veterans Administration Hospital, Newington, Connecticut, and University of Connecticut School of Medicine, Farmington, Connecticut
DENISE KANDEL, Department of Psychiatry and School of Public Health, Columbia University, and New York State Psychiatric Institute
JOHN KAPLAN, Stanford University School of Law
GARDNER LINDZEY (past chair), Center for Advanced Study in the Behavioral Sciences, Stanford, California
GERALD McCLEARN, College of Human Development, Pennsylvania State University
CHARLES P. O'BRIEN, Veterans Administration Hospital, Philadelphia, and Department of Psychiatry, University of Pennsylvania
JUDITH RODIN, Department of Psychology, Yale University
STANLEY SCHACHTER, Department of Psychology, Columbia University
THOMAS C. SCHELLING, John F. Kennedy School of Government, Harvard University
RICHARD L. SOLOMON, Department of Psychology, University of Pennsylvania
FRANK STANTON, New York (formerly, president, Columbia Broadcasting System)
ALBERT STUNKARD, Department of Psychiatry, University of Pennsylvania
RICHARD F. THOMPSON, Department of Psychology, Stanford University

PETER K. LEVISON, Study Director
DEAN R. GERSTEIN, Senior Research Associate
DEBORAH R. MALOFF, Research Associate
MARIE A. CLARK, Administrative Secretary

CONTENTS

PREFACE

In 1978 the Committee on Substance Abuse and Habitual Behavior began a study of marijuana policy at the request and with the support of the National Institute on Drug Abuse. Sharp increases in marijuana use along with suggestions for reform of existing marijuana laws from scientists and policy makers prompted a renewed look at those laws. In addition, the National Commission on Marijuana and Drug Abuse, in its 1973 final report, Drug Use in America: Problem in Perspective, had recommended that a follow-up commission be appointed to review possible changes in the situation four years later. That recommendation was not implemented, so the Committee took as a framework for its task the assessment that the Commission recommended, especially the assessment of new evidence regarding the effects of recent changes in state marijuana policies.

The Committee conducted its study with awareness of the intensity of past controversies about marijuana use in U.S. society. In the four years since the Committee began its work, there has been an increase in visible concern among many parents about marijuana use among youth, its potential risks to the health of children, and the possibility that heavy use by some young people may seriously threaten their education. Parents who have experienced problems with their own children, or observed those of others, have organized to make marijuana policies a major item on current political agendas. In comparison with the situation at the inception of this study, there is today greater rancor in public discussion, press reports, legislative hearings, and policy-oriented technical meetings related to marijuana use.

This is the context in which the Committee completed its review of the evidence and arguments of earlier studies and weighed the significance of subsequent evidence for the major policy alternatives. Every policy has potentially good and potentially bad effects, and policy choices involve difficult comparisons of such effects. It is important to recognize that to allow the inertia developed by existing policies to prevent change is itself a choice.

The Committee is aware that analyzing a topic that is the subject of heated social debate has its hazards. Many of those participating in the marijuana debate have already selected what they take to be the admissible terms of the discussion and look with disfavor on anyone's insistence on a wider set of considerations. For example, some would settle the issue on physiological grounds alone: whether cannabis products, in the dose ranges customarily used by most people, cause tissue damage. Defenders of marijuana use may seize on the ambiguity or absence of evidence for such damage and ignore any other effects on education or safety; those opposed to marijuana use may emphasize the possibility of chronic disease that is suggested by some laboratory findings and ignore the social, political, and economic costs of fighting a well-established custom.

This report does not review and analyze every conceivable policy nuance or option. It addresses the major choices--both because these families of alternative policies subsume many variants and because the choice among these major options must be discussed before specific, perhaps new, policy instruments can be designed.

The Committee wishes to make clear what it regards as the limits of this report for the selection of policy alteratives. Scientific judgment can estimate the prevalence of different kinds of use, risks to health, economic costs, and the like under current policies and can try to project such estimates for new policies. It can come to some conclusions based on those estimates. But selection of an alternative is always a value-governed choice, which can ultimately be made only by the political process. The role of scientific evidence in this process is not inconsiderable, even though, at times, the strongest evidence may be pushed aside and the wildest speculation prevail. But the weight of the evidence is only one factor in the process of policy formation; ultimately, that process involves value choices.

In completing its report, the Committee has benefited from many people in formulating, revising, and updating the analyses and data. A very early version of this report was discussed at the Committee's annual conference in 1979, and subsequent versions benefited from comments by staff of the National Institute on Drug Abuse and of the National Research Council. The final draft received close and constructive attention by members of the National Research Council's Commission on Behavioral and Social Sciences and Education, the Institute of Medicine, and the Report Review Committee of the National Academy of Sciences.

We have also maintained a close liaison with the staff and members of the Institute of Medicine's Committee to Study the Health-Related Effects of Cannabis and Its Derivatives, on which three members of our Committee also served, and whose recently published report, Marijuana and Health, significantly contributed to our work.

Two former Committee members, Troy Duster and Michael Agar, assisted in the early preparation of the report. At later stages we were very ably assisted by the staff of the Commission on Behavioral and Social Sciences and Education, in particular David Goslin, executive director, and Eugenia Grohman, associate director for reports. Without their help, it is doubtful that we could have completed this task. Finally, we are indebted to the staff and members of the Committee, for their diligence, patience, and commitment to a difficult assignment.

Louis Lasagna, Chair
Gardner Lindzey, Chair, 1977-1980
Committee on Substance Abuse and
Habitual Behavior

An Analysis of Marijuana Policy

INTRODUCTION

Since the early 1960s the use of marijuana as an intoxicant by a growing proportion of the American population has been an issue of major national concern. Despite repeated warnings of possible adverse health consequences and persistent efforts by law enforcement agencies to restrict the supply and use of marijuana, available data indicate that experimentation with or regular use of the drug is no longer restricted to a small minority of Americans. In 1979, for example, 68 percent of young adults between the ages of 18 and 25 reported having tried marijuana; 35.4 percent reported having used marijuana in the last month. Among adults over age 26, the proportion having ever used marijuana has more than doubled since 1971, from 9.2 percent to 19.6 percent (Fishburne et al., 1980; see Table 1, below).

Although "the marijuana problem" may be viewed as of recent origin, marijuana is not a new drug. The cannabis plant has been cultivated and used both for its intoxicating properties and for its fiber (hemp) throughout the world for more than 10,000 years (Abel, 1980). At various times and places attempts have been made to restrict its use as an intoxicant; at other times and places its virtues have been extolled for medical purposes, and it has played a significant role in religious ritual. Because cannabis is easily grown--indeed, it is one of the hardiest of all plant species--its resin has been used for centuries along with tobacco, fermented distillates of grains and fruits (alcohol), and opium derivatives as one means of relieving stresses associated with daily life.

Despite its long history, the use of cannabis as an intoxicant was relatively unknown in the United States until the latter part of the nineteenth century, and even then its use as a drug was restricted to a tiny fraction of the population, primarily immigrants from Mexico. The first efforts to restrict its use in this country did not occur until 1911, when Congress, which at that time was considering proposals for federal antinarcotics legislation, listened to arguments that cannabis should be included in the list of illegal drugs. That effort failed, but during the next two decades a number of state legislatures moved to prohibit the possession of marijuana unless prescribed by a physician. It was not until 1937, when the Marijuana Tax Law was enacted, that the federal government became involved in the attempt to control its use. Even this law recognized the industrial uses of hemp and also exempted the seeds of the plant, which were then being sold as bird feed. In 1956, Congress included marijuana in the Narcotics Act of that year and, in 1961, the United Nations adopted the Single Convention on Narcotic Drugs, the terms of which state that each participating country could "adopt such measures as may be necessary to prevent misuse of, and illicit traffic in, the leaves of the cannabis plant." Congress approved participation in the convention in 1967 and three years later passed the Comprehensive Drug Abuse Prevention and Control Act, which provides the basis for current federal prohibitions regarding marijuana use.

Despite this history it was not until the 1960s that most Americans became aware of marijuana. The political and cultural protests of that period focused public attention on young people, their life-styles, and their use of drugs, including marijuana. That period created the context in which public policies regarding marijuana use have been debated since the early 1970s. As Abel (1980) points out, for the first time marijuana use was not restricted to minority groups and fringe elements of society: many of the new users were native-born, middle-class, white college students. Without doubt, the political and cultural context in which marijuana emerged as an issue of national concern has strongly influenced the subsequent policy debate about its use.

The policy debate about marijuana use has also brought into sharp focus two conflicting but deeply held beliefs of large and overlapping segments of the American population. To many, the use of drugs of any kind solely for the purpose of producing states of intoxication is abhorrent, entirely apart from any presumed health effects. At the same time, many people strongly defend the right of individuals to privately indulge their desires, so long as others are not adversely affected. Adding to the complexity of the issues are continuing uncertainties about the health and developmental consequences of marijuana use, concern over the growing number of adolescent users, the social consequences of prosecuting otherwise law-abiding citizens for possession and use of marijuana, the relationship between the distribution of marijuana and that of other illegal drugs, the costs of enforcement of current laws, and the economic implications of the persistence of very large illegal markets.

The next section of this report presents a brief summary of existing evidence regarding the health consequences of marijuana use, drawing heavily on the recently completed study by the Institute of Medicine. The third section summarizes existing federal and state laws relating to the supply and use of marijuana. The fourth section of the report reviews the conclusions of the report of the National Commission on Marijuana and Drug Abuse (1972). The next two sections deal, respectively, with policies regarding the use and the supply of marijuana. The two final sections present a summary of the committee's conclusions regarding major policy options and recommendations for research needed to more adequately assess those options.

THE DANGERS OF MARIJUANA

Marijuana is not a harmless drug. Although available evidence suggests that marijuana may be less likely than opiates, barbiturates, or alcohol to induce psychological and physical dependence in its users, it has the capacity to reduce the effective functioning of individuals under its influence, and prolonged or excessive use may cause serious harmful biological and social effects in many users.

The recent report, Marijuana and Health, of the Institute of Medicine (1982:5 [reproduced in the appendix]) concludes:

> The scientific evidence published to date indicates that marijuana has a broad range of psychological and biological effects, some of

> which, at least under certain conditions, are harmful to human health. Unfortunately, the available information does not tell us how serious this risk may be.

Overall, the report concludes (p. 5):

> [W]hat little we know for certain about the effects of marijuana on human health--and all that we have reason to suspect--justifies serious national concern.

The complete summary of the Institute of Medicine report appears as the appendix to this report.

Over the past 40 years, marijuana has been accused of causing an array of antisocial effects, including: in the 1930s, provoking crime and violence; in the early 1950s, leading to heroin addiction; and in the late 1960s, making people passive, lowering motivation and productivity, and destroying the American work ethic in young people. Although beliefs in these effects persist among many people, they have not been substantiated by scientific evidence.

Concerns about how marijuana affects citizenship, motivation, and job performance have become less salient in recent years as marijuana has moved more into the mainstream of society and has become less exclusively associated with radicals, hippies, or disadvantaged minorities. Though there is still widespread belief that heavy marijuana use may be incompatible with a responsible, productive life, evidence that marijuana has not adversely affected either the productivity or the sense of social responsibility of some groups of users (see, e.g., Hochman and Brill, 1973) has tempered earlier fears of a widespread "amotivational syndrome." Research that correlates marijuana use with undesirable behavior, such as alienation or inattention to school studies, has not established the direction of causality or ruled out spurious associations (see, e.g., Beachy et al., 1979). This issue, however, continues to be the subject of lively controversy and the Institute of Medicine report (1982:125) concludes that "it appears likely that both self-selection and authentic drug effects contribute to the 'motivational' problems seen in some chronic marijuana users."

Recently, a body of literature has accumulated that reports on links between marijuana use and such health impairments as lung disease, chromosome damage, reduced reproductive function, and brain dysfunction (summarized in Institute of Medicine, 1982, and National Institute on Drug Abuse, 1980). In some areas--for example, effects on the nervous system and behavior and on the cardiovascular and respiratory systems--there is clear evidence that marijuana produces acute short-term effects (Institute of Medicine, 1982:2,3):

> With a severity directly related to dose, marijuana impairs motor coordination and affects tracking ability and sensory and perceptual functions important for safe driving and the operation of other machines. . . . [It also] increases the work of the heart, usually by raising the heart rate and, in some persons, by raising blood pressure.

There is as yet no such clear evidence on the possible long-term effects in these areas, or of other potential health consequences of marijuana use; further research is needed. In addition, most studies on human populations have been laboratory studies of young, healthy adult males. Differential effects of marijuana use on the elderly, on pregnant women, on groups that are psychiatrically vulnerable or at risk for disease or dysfunction, and particularly on adolescents have not been studied systematically.

In our view, the most troublesome aspects of marijuana use are its potential effects on the development of adolescents. Parents as well as a number of clinicians and researchers are concerned that the social and intellectual development of teenagers may be harmed by chronic marijuana use. There is good evidence that intoxication may seriously impair such important skills as comprehension and retention of newly presented educational materials (Institute of Medicine, 1982). Rapidly growing tissues have been shown to be particularly vulnerable to some, although by no means all, toxic agents, and there is at least a possibility that toxic effects may be subtle and not clearly manifest until adulthood. Scientifically, these are difficult relationships to identify, and the research to date is still insufficient to strongly support any relationship.

Perhaps more significant than any lasting biological effect is the effect of the drug in different patterns of use on emotional development, on the formation of habits, and on the acquisition of coping skills for stress situations. Indeed, although the many issues raised by the use of intoxicants to escape stressful challenge have not been systematically studied, the evident attractiveness of marijuana to many adolescents, and its possible dose-related interference with the study and hard work needed for intellectual development in the crucial high school years, make this a special matter for concern. This is particularly so in light of the fact that, unlike alcohol, marijuana is used by many adolescents during school hours. Finally, reports of the effects of marijuana use on automobile driving skills are worrisome.

This Committee has reviewed the scientific literature surveys of marijuana effects on health and behavior, including the major recent study conducted by the Institute of Medicine (1982) and those by the National Institute on Drug Abuse (1979; 1980), Tashkin et al. (1978), Nahas (1977), and Fried (1977). We agree with the conclusion of the Institute of Medicine report that it is likely that long-term heavy marijuana use will be shown to result in measurable damage to health, just as long-term chronic tobacco and alcohol use have proven to cause such damage. It is evident that the full impact of marijuana use on human health will not be clear without careful epidemiological studies involving substantial populations of users--a matter of some decades--even though it is predictable that this drug--like all others--will cause harm in some of its users, particularly in its heaviest users, and among these, in its heaviest adolescent users. At this time, however, our judgment as to behavioral and health-related hazards is that the research has not established a danger both large and grave enoug' to override all other factors affecting a policy decision.

OVERVIEW OF CURRENT MARIJUANA POLICIES

Current federal and state marijuana laws are in part governed by international treaty. The major federal law relevant to marijuana is the Comprehensive Drug Abuse Prevention and Control Act of 1970, which repealed all prior federal legislation and reduced federal penalties for possession and sale. Although marijuana possession and sale are still prohibited, possession has been reduced from a felony to a misdemeanor offense; the maximum penalty for a first offense is $5,000 and one year's imprisonment. The Act also provides for conditional discharge, by which first offenders found guilty of simple possession or casual transfer (which is treated as simple possession) may be placed on probation for up to one year (Congressional Digest, 1979).

The Uniform Controlled Substance Act of 1970, drafted by the National Conference of Commissioners on Uniform State Laws, was designed to make state laws more compatible with the new federal law. Like the federal act, the Uniform Act reclassified marijuana as a hallucinogen rather than a narcotic and reduced the penalty for possession from the felony to the misdemeanor level; a majority of the states have adopted the Uniform Act. Eleven states have withdrawn the criminal sanction from possession for personal use. In these states, arrest has been replaced with a traffic-ticket type of citation, and a small fine is the sole allowable penalty. About 30 states include some provision for conditional discharge of first offenders, and about a dozen of them provide for all records of the offense to be expunged. The Alaska Supreme Court ruled in 1975 that possession for personal use by adults at home was protected by the constitutional right to privacy and hence was not subject to any penalty (Rosenthal, 1979).

State penalties for second-offense possession and for selling marijuana are extremely variable. (See National Organization for the Reform of Marijuana Laws and Center for Study of Non-Medical Drug Use, 1979, for summary tables of state marijuana laws.) Sale is almost always a felony, with maximum sentences ranging from two years to life, although casual transfer, or "accommodation," is sometimes exempt from felony treatment. All but 15 jurisdictions punish cultivation as heavily as they do sale; the Uniform Act includes the two in the same classification (manufacture), with the same penalty provisions.

Federal prohibition of small-scale possession is virtually unenforced. At the March 1977 House of Representatives hearings on decriminalization, the chief of the criminal division of the Department of Justice testified that the federal government no longer effectively prosecutes the use of marijuana, "nor do we, under any conceivable way, in the Federal Government have the resources to do so" (Select Committee on Narcotics Abuse and Control, 1977:13). In terms of its effects from a law enforcement point of view, the present official federal policy of complete prohibition does not differ in fact from a policy of prohibition of supply only. Complete prohibition is the federal law, but partial prohibition is the practice. However, the law, even though partly unenforced, has probably had a restraining influence on the willingness of states to adopt policies of less than complete prohibition. The states traditionally have followed the federal lead in drug abuse legislation, although they are not legally required to do so (see the testimony of Jay Miller, American Civil Liberties Union, to the Select Committee on Narcotics Abuse and Control, 1977). In summary, in most states and according to federal law, U.S. marijuana policy is one of complete prohibition--that is, prohibition of both supply and use.

Major alternatives to complete prohibition include prohibition of supply only--called partial prohibition--and regulation.* Prohibition of supply only means having no penalty (or only civil penalties) for use, possession, or, sometimes, "casual transfer" of small quantities of marijuana, while having criminal penalties for manufacture, importation, or commercial sale of marijuana. Regulation means not only eliminating penalties for use but also allowing controlled production and distribution.

Within each of the three broad policy options--complete prohibition, prohibition of supply only, and regulation--numerous subsidiary policy choices exist. For example, a policy of complete prohibition necessitates decisions about the resources to be devoted to enforcement, the appropriate penalties to be imposed for violations, and whether marijuana should be made available for any medical uses. Under a policy of prohibition of supply only, decisions must still be made about penalties and permitted medical uses. In addition, one must also determine how to distinguish between users

---

*In this discussion, we use the terms "complete prohibition," and "prohibition of supply and use" interchangeably. We also use the terms "partial prohibition," "prohibition of supply only," and "decriminalization" as equivalent. We generally prefer the terms "partial prohibition," or "prohibition of supply only" since many people seem to regard decriminalization as the equivalent of legalization or regulation--which it most certainly is not. (The policy of partial prohibition has also been called the vice model.) Finally, we use "regulation" and "legalization" as equivalent terms.

and suppliers; whether cultivation should be permitted; how stronger preparations of the cannabis plant, such as hashish, should be treated; whether to criminalize small-scale casual transfers, made with or without payment; and what should be done about certain specific behaviors, such as the public use of marijuana and the operation of motor vehicles under the influence of the drug. Under a policy of regulation, some of the issues to be decided are the type of control system (e.g., state monopoly or licensed sale), the rules as to potency and quality, and appropriate penalties for violation of the system's rules.

The variety of choices within each of the broad policy options suggests that none can be characterized in a monolithic way. Some regulatory systems could be so stringent as to have results similar to prohibitory laws: e.g., a regulatory system that raised the price drastically above what the illegal market charges. Similarly, lack of enforcement could strongly reduce the impact of a prohibitory option. As we have already noted, this latter effect has already occurred in some jurisdictions in which the law provides for complete prohibition but users are not in fact prosecuted.

A REVIEW OF THE REPORT OF THE NATIONAL COMMISSION ON MARIJUANA AND DRUG ABUSE

An attempt to describe a full array of policy options together with associated benefits and detriments of each of them was made by the National Commission on Marijuana and Drug Abuse in its 1972 report, Marijuana: A Signal of Misunderstanding. With respect to the major policy choices, the Commission did a thorough job. The members and staff recognized the limited knowledge base for their deliberations and subsequently recommended that a second commission be appointed to review the situation four years later. Such a follow-up commission was never appointed. It seems appropriate, then, that this Committee reappraise the Commission's work in light of subsequent research findings, especially those relating to recent changes in marijuana policies.

The Commission examined the spectrum of social policies available to control marijuana use and the benefits and detriments of implementing each policy. The legal alternatives presented included those identified above: complete prohibition; prohibition of supply only; and regulatory approaches. The Commission emphasized that choosing among the three approaches requires consideration of the social milieu, cultural values, and practicalities of implementation. The Commission considered such social conditions particularly important in examining marijuana controls because both use of the drug and the laws prohibiting supply and use had symbolic importance, representing a clash of values between a dominant culture that opposed marijuana use and a large minority that either used marijuana or condoned its use. The probable effects of the various policies considered by the Commission include changes in use patterns, enforcement costs, and influence on related social concerns such as the marketing of other illicit drugs and general respect for law.

The Commission commented on all three broad policy options. It suggested first that total prohibition has resulted in costly enforcement, alienation of the young, discrimination through selective enforcement, some deterrence of supply (especially to middle-aged and middle-class potential users), but minimal deterrence of use by those with access to the drug. Second, the Commission stated its belief that prohibition of supply only would support the official policy of discouraging use, but at the same time would recognize the practical difficulties of attempting to eliminate use. The report listed a number of choices that might be made under a system of partial prohibition and described some of the practical problems they might entail (e.g., the need to distinguish between casual and commercial distributors). Finally, the Commission described regulation as a policy that only mildly disapproved of occasional use and that concentrated on controlling excessive use, but was mostly designed to lower the costs of prohibiting the drug. The Commission argued that marijuana consumption would increase considerably if complete prohibition were replaced by regulation. In addition, the Commission considered a major drawback of any regulatory system to be that its elimination of the main symbol of society's disapproval--criminal sanctions--would cause resentment among the nonuser majority of the population. Marijuana was described as being symbolic of countercultural lifestyles: "the drug's symbolism creates a risk of strong political reaction to any liberalization of the present laws by older members of the society" (National Commission on Marijuana and Drug Abuse, 1972, Appendix Volume II:1149).

On balance, the Commission concluded that, since the threat of punishment had not apparently deterred the millions of people who had already used marijuana, the replacement of complete by partial prohibition would not produce a significant increase in marijuana use. Consequently, the Commission recommended that individual marijuana users should not be subject to criminal prosecution for their private use or possession of small amounts of the drug, and that, on balance, the best policy was one of prohibition of supply only. In accordance with this view, the Commission recommended that federal and state laws should be amended to achieve partial prohibition. In the decade since the Commission report, a number of states have changed their laws in varying ways. These legal changes can be viewed as natural experiments, and one can use the data from them to reassess the Commission's conclusions regarding these policies.

THE USE OF MARIJUANA: COMPARING COMPLETE AND PARTIAL PROHIBITION

To compare the two types of marijuana control policies presently used in the United States--prohibition of supply and use and prohibition of supply only--we need to consider only the one particular in which they differ: the application of criminal sanctions against marijuana users. To compare the effects of the two policies, we can examine the effects of the prohibition of use and determine whether prohibition results in more costs than benefits or vice versa.

In recent years the prohibition of marijuana use has come under increasing criticism. Many students of the U.S. marijuana situation, including the National Commission on Marijuana and Drug Abuse, members of Congress, political analysts, and legal experts, have suggested that existing laws prohibiting marijuana use be repealed. These suggestions have been prompted by the failure of current policies to deter large numbers of users, the consequent criminalization of large numbers of young Americans, and the high social costs of such law enforcement. A number of professional associations and agencies have also gone on record in support of the removal of all criminal penalties for the private possession and use of marijuana as a means of reducing the economic costs of law enforcement and the social costs of arrest or imprisonment (criminalization) of young people who are otherwise not criminally involved or labeled. The organizations and agencies that have expressed this view include the American Medical Association, the American Bar Association, the American Public Health Association, the Canadian Commission of Inquiry into the Non-Medical Use of Drugs, the National Council of Churches, the National Advisory Commission on Criminal Justice Standards and Goals, the National Commission on Marijuana and Drug Abuse, among others. Eleven states, with one-third of the nation's population, have adopted some version of partial prohibition or "decriminalization." (In Oregon, Alaska, Maine, Colorado, California, Ohio, Minnesota, Mississippi, New York, North Carolina, and Nebraska, citations and small fines have replaced arrests and incarceration for use-only marijuana-related offenses.)

At first glance, criminalizing the selling of marijuana might appear inconsistent with failing to punish its purchase. But in the drafting of laws, a line is often drawn between legal and illegal conduct so that the maximum reduction in the proscribed behavior can be gained at minimum social cost. Frequently it turns out that laws aimed solely at suppressing sales are more cost-effective in reducing both the possession and use of a substance than are laws that attempt to suppress possession directly. There are several reasons for this. First, there are fewer sellers than buyers; this permits a concentration of law enforcement efforts where they do the most good. Second, juries are likely to be more sympathetic to a "mere" user, who may be ill-advised, than to a dealer making a profit from the weaknesses of others. Offenses treated under the vice model (partial prohibition) range from gambling--the person who takes illegal bets is guilty of a crime while the person who places them is not--to the offense of selling new automobiles not equipped with seat belts--the seller, not the buyer, is guilty of an offense. Even Prohibition in 1919 never criminalized the possession or use of alcohol, only its manufacture and sale.

Effects of Partial Prohibition

Probably the most important fact about a policy of prohibition of supply only is that where it has been adopted it has apparently not led to appreciably higher levels of marijuana use than would have existed if use were also prohibited. The National Commission on Marijuana and Drug Abuse's speculations about the lack of change in use patterns resulting from repeal of prohibitions on use have been confirmed by data since 1972. Reports from California, Oregon, and Maine indicate no appreciable increase in use following decriminalization of use, at least in the short term.

Oregon, the first state to repeal prohibition of use (in October 1973) has been studied in a series of Drug Abuse Council surveys (National Governors' Conference, 1977). Surveys in 1974 and 1975 showed no major increase following decriminalization. While the percentage of adults who were current users had increased by January 1977 (from 20 to 24 percent), use had increased similarly nationwide in the same period, suggesting that the causes for the adult increase in Oregon were the same as those for increases in the rest of the country rather than the result of changes in the law. Indeed, the percentage of adult ever-users in Oregon in 1976 (24 percent) was lower than the average percentage of adult ever-users in the western United States (28 percent) in 1975-1976, although higher than the national average (21.3 percent). (It should be noted that aggregate use rates in the western United States are heavily weighted by use rates in California, the largest western state, which had relatively high rates even prior to the state repeal of prohibition of use.) That the increase in use in Oregon from 1973 to 1976 was probably not due to the new law is suggested by other survey data. Only a small proportion of nonusers said fear of legal prosecution was a reason for nonuse in 1974, 1975, and 1976 (National Governors' Conference, 1977). On the question of the fear of health dangers, Drug Abuse Council survey data show that such fear decreased significantly over those years but has increased since 1976.

The state of Maine, which repealed criminal penalties for marijuana use in May 1976, surveyed the effects of legislation in July and August 1978 (State of Maine Department of Human Services, 1979). Its study concluded that the change from criminal to civil penalties has not caused a large increase in marijuana use; less than 1 percent of all adults and 3.1 percent of all high school students reported any increase in their use as a result of the new law; 3.5 percent of adult regular users and 7 percent of high school regular users reported any increase in their use directly attributable to the change in the law. There is also preliminary evidence, based on a nationwide study of high school students between 1975 and 1979, that "any increase in marijuana use in the decriminalized states, taken as a group, was equal to or less than the increases being observed in the rest of the country where decriminalization was not taking place" (Johnston, 1980:5). It could be argued that because de facto repeal of prohibition of use has been taking place throughout the country, one should not expect to see larger increases in use in states that legally decriminalize than in others. Even if this is true, however, the important point is that the legal change to decriminalization does not, in itself, appear to lead to increases in use.

This lack of change is not particularly surprising. The statistical chance that any person would be apprehended for his or her use is, in fact, extremely low throughout the United States (though, as we note below, the large number of users is sufficient to generate a substantial volume of arrests in states that do prohibit use). As a result, it is hard to imagine that the deterrent effect of prohibition laws on any given user would be very great.

It has been suggested that repeal of government prohibitions might change attitudes related to health or morals, perhaps symbolizing that health officials certify marijuana use to be safe. The absence of large increases in marijuana use in repeal states, however, indicates that either the change in policy has not had such a symbolic effect, or that, if it has, its causal significance is not appreciable--though it must be acknowledged that changes of this type might take generations to occur.

Costs of Prohibition of Use

The costs of policies directed at the user are not negligible, although actual savings in law enforcement costs attributable to repeal of prohibition of use per se are difficult to estimate. The difficulty arises in part because marijuana arrests have decreased nationally in recent years, reflecting the overall tendency to relax enforcement of marijuana laws, and that change could lead to inaccurate estimates of the impact of repeal. Nevertheless, reduced law enforcement activities seem to have led to substantial savings in states that have repealed laws that prohibit use.

California made a careful study of the economic impact of its law repealing prohibition of use, which went into effect in January 1976 (State Office of Narcotics and Drug Abuse, 1977). The law reduced the penalty for personal possession of one ounce or less of marijuana from a possible felony to a citable misdemeanor, punishable as an infraction with a maximum fine of $100 without regard to prior possession offenses. Criminal custody, booking, and pretrial incarceration procedures were eliminated. Possession of more than one ounce was also made a misdemeanor, with a maximum fine of $500, six months in jail, or both. According to the study, these changes resulted in a 74 percent reduction in what the state had been spending yearly to enforce its marijuana laws. (Estimates of what the state had been spending ranged from $35 million to more than $100 million yearly; see National Governors' Conference, 1977.)

In addition to its economic benefits, repealing prohibition of use saves the social costs of criminalizing the marijuana user. In recent years, close to 400,000 people have been arrested each year for marijuana-related offenses despite the general nonenforcement of criminal sanctions for use (Federal Bureau of Investigation, 1980). Only a small fraction of the arrests are made under federal law, largely for importation of marijuana. About 85 percent of all marijuana-related arrests are for possession, usually of one ounce or less (see, e.g., State Office of Narcotics and Drug Abuse, 1977).

A study by the National Commission on Marijuana and Drug Abuse of a sample consisting of some 3,000 of the people arrested for marijuana-related offenses in 1970 indicated that the marijuana arrest was usually the arrestee's first experience with the criminal justice system, particularly among juveniles (National Commission on Marijuana and Drug Abuse, 1972). Yet, "it is standard practice for law enforcement agencies to report such offenses to prospective employers, licensing agencies, and other authorities as 'narcotic drug arrests'" (testimony of Jay Miller, American Civil Liberties Union, to the Select Committee on Narcotics Abuse and Control, 1977). Thus young users, who are often otherwise law-abiding people, are subject to an arrest record, or even a prison term, with implications extending into many aspects of their lives.

Alienation from the rule of law in democratic society may be the most serious cost of current marijuana laws. The National Commission on Marijuana and Drug Abuse was concerned that young people who see no rational basis for the legal distinction between alcohol and marijuana may become cynical about America's political institutions and democratic process. The American Bar Association report (printed in Select Committee on Narcotics and Drug Abuse, 1977) concurs in the view that marijuana laws that criminalize the millions of Americans who have used marijuana engender disrespect for the law.

Public Attitudes Toward Partial Prohibition

Although the National Commission on Marijuana and Drug Abuse concluded that prohibition of supply only would be a better policy than prohibition of supply and use, it felt that a serious disadvantage of such a course would be the upset and moral outrage such a policy would engender. Hindsight now shows that the Commission was mistaken in predicting a strong uniform public reaction to the adoption of partial prohibition policies. Experience since 1973 has shown that repeal of criminal penalties for use of marijuana has not been accompanied by massive public protest in the states in which it occurred and, in fact, has had the approval of the majority of citizens in those states (National Governors' Conference, 1977).

Nationally, attitude trends are consistent with the experience of the repeal states. Roffman (1978) reports that public opinion surveys indicate a slowly increasing preference for a reduction in penalties for marijuana offenses; a 1975 national survey (National Institute on Drug Abuse, 1975-1976) found that 52 percent of American adults favored only a fine or probation for small marijuana offenses; and a 1977 Gallup poll showed that 28 percent of the public favored legalization, compared with 12 percent in 1969.

THE SUPPLY OF MARIJUANA: COMPARING PROHIBITED AND REGULATED MARKETS

Policy implementation does not occur in an ideal world. Prohibition of supply has not, in practice, meant that no one has had access to marijuana--though this may have been the intent of those who framed that law. Similarly, regulation of supply does not mean that everyone who uses marijuana will use it moderately, minimizing its harm. Prohibition of supply does make marijuana less accessible than it might otherwise be to a large number of Americans, and thus it almost certainly reduces the total amount of the drug used and the number of users. Such reduction is the purpose of a partial prohibition policy and to some extent it is accomplished. Arguments for a regulated, legal supply of marijuana are largely based on the social costs and incomplete effectiveness of prohibition of supply and on the belief that regulating rather than prohibiting the supply would not lead to an unacceptably large increase in use.

Under a regulatory policy, the cultivation, importation, manufacture, distribution, retailing, and, of course, use of marijuana would no longer be illegal per se. Within this broad category, specific policy options range from a virtual withdrawal of the government from marijuana control (allowing the drug to be freely produced, advertised, and sold, very much as coffee is today--but protecting the consumer against harmful adulterants), to a carefully controlled system of licensing, to a government monopoly on retail sales, wholesale distribution, or manufacture of marijuana. Thus, controls might be placed on such factors as quality, potency, amount purchased, time and place of sales, age of buyers, etc. If marijuana were regulated as is alcohol, restrictions would derive from federal, state, or local statutes, with the majority of them not at the federal level. Regulations might also include legally fixed prices--as in state-controlled alcohol beverage retailing or as a consequence of the levying of excise taxes.

The specific form and content of any proposed regulatory system are very important for those faced with the decision as to whether and under what conditions to remove penalties for the distribution of marijuana, but such details are beyond the scope of this report.

The advantages of a policy of regulation include the disappearance of most illegal market activity, the savings in economic and social costs of law enforcement directed against illegal supply systems, better controls over the quality and safety of the product, and, possibly, increased credibility for warnings about risks. The major disadvantages are a consequence of increased marijuana use--increases in harm to physical health and to individual development and behavior.

Costs of Prohibition of Supply

The number of arrests for violations related to supply is much lower than for those related to use. But enforcement of prohibition of supply is far more costly per arrest. Long undercover investigations, the purchase of expensive hardware, and the major consumption of trial and correctional resources are largely attributable to the prohibition of supply.

The National Institute on Drug Abuse (1975) estimated that in 1974 costs for enforcement of marijuana laws totaled $600 million for state and local agencies. If we extrapolate from the California data (State Office of Narcotics and Drug Abuse, 1977), about three-fourths of the total is spent enforcing the law against marijuana supply. The total federal drug abuse law enforcement budget was more than $400 million in 1979, about half of which was the budget for the Drug Enforcement Administration. At the federal level, authorities do not break down their expenditures on enforcement between marijuana and other drugs; virtually all of the federal resources that are allocated to marijuana are spent in attempting to enforce the laws against supply.

The task of attempting to make the prohibition of supply effective is, of course, formidable. In 1969 Operation Intercept demonstrated the practical difficulty of sealing off the Mexican border. In the weeks the operation lasted, hundreds of thousands of vehicles and passengers were searched every day; ensuing traffic jams caused expenditures by U.S. tourists and commuters to Mexico to drop 50-70 percent below normal (Kaplan, 1971). The situation was intolerable and the program was halted. However, the federal government has continued efforts to improve border surveillance and to penetrate trafficking networks. The White House Strategy Council on Drug Abuse (1979) notes that more than 5.6 million pounds of marijuana was seized at the Mexican border over a 12-month period in 1977-1978; a large increase over the 1.5 million pounds seized during the previous 12 months, "but a fraction of marijuana entering the country." Recently, the Council has suggested strengthening border surveillance by cooperative efforts of the Drug Enforcement Administration, the Customs Service, the Coast Guard, and the Department of State and by the use of the detection capabilities of the armed forces as well.

In our view, the prospects for major success in these ventures are not great. Nor is there much likelihood that some recently suggested measures against marijuana production outside the U.S. would make future prohibition of supply more effective. For example, the White House Strategy Council on Drug Abuse has supported crop eradication programs, provided that the proposed method of eradication is evaluated for possible health and environmental consequences and that a readily distinguishable marker is added to any chemical herbicides that are used, but the political obstacles to this course would be significant. Entirely apart from the views of producer nations, which are likely to be quite negative, the public is unlikely to support the use of chemicals of unknown toxicity on an import product, legal or not, that may be used by large numbers of Americans. And irrespective of the degree of success of controlling imports, the problem of domestic production under a policy of partial prohibition remains. Although the illegal domestic industry is thought to account for only about 15 percent of American marijuana consumption, marijuana grows easily in many parts of the United States. The National Commission on Marijuana and Drug Abuse cited a Department of Agriculture estimate that in 1972 there were 5 million acres containing wild marijuana in the United States and an undetermined but obviously growing number of acres under cultivation.

Law enforcement costs are by no means the only costs of prohibition of supply. There are large amounts of money being made in marijuana--which, like any illegal business, carries with it the likelihood of corruption of public officials and the loss of tax dollars. Violence is also a cost of attempting to prohibit marijuana supply; this problem is not confined to illegal marijuana production abroad. There has been violence in marijuana-growing regions in the United States. The extent of such violence is not known with any precision, but there have been popular press reports of kidnappings, assaults, burglaries, and homicides known to be connected with the marijuana business in northern California and elsewhere.

Another major cost of attempts to prohibit the supply of marijuana is related to the fact that many illegal sellers of marijuana also sell other illegal drugs, e.g., PCP, amphetamine, and barbiturates (Blum, 1971). It is likely, therefore, that prohibition of the supply of marijuana increases access to and use of other illegal drugs through the creation of an illegal marketing system for all drugs. Little is known about the structures and activities of illicit drug markets. It is clear,

TABLE 1 Lifetime Prevalence and Use in Past Month of Marijuana, 1971-1979, by Category of User (percentage)

Category of User	1971	1972	1974	1976	1977	1979
Youth: Ages 12-17						
Ever used	14.0	14.0	23.0	22.4	28.0	30.9
Used in past month	6.0	7.0	12.0	12.3	16.6	16.7
Young Adults: Ages 18-25						
Ever used	39.3	47.9	52.7	52.9	59.9	68.2
Used in past month	17.3	27.8	25.2	25.0	27.4	35.4
Older Adults: Ages 26+						
Ever used	9.2	7.4	9.9	12.9	15.3	19.6
Used in past month	1.3	2.5	2.0	3.5	3.3	6.0
(Number)	(3,186)	(3,265)	(4,022)	(3,576)	(4,594)	(7,224)

SOURCE: Fishburne et al. (1980).

however, that there are many small-scale marijuana dealers, that many sellers service only their friends and acquaintances, and that those who sell marijuana are thereby more likely to come into contact with users and sellers of more dangerous drugs, to use such drugs, and to make them available to their clientele (Blum, 1971). Moreover, there is reason to believe that marijuana sellers may become socialized into other illegal activities.

Costs of Regulating Supply

The wide availability and use of marijuana are not only major factors in the cost of attempts to prohibit the supply of the drug, they also have implications for the likely magnitude of increases in use that could be expected under a regulatory policy. Greater use of marijuana under a regulatory policy is regarded as the most significant cost of such a policy. In an analysis of this potential cost, however, it is important to note that under the present policy of prohibition, prevalence and frequency of marijuana use are substantial and have increased in recent years.*

A National Institute on Drug Abuse general household survey (Fishburne et al., 1980) shows that 35.4 percent of the 18-25-year-olds in the United States report having used marijuana in the month preceding the survey. Yearly surveys show a steady increase from 1971 to 1979 in the percentage of people who report having ever used marijuana as well as in the percentage of people who report being current users (see Table 1). These survey results (Fishburne et al., 1980) also indicate that between 1976 and 1977, the percentage of current users among 12-17-year-olds increased from 12.3 to 16.6 percent; this trend

*The data indicating rates of use are based on self-reports; as such, their reliability and validity may be questioned. Nevertheless, as Radosevich et al. (1979) indicate, studies of questions on drug use have consistently demonstrated reliable responses within the same instrument and over time. Furthermore, there are indications that most drug surveys do not have serious validity problems (see Whitehead and Smart and Abelson and Atkinson, both cited in Radosevich et al., 1979; Johnston et al., 1982).

TABLE 2 Trends in Prevalence of Marijuana Use by High School Seniors (percentage)

Prevalence	Class 1975	1976	1977	1978	1979	1980	1981
Ever used	47.3	52.8	56.4	59.2	60.4	60.3	59.5
Used in last 12 months	40.0	44.5	47.6	50.2	50.8	48.8	46.1
Used in last 30 days	27.1	32.2	35.4	37.1	36.5	33.7	31.6
Used daily in last 30 days[a]	6.0	8.2	9.1	10.7	10.3	9.1	7.0

[a]Daily use defined as using marijuana on 20 or more occasions in the last 30 days.

SOURCE: Johnston et al. (1982).

had leveled off by 1979 and has since shown a decline. In an annual survey of national samples of some 17,000 high school seniors, Johnston et al. (1982) found that 7.0 percent of the class of 1981 reported daily marijuana use, compared with 6.0 percent in 1975 and 10.7 percent in 1978, the peak year (see Table 2). There has been a similar trend in initial use at younger ages.

Although the present policy of prohibition of supply is not preventing the current levels of marijuana use, including use among the very young, it is probable that most strategies under a regulatory policy would result in an overall increase in use. Even more important than overall use rates, however, are likely changes in consumption patterns; such patterns are the most difficult changes to predict. The smallest increases in numbers of users can be expected to occur among those to whom marijuana is now most readily available--the young. Johnston et al. (1982) found that close to 90 percent of the high school seniors in their national sample survey report that marijuana is "fairly easy" or "very easy" for them to get. This percentage remained relatively stable over the seven years, 1975-1981. At the same time, the reported availability of most other illegal drugs (except cocaine) declined considerably. For example, while 46.2 percent of the 1975 high school seniors said that LSD would be "fairly easy" or "very easy" to get, only 32.2 percent of the class of 1978 gave those responses. It would appear, therefore, that the reports of easy availability are not due to a tendency of adolescents to report any illegal drug as easy to get, but reflect their actual access to the drug. It might also be noted that only 13.9 percent of the class of 1978 reported having no friends who smoke marijuana; thus it is reasonable to expect that at least 86 percent have a factual basis for estimating the availability of the drug.

Other survey data corroborate these findings. Radosevich et al. (1979) report that a 1975 national survey by the Drug Abuse Council found that at least 70 percent of the high school students in their sample reported marijuana "easy to get," and O'Donnell et al. (1976) found similar results. There are no contrary reports for recent years. In sum, one can be reasonably confident that, at least with respect to older adolescents, the prohibition against supply does not succeed in suppressing access to marijuana. (The effect on price is discussed below.)

Regulation could be expected to provide the greatest increase in availability to those to whom the drug is now least available, i.e., older adults who are not in contact with marijuana sellers or a drug-using subculture and who are most likely to avoid illegal "connections."

It has been argued that a serious cost of the adoption of a regulatory policy for marijuana is the likelihood that such a change might delude many people into believing that the drug is safe. As noted above, there is no indication that the elimination of penalties for marijuana use has caused the drug to be regarded as any less dangerous. Moreover, alcohol and tobacco are almost universally regarded as involving risks to health, and these drugs are already made available under regulatory systems.

To the extent that marijuana use causes harm, one is necessarily concerned about policy changes that will lead to increases in use. As we have noted, however, it is a fact that marijuana is already widely available despite the legal prohibition of supply and that, despite the best efforts of government under any foreseeable set of conditions, it will continue to be. Though a regulatory policy would increase the availability of the drug, estimates of the size of these increases, and associated increases in harm, must be weighed against estimates of the costs and weaknesses of continuing prohibitions of supply. In pragmatic terms, the issue is whether more harm would be done, overall, by retaining the partly effective, costly prohibition of supply or by moving to a system of legalized regulated sales--wherein presumably more people would use more marijuana, but some of the costs imposed by prohibition of supply would be removed.

Regulatory Systems: Some Concrete Aspects

To this point, a policy of regulation has been discussed rather abstractly in contrast with the more concrete discussion of prohibition policies. Experimentation with varying systems of regulation followed by adjustment and readjustment based on experience would be necessary before those most appropriate for particular circumstances could be developed. This can be a complex matter. For instance, U.S. alcohol policy, developed with the repeal of Prohibition, consists of an umbrella of national policy and a wide variety of supporting state and local regulation. The national policy umbrella includes controls on importation, taxation, potency, packaging, labeling, advertising, use in federal jurisdictions (e.g., parks, military installations), and use in systems regulated by the federal government (e.g., air transportation); it also provides funds and guidelines for the treatment of casualties of excessive use. Under the umbrella policy, states and local jurisdictions regulate taxes, retail sales, hours of availability, age limits, and the like, where supply is legal, or prohibit sales entirely. Some states have monopoly systems for package sales, others use licensed private stores. Historically, under this system, the strictness of controls has reflected local sentiment about the consumption of alcohol. Although few "dry" jurisdictions exist today, various degrees of local "dryness" were quite widespread until very recently (National Research Council, 1981).

Controlling Use

A regulated system of marijuana sale might attempt to moderate use by inhibiting the frequency of use and the amounts used as well as by prescribing conditions of purchase and use. However, it is likely that under a regulatory system consumption would in great part be controlled by informal social norms--as it is today.

Manipulating the price of the drug is an obvious means of inhibiting use. It has been argued that most adults would be willing to pay a higher price for legal marijuana than they currently pay for illegal supplies in return for not having to seek out "connections" and being relieved of the feeling that they may be supporting organized crime. A high price would be comparatively more restrictive for young people--precisely those whom one would most want to discourage from use--since, though they seem affluent compared with young people in previous times, their budgets are in fact more constrained than those of adults. The possibility of illegal markets selling to young people remains, but today's kind of illegal market for marijuana would probably shrink greatly under a regulatory system in the same way that illegal alcohol distribution systems have become so scarce. Young users would be much more likely to gain access to marijuana by diversion from the legal market--as they do today for alcohol--or from homegrown plants than from a wholly illegal chain of distributors. Such a development would make marijuana selling a less profitable and status-producing occupation among the young.

It has been suggested that if legal limits were imposed on the potency of legally available marijuana, a substantial illegal market for high-potency forms of the drug, including hashish, would still exist. Since it is likely that there would continue to be some users who prefer high-potency forms of cannabis, this is a reasonable concern. But there is no compelling a priori reason to believe that a legal structure for retail marijuana sales, which includes limits on potency, would result in any increase in the availability and use of high-potency products.

Home Cultivation

Cultivation of marijuana by users is another issue that would have to be confronted in devising a regulatory system. Growing marijuana without payment of a tax might be treated as a revenue offense. Without criminal penalties or vigorous enforcement, however, deterrent effects would be minimal since marijuana can be grown indoors anywhere in the United States using artificial light--and at comparatively little expense. A recent British study of options for marijuana control (Logan, 1979) suggests that, from a law enforcement perspective, it is not feasible to attempt to control home cultivation. Whether users would take the trouble to grow their own marijuana would depend in part on the legal price. The relatively high prices that might be charged in order to discourage use and to increase revenues would also tend to encourage home cultivation. Whatever its disadvantages, however, the use of homegrown marijuana at least would not bring users into contact with those who illegally sell the drug. With respect to young people, moreover, marijuana under cultivation is much harder for children to hide from parents than is the purchased prepared drug, and cultivation by juveniles could remain illegal if age limits on use were imposed. Nonetheless, the treatment of home cultivation represents a major issue for the design of a regulatory system.

Public Education

Excessive use may be discouraged by policies aimed at public education and at the use of the media, including a ban on commercial advertising. Although information on how to use drugs, on drug hazards, and on the attributes of drugs is passed along most effectively through informal channels (see, e.g., Hanneman, 1972), media and education programs can make such information far more readily available.

Research on the communication of messages to the public has identified source credibility as a major factor contributing to the persuasive power of a message (McGuire, 1969). It appears that the public is now extremely wary of some government information programs that attempt to influence health behaviors. The credibility of the federal government may be especially suspect when it issues health warnings about an illegal substance that it is clearly trying to prohibit. Rosenthal (1979) asserts that distrust of the government and the medical establishment has grown because of past exaggerations and distortions of the effects of some mind-altering drugs.

Informal Social Controls

In an assessment of possibilities for governmental controls under a regulatory system, the operation of informal norms for controlling substance use practices must be taken into account (Maloff et al., 1980). National experience with alcohol use, for example, provides evidence that there are informal rituals and sanctions that generally encourage moderation in the use of recreational drugs. Moreover, moderation is encouraged when a drug is introduced gradually, that is, to a growing population of users, like marijuana in the 1960s and early 1970s. One might expect that when a new drug is introduced into a society, governmental control would be particularly important since no informal controls for teaching people appropriate rules for use would have developed. If a potent drug is made widely available precipitously and very cheaply to a novice population, severe societal disruptions may occur: for example, the gin epidemics of early eighteenth-century England (see Clark, 1976). Because in the past two decades informal norms for controlling marijuana use have spread in the United States under conditions of greatly increased availability of marijuana, there is reason to believe that widespread uncontrolled use would not occur under regulation. Indeed, regulation might facilitate patterns of controlled use by diminishing the "forbidden fruit" aspect of the drug and perhaps increasing the likelihood that an adolescent would be introduced to the drug through families and friends who practice moderate use, rather than through their heaviest-using, most drug-involved peers.

Relations Among States

As has historically been the case with respect to alcohol, state governments differ in their approaches to marijuana. So long as present federal law continues to prohibit cultivation and distribution of marijuana, states cannot adopt a regulatory system, although they are legally free to reduce or eliminate their own penalties for sale and are not compelled to enforce federal laws. If federal law were changed, however, the institution of a regulatory system in one state would have reverberations in other states. Residents of states that continued to prohibit marijuana could be expected to cross state lines to purchase the drug in a state with a regulated system, thus further compromising the ability of states to enforce prohibition of supply among its residents. Furthermore, states that attempted to curtail consumption by raising prices might find their populations turning to lower-cost marijuana from neighboring states with lower prices. This is a familiar situation. Large numbers of both cigarettes and guns are smuggled illegally into New York from other states. Moreover, New Yorkers may travel to New Jersey to gamble in a casino, or Virginians to the District of Columbia to buy cheaper liquor. It is difficult to see how state prohibitions could remain effective if the number of states with regulatory systems grew very large unless the changes occurred in only one region of the country. However, there may be advantages in permitting a state-by-state approach. Conditions governing the costs and benefits both of partial prohibition and of regulation vary among the states. In this area of uncertainty, we may learn from experiment. If one regulatory system proved successful, other states would be more likely to adopt similar systems; similarly, if it worked poorly in one state, other states would be less inclined to adopt a regulatory policy.

Effects on Foreign Relations

The 1961 Single Convention on Narcotic Drugs, which now obligates the U.S. government to prevent the importation of marijuana and to prohibit the adoption of a licensing system by any state, is a serious (although not an insurmountable) obstacle to the adoption of a federal regulatory policy and the development of state licensing. The treaty allows a signatory to terminate its adherence to the agreement at any time after two years from the date of the convention. Of course the general impact of any move to withdraw from the convention includes a broad foreign policy context, which is beyond the expertise of this Committee to judge.

CONCLUSIONS

For the last decade, concern with health hazards attributable to marijuana has been rising. The hearts, lungs, reproductive functions, and mental abilities of children have been reported to be threatened by marijuana, and such threats are not to be taken lightly. Heavy use by anyone or any use by growing children should be discouraged. Although conclusive evidence is lacking of major, long-term public health problems caused by marijuana, they are worrisome possibilities, and both the reports and the a priori likelihood of developmental damage to some young users makes marijuana use a cause for extreme concern.

At the same time, the effectiveness of the present federal policy of complete prohibition falls far short of its goal--preventing use. An estimated 55 million Americans have tried marijuana, federal enforcement of prohibition of use is virtually nonexistent, and 11 states have repealed criminal penalties for private possession of small amounts and for private use. It can no longer be argued that use would be much more widespread and the problematic effects greater today if the policy of complete prohibition did not exist: The existing evidence on policies of partial prohibition indicates that partial prohibition has been as effective in controlling consumption as complete prohibition and has entailed considerably smaller social, legal, and economic costs. On balance, therefore, we believe that a policy of partial prohibition is clearly preferable to a policy of complete prohibition of supply and use.

We believe, further, that current policies directed at controlling the supply of marijuana should be seriously reconsidered. The demonstrated ineffectiveness of control of use through prohibition of supply and the high costs of implementing such a policy make it very unlikely that any kind of partial prohibition policy will be effective in reducing marijuana use significantly below present levels. Moreover, it seems likely to us that removal of criminal sanctions will be given serious consideration by the federal government and by the states in the foreseeable future. Hence, a variety of alternative policies should be considered.

At this time, the form of specific alternatives to current policies and their probable effect on patterns of use cannot be determined with confidence. It is possible that, after careful study, all alternatives will turn out to have so many disadvantages that none could command public consensus. To maximize the likelihood of sound policy for the long run, however, further research should be conducted on the biological, behavioral, developmental, and social consequences of marijuana use, on the structure and operation of drug markets, and on the relations of various conditions of availability to patterns of use.

RECOMMENDATIONS FOR RESEARCH

Health and Behavior

The persistent concern about the health-related effects of marijuana requires both an immediate and a continuing response. First, as the report of the Institute of Medicine (1982:5) recommends, there should be "a greatly intensified and more comprehensive program of research into the effects of marijuana on the health of the American people." An important goal of this research program should be the identification of subgroups at high risk for physiological and psychological damage in relation to patterns of use and doses of marijuana. The report presents a detailed agenda of needed research. Second, to the extent that potential health hazards are identified, policy research should address possible safeguards and precautions to protect the user.

If marijuana use can be scientifically shown to entail grave risks--to the brain, the cardiovascular and respiratory systems, or to reproductive functions, for example--that are currently not known, it can be argued that, as was the case with cigarette smoking, knowledge of those effects will be more effective than criminal enforcement as a deterrent to use.

Drug Markets

Research on the price elasticity of demand in legal and illegal markets is a clear priority. The result of such research will be important in determining the likelihood of controlling heavy use through price mechanisms and in computing the amount of money--if any--that could be realized in taxation of marijuana.

Present knowledge of the structure and activities of drug markets and networks is insufficient to allow prediction of the effects of policy changes on them. Research in this area is difficult but the questions are important. If many dealers who sell cocaine, PCP, amphetamines, and barbiturates as well as marijuana would be put out of business if marijuana were available through legal channels, it might result in a curtailed market for a variety of other drugs. On the other hand, it is also possible that the market structure is so loosely organized, and dealers so transiently involved, that removing marijuana from the illegal markets would have little effect. To be sure, much research on some of these questions could not be conducted unless a regulatory system were in place in some state. Nonetheless, some research, particularly ethnographic and economic studies, should be undertaken now to discover the importance of marijuana profits to drug-dealing networks; the transiency, size, and nature of such networks; etc. It is essential for research in this area to be supported by appropriate government agencies.

Effects on Use

Although many questions remain to be answered before the most informed choices can be made between prohibiting and regulating supply, there are many things that cannot be known unless some jurisdiction tries a regulatory policy. Although adoption of a regulatory policy is likely to result in increased use, little is known about changes in patterns of use that are likely to result. If federal laws prohibiting supply are changed to allow states to license marijuana sales, epidemiological research programs must be ready to monitor any changes in use and their consequences. To do so, research should be organized and operating well in advance of any such policy changes in order to determine rates of use before the change. Although the shift in the law from complete to partial prohibition in 11 states has apparently had little effect on consumption patterns there, we do not know the degree to which legally available marijuana would attract a larger market. The impact on use of educational campaigns, health warnings, and informal social controls under a regulatory system should be investigated.

In the absence of the opportunity for states to adopt regulatory policies, there can only be educated guesses about which age groups are likely to increase use or whether individuals who now use marijuana will use more, etc. Meanwhile, every bit of analysis to predict the answers to these questions, by surveying public attitudes, assessing past experiences with the spread of drug use in society (e.g., alcohol use following the repeal of Prohibition), and critically reviewing the experience of other societies in which marijuana is more readily available, will be valuable.

Marijuana regulation would permit systematic provision of comprehensive, clearly communicated health warnings on package inserts or covers, in public health education, by medical practitioners, and by public health interest groups as well as by the government. The extent to which such warnings would have more credibility for users than current health warnings, generated in an atmosphere of prohibition, is an important subject for research. Despite widespread pessimism about the failures of drug education campaigns, there are encouraging results in educational approaches based on the Stanford Heart Disease Prevention Program experience. With appropriate, research-based models and techniques, public health education may be an attractive means for limiting excessive use (see, e.g., Maccoby, 1979).

REFERENCES

Abel, E.L. (1980) Marijuana: The First Twelve Thousand Years. New York and London: Plenum Press.

Beachy, G.M., Petersen, D.M., and Pearson, F.S. (1979) Adolescent drug use and delinquency: a research note. Journal of Psychedelic Drugs 11(4):313-316.

Blum, R.H. (1971) Drug pushers: a collective portrait. Trans-Action 8:18-21.

Congressional Digest (1979) Summary of federal and state laws. 58(2):37-38.

Clark, N.H. (1976) Deliver Us From Evil: An Interpretation of American Prohibition. New York: Norton.

Federal Bureau of Investigation (1980) Uniform Crime Reports for the United States: 1980. Available from the Superintendent of Documents, U.S. Government Printing Office. Washington, D.C.: U.S. Department of Justice.

Fishburne, P., Abelson, H., and Cisin, I. (1980) National Survey on Drug Abuse: Main Findings 1979. National Institute on Drug Abuse, DHHS Publication No. (ADM) 80-976. Washington, D.C.: U.S. Government Printing Office.

Fried, P.A. (1977) Behavioral and electroencephalographic correlates of marijuana: a review. Behavioral Biology 21(2):163-196.

Hanneman, G.J. (1972) Dissemination of Drug Related Information. Communication Research Program. Storrs: University of Connecticut.

Hochman, J.S., and Brill, N.Q. (1973) Chronic marijuana use and psychosocial adaptation. American Journal of Psychiatry 130(2):132-140.

Institute of Medicine (1982) Marijuana and Health. Report of the Committee to Study the Health-Related Effects of Cannabis and Its Derivatives. Washington, D.C.: National Academy Press.

Johnston, L. (1980) Marijuana Use and the Effects of Marijuana Decriminalization. Testimony delivered at hearings on the effects of marijuana, Subcommittee on Criminal Justice, Senate Judiciary Committee, January 16, Washington, D.C.

Johnston, L.D., Bachman, J.G., and O'Malley, P.M. (1982) Student Drug Use in America 1975-1981. National Institute on Drug Abuse. Available from the Superintendent of Documents, U.S. Government Printing Office. Washington, D.C.: U.S. Department of Health and Human Services.

Kaplan, J. (1971) Marijuana--The New Prohibition. New York: World Publishing Co.
Logan, F. (1979) Cannabis: Options for Control. London: Quartermaine House.
Maccoby, N. (1979) Promoting Positive Health-Related Behavior in Adults. Paper presented at Fourth Vermont Conference on Primary Prevention of Psychopathology.
Maloff, D.R., Becker, H.S., Fonaroff, A., and Rodin, J. (1980) Informal social controls and their influence on substance use. Pp. 5-35 in D.R. Maloff and P.K. Levison, eds., Issues in Controlled Substance Use. Committee on Substance Abuse and Habitual Behavior, National Research Council. Washington, D.C.: National Academy of Sciences.
McGuire, W.J. (1969) The nature of attitudes and attitude change. In G. Lindzey and E. Aronson, eds., The Handbook of Social Psychology, Vol. 3. Menlo Park, Calif.: Addison-Wesley Publishing Co.
Nahas, G. (1977) Biomedical aspects of cannabis usage. United Nations Bulletin on Narcotics 29(2):13-27.
National Commission on Marijuana and Drug Abuse (1972) Marijuana: A Signal of Misunderstanding. Washington, D.C.: U.S. Government Printing Office. [Reprinted as a Signet Special. New York: New American Library]
National Commission on Marijuana and Drug Abuse (1973) Drug Use in America: Problem in Perspective. Washington, D.C.: U.S. Government Printing Office.
National Governors' Conference (1977) Marijuana: A Study of State Policies and Penalties. Washington, D.C.: Center for Policy Research and Analysis.
National Institute on Drug Abuse (1975) Training the human. Resources Bulletin 1(3).
National Institute on Drug Abuse (1975-1976) Nonmedical Use of Psychoactive Substances. Washington, D.C.: U.S. Department of Health, Education, and Welfare.
National Institute on Drug Abuse (1979) Seventh Annual Report on Marijuana and Health. Available from the Superintendent of Documents, U.S. Government Printing Office. Washington, D.C.: U.S. Department of Health, Education, and Welfare.
National Institute on Drug Abuse (1980) Eighth Annual Report on Marijuana and Health. Available from the Superintendent of Documents, U.S. Government Printing Office. Washington, D.C.: U.S. Department of Health, Education, and Welfare.

National Organization for the Reform of Marijuana Laws and Center for the Study of Non-Medical Drug Use (1979) The Marijuana Laws; State and Federal Penalties. Washington, D.C.

National Research Council (1981) Alcohol and Public Policy: Beyond the Shadow of Prohibition. M.H. Moore and D.R. Gerstein, eds. Panel on Alternative Policies Affecting the Prevention of Alcohol Abuse and Alcoholism, Committee on Substance Abuse and Habitual Behavior, National Research Council. Washington, D.C.: National Academy Press.

O'Donnell, J.A., Voss, H.L., Clayton, R.R., Slatin, G.L., and Room, R.G.W. (1976) Young Men and Drugs--A Nationwide Survey. National Institute on Drug Abuse Monograph Series No. 5. Available from the Superintendent of Documents, U.S. Government Printing Office. Washington, D.C.: U.S. Department of Health, Education, and Welfare.

Radosevich, M., Lanza-Kaduce, L., Akers, R.L., and Krohn, M.D. (1979) The sociology of adolescent drug and drinking behavior: a review of the state of the field; part 1. Deviant Behavior 1:15-35.

Roffman, R. (1978) Marijuana and its control in the late 1970s. Contemporary Drug Problems 6(4):533-552.

Rosenthal, M. (1979) Partial prohibition of nonmedical use of mind-altering drugs: proposal for change. Houston Law Review 16:603-665.

Select Committee on Narcotics Abuse and Control (1977) Hearings: Decriminalization of Marijuana. House of Representatives, 95th Congress, March 14-16, 1977. Washington, D.C.: U.S. Government Printing Office.

State of Maine Department of Human Services (1979) An Evaluation of the Decriminalization of Marijuana in Maine--1978. Office of Alcoholism and Drug Abuse Prevention, Augusta.

State Office of Narcotics and Drug Abuse (1977) A First Report of the Impact of California's New Marijuana Law (SB95). Sacramento, Calif.

Tashkin, D., et al. (1978) Cannabis, 1977. Annals of Internal Medicine 89:539-549.

White House Strategy Council on Drug Abuse (1979) Federal Strategy for Drug Abuse and Drug Traffic Prevention, 1979. Washington, D.C.: U.S. Government Printing Office.

APPENDIX: SUMMARY OF MARIJUANA AND HEALTH

The Institute of Medicine (IOM) of the National Academy of Sciences has conducted a 15-month study of the health-related effects of marijuana, at the request of the Secretary of Health and Human Services and the Director of the National Institutes of Health. The IOM appointed a 22-member committee to:

- analyze existing scientific evidence bearing on the possible hazards to the health and safety of users of marijuana;
- analyze data concerning the possible therapeutic value and health benefits of marijuana;
- assess federal research programs in marijuana;
- identify promising new research directions, and make suggestions to improve the quality and usefulness of future research; and
- draw conclusions from this review that would accurately assess the limits of present knowledge and thereby provide a factual, scientific basis for the development of future government policy.

This assessment of knowledge of the health-related effects of marijuana is important and timely because marijuana is now the most widely used of all the illicit drugs available in the United States. In 1979, more than 50 million persons had tried it at least once. There has been a steep rise in its use during the past decade, particularly among adolescents and young adults, although there has been a leveling-off in its overall use among high school seniors in the past 2 or 3 years and a small decline in the percentage of seniors who use it frequently. Although substantially more high school students have used alcohol than have ever used marijuana, more high school seniors use marijuana on a daily or near-daily basis (9 percent) than alcohol (6 percent). Much of the heavy use of marijuana, unlike alcohol, takes place in school, where effects on behavior, cognition, and psychomotor performance can be particularly disturbing. Unlike alcohol, which is rapidly metabolized and eliminated from the body, the psychoactive components of marijuana persist in the body for a long time. Similar to alcohol, continued use of marijuana may cause tolerance and dependence. For all these reasons, it is imperative that we have reliable and detailed information about the effects of marijuana use on health, both in the long and short term.

What, then, did we learn from our review of the published scientific literature? Numerous acute effects have been described in animals, in isolated cells and tissues, and in studies of human volunteers; clinical and epidemiological observations also have been reported. This information is briefly summarized in the following paragraphs.

EFFECTS ON THE NERVOUS SYSTEM AND ON BEHAVIOR

We can say with confidence that marijuana produces acute effects on the brain, including chemical and electrophysiological changes. Its most clearly established acute effects are on mental functions and behavior. With a severity directly related to dose, marijuana impairs motor coordination and affects tracking ability and sensory and perceptual functions important for safe driving and the operation of other machines; it also impairs short-term memory and slow learning. Other acute effects include feelings of euphoria and other mood changes, but there also are disturbing mental phenomena, such as brief periods of anxiety, confusion, or psychosis.

There is not yet any conclusive evidence as to whether prolonged use of marijuana causes permanent changes in the nervous system or sustained impairment of brain function and behavior in human beings. In a few unconfirmed studies in experimental animals, impairment of learning and changes in electrical brain-wave recordings have been observed several months after the cessation of chronic administration of marijuana. In the judgment of the committee, widely cited studies purporting to demonstrate that marijuana affects the gross and microscopic structure of the human or monkey brain are not convincing; much more work is needed to settle this important point.

Chronic relatively heavy use of marijuana is associated with behavioral dysfunction and mental disorders in human beings, but available evidence does not establish if marijuana use under these circumstances is a cause or a result of the mental condition. There are similar problems in interpreting the evidence linking the use of marijuana to subsequent use of other illicit drugs, such as heroin or cocaine. Association does not prove a causal relation, and the use of marijuana may merely be symptomatic of an underlying disposition to use psychoactive drugs rather than a "stepping stone" to involvement with more dangerous substances. It is also difficult to sort out the relationship between use of marijuana and the complex symptoms known as the amotivational syndrome. Self-selection and effects of the drug are probably both contributing to the motivational problems seen in some chronic users of marijuana.

Thus, the long-term effects of marijuana on the human brain and on human behavior remain to be defined. Although we have no convincing evidence thus far of any effects persisting in human beings after cessation of drug use, there may well be subtle but important physical and psychological consequences that have not been recognized.

EFFECTS ON THE CARDIOVASCULAR AND RESPIRATORY SYSTEMS

There is good evidence that the smoking of marijuana usually causes acute changes in the heart and circulation that are characteristic of stress, but there is no evidence to indicate that a permanently deleterious effect on the normal cardiovascular system occurs. There is good evidence to show that marijuana increases the work of the heart, usually by raising heart rate and, in some persons, by raising blood pressure. This rise in workload poses a threat to patients with hypertension, cerebrovascular disease, and coronary atherosclerosis.

Acute exposure to marijuana smoke generally elicits broncho-dilation; chronic heavy smoking of marijuana causes inflammation and pre-neoplastic changes in the airways, similar to those produced by smoking of tobacco. Marijuana smoke is a complex mixture that not only has many chemical components (including carbon monoxide and "tar") and biological effects similar to those of tobacco smoke, but also some unique ingredients. This suggests the strong possibility that prolonged heavy smoking of marijuana, like tobacco, will lead to cancer of the respiratory tract and to serious impairment of lung function. Although there is evidence of impaired lung function in chronic smokers, no direct confirmation of the likelihood of cancer has yet been provided, possibly because marijuana has been widely smoked in this country for only about 20 years, and data have not been collected systematically in other countries with a much longer history of heavy marijuana use.

EFFECTS ON THE REPRODUCTIVE SYSTEM AND ON CHROMOSOMES

Although studies in animals have shown that delta-9-THC (the major psychoactive constituent of marijuana) lowers the concentration in blood serum of pituitary hormones (gonadotropins) that control reproductive functions, it is not known if there is a direct effect on reproductive tissues. Delta-9-THC appears to have a modest reversible suppressive effect on sperm production in men, but there is no proof that it has a deleterious effect on male fertility. Effects on human female hormonal function have been reported, but the evidence is not convincing. However, there is convincing evidence that marijuana interferes with ovulation in female monkeys. No satisfactory studies of the relation between use of marijuana and female fertility and child-bearing have been carried out. Although delta-9-THC is known to cross the placenta readily and to cause birth defects when administered in large doses to experimental animals, no adequate clinical studies have been carried out to determine if marijuana use can harm the human fetus. There is no conclusive evidence of teratogenicity in human offspring, but a slowly developing or low-level effect might be undetected by the studies done so far. The effects of marijuana on reproductive function and on the fetus are unclear; they may prove to be negligible, but further research to establish or rule out such effects would be of great importance.

Extracts from marijuana smoke particulates ("tar") have been found to produce dose-related mutations in bacteria; however, delta-9-THC, by itself, is not mutagenic. Marijuana and delta-9-THC do not appear to break chromosomes, but marijuana may affect chromosome segregation during cell division, resulting in an abnormal number of chromosomes in daughter cells. Although these results are of concern, their clinical significance is unknown.

THE IMMUNE SYSTEM

Similar limitations exist in our understanding of the effects of marijuana on other body systems. For example, some studies of the immune system demonstrate a mild, immunosuppressant effect on human beings, but other studies show no effect.

THERAPEUTIC POTENTIAL

The committee also has examined the evidence on the therapeutic effects of marijuana in a variety of medical disorders. Preliminary studies suggest that marijuana and its derivatives or analogues might be useful in the treatment of the raised intraocular pressure of glaucoma, in the control of the severe nausea and vomiting caused by cancer chemotherapy, and in the treatment of asthma. There also is some preliminary evidence that a marijuana constituent (cannabidiol) might be helpful in the treatment of certain types of epileptic seizures, as well as for spastic disorders and other nervous system diseases. But, in these and all other conditions, much more work is needed. Because marijuana and delta-9-THC often produce troublesome psychotropic or cardiovascular side-effects that limit their therapeutic usefulness, particularly in older patients, the greatest therapeutic potential probably lies in the use of synthetic analogues of marijuana derivatives with higher ratios of therapeutic to undesirable effects.

THE NEED FOR MORE RESEARCH ON MARIJUANA

The explanation for all of these unanswered questions is insufficient research. We need to know much more about the metabolism of the various marijuana chemical compounds and their biologic effects. This will require many more studies in animals, with particular emphasis on subhuman primates. Basic pharmacologic information obtained in animal experiments will ultimately have to be tested in clinical studies on human beings.

Until 10 or 15 years ago, there was virtually no systematic, rigorously controlled research on the human health-related effects of marijuana and its major constituents. Even now, when standardized marijuana and pure synthetic cannabinoids are available for experimental studies, and good qualitative methods exist for the measurement of delta-9-THC and its metabolites in body fluids, well-designed studies on human beings are relatively few. There are difficulties in studying the clinical effects of marijuana in human beings, particularly the effects of long-term use. And yet, without such studies the debate about the safety or hazard of marijuana will remain unresolved. Prospective cohort studies, as well as retrospective case-control studies, would be useful in identifying long-term behavioral and biological consequences of marijuana use.

The federal investment in research on the health-related effects of marijuana has been small, both in relation to the expenditure on other illicit drugs and in absolute terms. The committee considers the research particularly inadequate when viewed in light of the extent of marijuana use in this country, especially by young people. We believe there should be a greater investment in research on marijuana, and that investigator-initiated research grants should be the primary vehicle of support.

The committee considers all of the areas of research on marijuana that are supported by the National Institute on Drug Abuse to be important, but we did not judge the appropriateness of the allocation of resources among those areas, other than to conclude that there should be increased emphasis on studies in human beings and other primates. Recommendations for future research are presented at the end of Chapters 1-7 of this report.

CONCLUSIONS

The scientific evidence published to date indicates that marijuana has a broad range of psychological and biological effects, some of which, at least under certain conditions, are harmful to human health. Unfortunately, the available information does not tell us how serious this risk may be.

The major conclusion is that what little we know for certain about the effects of marijuana on human health--and all that we have reason to suspect--justifies serious national concern. Of no less concern is the extent of our ignorance about many of the most basic and important questions about the drug. Our major recommendation is that there be a greatly intensified and more comprehensive program of research into the effects of marijuana on the health of the American people.

NAS NAE IOM NRC

National Academy Press

The National Academy Press was created by the National Academy of Sciences to publish the reports issued by the Academy and by the National Academy of Engineering, the Institute of Medicine, and the National Research Council, all operating under the charter granted to the National Academy of Sciences by the Congress of the United States.

American Civil Liberties Union

Alaska Civil Liberties Union -Legislative Committee-217 Second St. #204-Juneau, Alaska 99801

ACLU POSITION ON MARIJUANA AND THE RIGHT TO PRIVACY

The Alaska Civil Liberties Union is the local affiliate of the American Civil Liberties Union, representing approximately 900 members in Alaska. The ACLU opposes proposed legislation to recriminalize the personal possession and consumption of marijuana.

The use of marijuana involves protected constitutional rights, including the right to privacy which is explicitly guaranteed in Article I, Section 22 of the Alaska Constitution. Intrusion by government on such a constitutionally protected act places a burden of justification upon government. That burden has not been met with respect to federal and state laws that impose penalties on the use and possession of personal use quantities of marijuana.

ACLU opposes the definition of behavior as criminal when such behavior, engaged in either alone or with other consenting adults, does not in and of itself harm another person or force another person to act unwillingly in any way. Private personal possession and consumption of marijuana falls within this protected sphere of private personal activity.

The showings of government interest in regulating marijuana use, upon which the proposed legislation rests, are neither clear nor conclusive, as the Alaska Supreme Court has ruled in the case of Ravin v. State. The present state of scientific knowledge fully supports the rationale of the Ravin decision; there have been no scientific developments since Ravin which would change the constitutional basis for that decision. The medical findings contained in HB 55 and SB 32 are innacurate, selective, and misleading. The sentences of imprisonment and large fines called for under the proposed legislation are excessive and unconstitutional interventions into personal and private rights.

The sale of marijuana to adults over 18 should not be subject to criminal penalties. However, reasonable regulation and taxation of the sale of marijuana does not in and of itself constitute a violation of civil liberties. ACLU strongly supports educational efforts aimed at teaching all persons, and in particular minors, about the dangers of drug use and abuse.

The ACLU opposes laws which criminalize the possession, use and sale of marijuana, for these reasons:

1. They impose arbitrary, often harsh, and cruel penalties for private conduct for which no criminal penalty at all is appropriate.
2. They impose all of the hardships of an arrest, and arrest record, and often a prison term on otherwise law-abiding young people.
3. They are selectively enforced.
4. Their enforcement relies on entrapment, illegal searches, and other police conduct which violates civil liberties.
5. They encourage police corruption.
6. They divert law enforcement money and manpower from the enforcement of laws against serious crimes.
7. They engender contempt for the law.
8. They interfere with honest efforts to educate young people about the dangers of drug use and to combat the problems of drug abuse.

ACLU urges the defeat of legislation which would impose criminal penalties for the use or possession of marijuana.

STATE OF ALASKA 1987 LEGISLATIVE SESSION
FISCAL NOTE

REQUEST:

Bill Version: SB 32
Publish Date:

Revision Date:
Title: An act relating to marijuana

Agency Affected: Alaska Court System
BRU: Trial Courts

Sponsor: Fischer
Requestor: Senate Judiciary

Components:

EXPENDITURES/REVENUES: (Thousands of Dollars)

OPERATING	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92
Personal Services	....	143.6	143.6	143.6	143.6	143.6
Travel	....	....	....	....	....	....
Contractual	....	....	....	....	....	....
Supplies	....	....	....	....	....	....
Equipment	....	11.5	....	....	....	....
Land & Structures	....	....	....	....	....	....
Grants & Claims	....	....	....	....	....	....
TOTAL OPERATING	0.0	155.1	143.6	143.6	143.6	143.6
CAPITAL	....	....	....	....	....	....
REVENUE	....	....	....	....	....	....

FUNDING: (Thousands of Dollars)

General Funds	0.0	155.1	143.6	143.6	143.6	143.6
Federal Funds	....	....	....	....	....	....
Other	....	....	....	....	....	....
TOTAL	0.0	155.1	143.6	143.6	143.6	143.6

POSITIONS:

Full-time	....	4.0	4.0	4.0	4.0	4.0
Part-time	....	1.0	1.0	1.0	1.0	1.0
Temporary	....	....	....	....	....	....

ANALYSIS: (Attach a separate page if necessary)

See attached fiscal analysis.

Prepared by: Karla Forsythe, General Counsel
Division: Alaska Court System

Phone: 264-8228
Date: 4-23-87

Stephanie J. Cole

Approved by: Stephanie J. Cole, Deputy Director
Agency: Alaska Court System

Date: 4-23-87

Distribution (by preparer):
- Legislative Finance
- Legislative Sponsor
- Requestor
- Office of Management & Budget
- Impacted Agency(ies)
- Senate Secretary

ALASKA COURT SYSTEM
SB 32 - Fiscal Analysis

The Court System's fiscal note is based on the assumption that this bill will be enforced if enacted into law. The fiscal note submitted by the Department of Law reports that enforcement personnel anticipate several thousand new cases. This figure does not include prosecution resulting from municipal enforcement. Municipal police will generate a significant volume of cases for the courts, since they are responsible for enforcement in Alaska's urban communities and are more likely to arrest a large number of individuals than state troopers who focus on organized drug activity.

Using a conservative estimate of 2,000 cases annually, it appears that the increased caseload could be absorbed with existing judicial resources, but additional clerical support would be needed to process the high volume of paperwork attributable to these new criminal offenses which will be entering the criminal justice system.

ALASKA COURT SYSTEM
SB 32 - Fiscal Analysis

Personal Services:

	Salary	Benefits	Total
2 - Court Clerk II, Range 10B, Anchorage, PFT - 12 months	$45,672	$16,580	$62,252
1 - Court Clerk II, Range 10B, Fairbanks, PFT - 12 months	25,740	8,936	34,676
1 - Court Clerk II, Range 10B, Juneau, PFT - 12 months	22,836	8,290	31,126
1 - Court Clerk II, Range 10B, Ketchikan, PPT - 6 months	11,418	4,145	15,563
Total Personal Services			143,617

Equipment: (one-time cost)

Desk, chair, typewriter, and filing cabinet for each new position	11,540
Total First-Year Cost	$155,157

ANCHORAGE POLICE DEPARTMENT

4501 SOUTH BRAGAW STREET • ANCHORAGE, ALASKA 99507-1599
TELEPHONE (907) 786-8500

TONY KNOWLES
MAYOR

RONALD L. OTTE
CHIEF

March 13, 1987

MAR 1 8 1987

Senator Paul Fischer
Chairman, H.E.S.S. Committee
Alaska State Legislature
Pouch V (MS 3100)
Juneau, Alaska 99811

Dear Senator Fischer,

The purpose of this letter is to inform you of our support for Senate Bill 32 addressing the recriminalization of marijuana.

We believe that recent research may indicate that marijuana is more of a health hazard than originally thought. We believe that the legislature of the State of Alaska should take a serious look at recriminalization and hold hearings regarding its potential medical effects upon the populace. In addition, we believe that the youth of Alaska receive a mixed signal regarding the appropriateness of drug usage when marijuana is essentially legal in this state. In addition to that, we feel that the populace develops a scoff law attitude when the possession of marijuana is legal, but the purchase of and transportation of is illegal.

We urge that the recriminalization of marijuana be brought from the committee and addressed on the floor of the State Legislature.

If we can be of any further assistance regarding this issue or any other law enforcement related issue that you wish to call upon us for, feel free to do so.

Sincerely,

Del Smith
Del Smith
Deputy Chief of Operations

DS:dl

Statements of Support

City of Ketchikan
Police Department

334 Front Street
Ketchikan, Alaska 99901
907-225-3111

February 24, 1987

Senator Paul Fisher
Chairman, Hess Committee
Pouch V
Juneau, Alaska 99811

Dear Senator Fisher:

Substance abuse problems of all types are significant in Ketchikan as well as throughout the State of Alaska. The attached figures - obtained from the Alaska Department of Public Safety - represents arrests for substance abuse problems and provide some indicators of the scope of the problems.

For a number of years, law enforcement officers throughout the state have been concerned that a contributing factor to substance abuse has been the permissive Alaska State Statutes allowing the possession and use of marijuana in certain circumstances. Those statutes are inconsistent with Federal marijuana laws. The primary reason for law enforcement concern is that those inconsistencies provide conflicting messages to the public regarding the acceptability of the use of illegal substances.

Senate Bill 32 supports recriminalization of marijuana in the state of Alaska which will make state drug law consistent with the rest of the United States. That recriminalization is supported by the Alaska Association of Chiefs of Police and the Alaska Peace Officers Association as well as this Department. I would urge your support of SB32 and request your action to get the bill out of committee to the floor for a vote. If I can provide any further information in support of this bill, please contact me.

Sincerely,

D. A. Anslinger, III
Chief of Police

DAA:mp
Attachments

cc: Senator Lloyd Jones
Representative John Sund
Representative Robin Taylor
Representative Terry Martin

SUBSTANCE ABUSE ARREST SUMMARY

SOUTHEAST ALASKA

CONTROLLED SUBSTANCE AND ALCOHOL OFFENSES

	1979	1980	1981	1982	1983	1984	1985	*1986
Ketchikan P.D.								
Controlled Substance	23	12	43	34	74	70	56	93
Alcohol	219	235	443	322	306	358	398	548
TOTAL Ketchikan P.D.	242	247	486	356	380	428	454	641
Juneau P.D.								
Controlled Substance	27	43	23	34	43	30	48	
Alcohol	273	348	379	428	328	352	396	
TOTAL Juneau P.D.	300	391	402	462	371	382	444	
Sitka P.D.								
Controlled Substance	30	12	27	2	5	5	4	
Alcohol	261	263	185	212	280	197	115	
TOTAL Sitka P.D.	291	275	212	214	285	202	119	
Wrangell P.D.								
Controlled Substance	10	6	14	11	12	-	6	
Alcohol	87	81	114	84	83	72	83	
TOTAL Wrangell P.D.	97	87	128	95	95	72	89	
Petersburg P.D.								
Controlled Substance	1	2	2	10	14	3	4	
Alcohol	46	39	42	34	30	69	49	
TOTAL Petersburg P.D.	47	41	44	44	44	72	53	

* NOTE 1986 SUMMARIES NOT AVAILABLE FOR CITIES OTHER THAN KETCHIKAN

PD00000001/MEMOSDEPTS/MGRSEC

SUBSTANCE ABUSE ARREST ANALYSIS

SOUTHEAST ALASKA

CONTROLLED SUBSTANCE AND ALCOHOL OFFENSES

	1979	1980	1981	1982	1983	1984	1985	*1986
Ketchikan P.D.								
Juvenile Controlled Substance								18
Marijuana	8	1	12	7	11	15	13	
Cocaine	-	-	-	-	-	-	-	
Other	-	-	2	1	1	2	-	
Adult Controlled Substance								75
Marijuana	6	6	12	12	51	39	35	
Cocaine	5	2	11	12	6	12	8	
Other	4	3	6	2	5	2	-	
Juvenile DWI	2	5	6	4	8	3	8	8
Adult DWI	82	86	127	130	133	134	107	115
Juvenile Alcohol	71	74	152	92	71	94	125	185
Adult Alcohol	64	72	131	96	94	127	158	240
TOTAL Ketchikan P.D.	242	247	486	356	380	428	454	641
Juneau P.D.								
Juvenile Controlled Substance								
Marijuana	17	17	5	9	11	8	13	
Cocaine	-	-	-	3	-	1	2	
Other	-	2	-	-	-	2	1	
Adult Controlled Substance								
Marijuana	10	21	17	15	19	19	32	
Cocaine	-	-	-	6	13	-	-	
Other	-	3	1	1	-	-	-	
Juvenile DWI	6	4	4	6	2	3	2	
Adult DWI	91	82	70	133	137	172	103	
Juvenile Alcohol	98	166	161	138	100	89	93	
Adult Alcohol	78	96	144	151	89	88	108	
TOTAL Juneau P.D.	300	391	402	462	371	382	444	
Sitka P.D.								
Juvenile Controlled Substance								
Marijuana	9	1	2	1	3	-	2	
Cocaine	1	1	1	-	-	-	-	
Other	1	-	1	-	-	-	-	
Adult Controlled Substance								
Marijuana	10	7	3	1	2	3	-	
Cocaine	3	3	14	-	-	2	2	
Other	6	-	6	-	-	-	-	
Juvenile DWI	4	11	3	10	6	4	1	
Adult DWI	87	142	92	81	123	126	59	
Juvenile Alcohol	108	84	48	78	102	30	25	
Adult Alcohol	62	26	42	43	49	37	30	
TOTAL Sitka P.D.	291	275	212	214	285	202	119	

Mayor and City Council
Substance Abuse Arrest Analysis
January 2, 1987

	1979	1980	1981	1982	1983	1984	1985	*1986
Wrangell P.D.								
Juvenile Controlled Substance								
Marijuana	2	4	7	3	2	-	6	
Cocaine	-	-	-	-	-	-	-	
Other	4	-	-	-	-	-	-	
Adult Controlled Substance								
Marijuana	4	2	4	4	8	-	-	
Cocaine	-	-	3	3	2	-	-	
Other	-	-	-	1	-	-	-	
Juvenile DWI	-	-	-	-	2	1	-	
Adult DWI	5	7	13	36	55	32	22	
Juvenile Alcohol	57	58	88	32	15	22	32	
Adult Alcohol	25	17	13	16	11	17	29	
TOTAL Wrangell P.D.	97	87	128	95	95	72	89	
Petersburg P.D.								
Juvenile Controlled Substance								
Marijuana	-	1	-	4	11	-	-	
Cocaine	-	-	-	-	-	-	-	
Other	-	-	-	-	-	-	-	
Adult Controlled Substance								
Marijuana	1	1	2	3	1	3	2	
Cocaine	-	-	-	3	-	-	1	
Other	-	-	-	-	2	-	1	
Juvenile DWI	1	-	-	6	-	3	1	
Adult DWI	18	18	25	19	18	24	25	
Juvenile Alcohol	21	16	14	-	5	28	8	
Adult Alcohol	6	5	3	9	6	14	15	
TOTAL Petersburg P.D.	47	41	44	44	44	72	53	

* NOTE 1986 ANALYSIS NOT AVAILABLE FOR CITIES OTHER THAN KETCHIKAN

PD00000002/MEMOSDEPTS/MGRSEC

KETCHIKAN GATEWAY BOROUGH SCHOOL DISTRICT

Darroll Hargraves
SUPERINTENDENT

Resolution No. 210
Ketchikan Gateway Borough School District

A REQUEST FOR CHANGING THE
STATE STATUTES TO MAKE THE POSSESSION AND USE OF
MARIJUANA ILLEGAL

WHEREAS, the State of Alaska allows legal private possession and use of marijuana,

WHEREAS, Alaska's present statutes regarding possession and use of marijuana appear to be in conflict with the laws of the United States, and

WHEREAS, the problem of drug and alcohol abuse in our schools and our society appears to be on the rise, and

WHEREAS, the President of the United States initiated a national crusade to counter the current drug problem, and

WHEREAS, many students find easy access to illegal drugs, particularly marijuana, and

WHEREAS, Alaska statutes present a mixed message by currently allowing the use and possession of marijuana in the home, and

WHEREAS, current research and medical opinion concerning marijuana indicates that marijuana is harmful and does present a serious health problem, and

WHEREAS, the utilization of marijuana possession in Alaska sends the message to outside suppliers that Alaska is an open state which condones the "personal use" of marijuana, and

WHEREAS, a show of community resolve against the legal possession and use of marijuana sends a message to the state legislature and the governor's office,

POUCH Z • KETCHIKAN, ALASKA 99901-5026 • (907) 225-2118

KETCHIKAN SCHOOL DIST.

THEREFORE BE IT RESOLVED by the Ketchikan Gateway Borough School District that:

1. The School District encourages and supports the reinactment of statutes which will recriminalize the possession of marijuana.

2. The School District makes this position one of public record so that all in the community, in other school districts, and across the state will understand our position that the present statutes in Alaska governing marijuana are not in the best interest of its citizens.

3. The School District requests our legislators, locally and across the state, to give the recriminalization of marijuana immediate attention during the 1st session of the 15th legislature so that effective July 1, 1987 the possession and use of marijuana will be illegal and carry consequences.

PASSED, APPROVED, AND ADOPTED BY THE BOARD OF EDUCATION OF THE KETCHIKAN GATEWAY BOROUGH SCHOOL DISTRICT OF KETCHIKAN, ALASKA THIS _____ DAY OF ___________, 1987.

____
President of the Board

____
Clerk-Treasurer of the Board

Submitted by: Assemblyman Brad Bradley

Prepared by: Assemblyman Brad Bradley

AMENDED AND APPROVED

Date: 12-9-86

For Reading: November 25, 1986

AR No. 86-284

A RESOLUTION OF THE MUNICIPALITY OF ANCHORAGE SUPPORTING REPEAL OF AS 11.71.070 AND AMENDMENT OF AS 11.71.060(a) TO MAKE MARIJUANA ILLEGAL

WHEREAS, Alaska is the only state in the union with a permissive statute for personal possession of marijuana, and

WHEREAS, findings of local, state and federal authorities conclude that marijuana is detrimental to the health, welfare and public safety of all people, and

WHEREAS, the Supreme Courts of other states and the U.S. Supreme Court have upheld state statutes prohibiting the use and possession of marijuana, and

WHEREAS, current Alaska state statutes are not in conformity with federal drug enforcement laws controlling drug abuse, and

WHEREAS, the conflict between federal and state law pertaining to marijuana causes unnecessary barriers for local police and Alaska State Troopers in protecting the public from drug abusers, and

WHEREAS, the Anchorage Crime Commission has for the past three years concluded that Alaska's permissive laws on marijuana should be repealed, and

ANCHORAGE ASSEMBLY

POSITION PAPER/Department of Health & Social Services

POSITION PAPER
SB 32

For an Act entitled: "An Act Relating . Marijuana; providing for an effective date."

The Department of Health and Social Services is neutral regarding this legislation. The department, through the State Office of Drug and Alcohol Abuse, discourages the use of drugs of all kinds, including marijuana, and promotes this position through its support of community education and treatment of individuals who use drugs or alcohol. The criminalization of the use of marijuana by adults will not affect these programs.

The use of marijuana by youth is already a violation of law. These laws are enforced by local law enforcement agencies with the support of the Division of Family and Youth Services through its juvenile intake functions and delinquency programs. Discouraging the use of drugs and alcohol by youth is accomplished, again, through the work of the Division of Family and Youth Services in its direct contact with youth who may be using drugs or alcohol, and through the community education and treatment programs sponsored through the State Office of Drug and Alcohol Abuse.

Myra M. Munson

Myra M. Munson, Commissioner
Department of Health
and Social Services

DATE: March 4, 1987

Position Papers

BILL NO: SB 32 DATE: 1/21/87

TITLE: "An Act relating to marijuana; and providing for an effective date.

CONTACT: Maj. Walter J. Gilmour
Acting Director

The Division of Alaska State Troopers is neutral on this legislation.

Many individuals and groups in Alaska feel that the use of marijuana is harmful to public health and welfare. The purpose of this legislation is to recriminalize the possession of any amount of marijuana.

Presently the state law allows up to four ounces of marijuana for personal use. This is in direct conflict with the existing Federal law. This in effect encourages the violation of Federal law.

The existing conflict of Federal and State law is confusing in the mind of the public. The public expects consistency rather than diversity in the law. Such diversity tends to breed disrespect for the law in general, especially upon the impressionable minds of our youth.

Alaska's lenient attitude toward marijuana in effect creates a legal market for a substance that is illegally grown in other states.

Alaska's legalization of small amounts of marijuana directly contravenes the terms of the Single Narcotics Convention, the international treaty which outlaws marijuana and other controlled substances. The United States is one of numerous countries which are signators to the convention.

Recriminalizing marijuana would not, as some fear, result in wholesale arrest of individuals possessing small amounts of marijuana. The present drug enforcement philosophy of source interdiction recognizes the far greater cost-effectiveness of striking against high-level distributors, and sadly, there is no lack of high-level drug dealers in Alaska to occupy the enforcement efforts of narcotics officers.

William R. Nix
Acting Commissioner

POSITION PAPER

SB 32

The Alaska Public Defender Agency and the Office of Public Advocacy are totally reactive agencies which provide representation to indigent persons when appointed by the court. These agencies do not make policy nor do they initiate litigation. Only proposed legislation with fiscal or program ramifications for these agencies can be said to have a direct agency impact. Thus, the Public Defender Agency and Office of Public Advocacy submit position papers for legislation which will affect these agencies fiscally or programatically or will require these agencies to litigate constitutional issues raised by the legislation.

Fiscal impact: _____ None See attached fiscal note __X__

Program impact: _____ None See analysis below __X__

Contitutional impact: _____ None See analysis below __X__

This bill recriminalizes the use of marijuana in the home.

This bill appears to be violative of the Alaska Supreme Court's holding in Ravin v. State and will certainly lead to extensive trial and appellate court hearings on the issue of its constitutionality.

Furthermore, in a time of declining revenues, this bill may divert costly law enforcement, prosecution, defense and court resources from more serious cases.

Marsha Hubbard for
Dana Fabe, Director
Public Defender

3/5/87
Date

Marsha Hubbard for
Brant McGee, Director
Office of Public Advocacy

3/5/87
Date

Garrey Peska
Commissioner Garrey Peska
Department of Administration

3/6/87
Date

4/2K1/0305-03/2

STATE OF ALASKA 1987 LEGISLATIVE SESSION
FISCAL NOTE

Bill Version: SB 32
Publish Date:

REQUEST
Revision Date:
Title: "An Act relating to marijuana; and providing for an effective date."
Sponsor: Sen. Fischer
Requestor: Senate HESS

Agency Affected: Public Safety
BRU: Alaska State Troopers
Components: Detachments & C.I.B. Narcotics

EXPENDITURES/REVENUES: (Thousands of Dollars)

	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92
OPERATING						
PERSONAL SERVICES						
TRAVEL						
CONTRACTUAL						
SUPPLIES						
EQUIPMENT						
LAND & STRUCTURES						
GRANTS, CLAIMS						
MISCELLANEOUS						
TOTAL OPERATING	0	0	0	0	0	0
CAPITAL						
REVENUE						

FUNDING: (Thousands of Dollars)

	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92
GENERAL FUNDS						
FEDERAL FUNDS						
OTHER						
TOTAL	0	0	0	0	0	0

POSITIONS:

	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92
FULL-TIME	0	0	0	0	0	0
PART-TIME						
TEMPORARY						

ANALYSIS: (Attach a separate page if necessary)

No additional enforcement activities are anticipated and thus no fiscal impact is anticipated.

F.C.A.

Prepared by: Francis C. Allan
Division: Alaska State Troopers
Phone: 269-5691
Date: 1/21/87

Approved by Commissioner: [signature]
Date: 1/26/87
Agency: Public Safety

Distribution (by preparer):
- Legislative Finance
- Legislative Sponsor
- Requestor
- Office of Management and Budget
- Impacted Agency(ies)
- Senate Secretary

page 1 of 1

Fiscal Notes — State Troopers

+1

STATE OF ALASKA 1987 LEGISLATIVE SESSION
FISCAL NOTE

REQUEST:

Revision Date:

Title: "An act relating to marijuana"

Sponsor: Senator Paul Fischer

Requestor: Senator Paul Fischer

Bill Version: Senate Bill 32

Publish Date:

Agency Affected: Department of Corrections

BRU:

Components:

EXPENDITURES/REVENUES: (Thousands of Dollars)

OPERATING	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92
PERSONAL SERVICES						
TRAVEL						
CONTRACTUAL						
SUPPLIES						
EQUIPMENT						
LAND & STRUCTURES						
GRANTS, CLAIMS						
MISCELLANEOUS						
TOTAL OPERATING	0	0	0	0	0	0
CAPITAL	0	0	0	0	0	0
REVENUE	0	0	0	0	0	0

FUNDING: (Thousands of Dollars)

GENERAL FUND	0	0	0	0	0	0
FEDERAL FUNDS						
OTHER						
TOTAL						

POSITIONS:

FULL-TIME	0	0	0	0	0	0
PART-TIME						
TEMPORARY						

ANALYSIS: (Attach a separate page if necessary)

Prepared by: Susie Riley, Budget Analyst Phone: 465-3376

Division: Administrative Services Date: 01/26/87

Approved by Commissioner: William W. Ladwig Date: 01/26/87

Agency: Department of Corrections

Distribution (by preparer):
- Legislative Finance
- Legislative Sponsor
- Requestor
- Office of Management and Budget
- Impacted Agency(ies)
- Senate Secretary

page ___ of ___

Dept. of Corrections

STATE OF ALASKA 1987 LEGISLATIVE SESSION
FISCAL NOTE

Bill Version: SB 32
Publish Date:

REQUEST:

Revision Date:
Title: "An Act relating to marijuana..."

Sponsor: Sen. Fischer
Requestor: Sen. Fischer

Agency Affected: Department of Law
BRU: Prosecution

Components: Third Judicial District, Fourth Judicial District, Admin. & Support

EXPENDITURES/REVENUES: (Thousands of Dollars)

OPERATING	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92
PERSONAL SERVICES		160.9	165.7	170.7	175.8	181.1
TRAVEL		5.4	5.6	5.8	6.0	6.2
CONTRACTUAL		53.7	36.5	11.9	12.3	12.7
SUPPLIES		12.6	9.3	9.6	9.9	10.2
EQUIPMENT		4.5	-0-	-0-	-0-	-0-
LAND & STRUCTURES						
GRANTS, CLAIMS						
MISCELLANEOUS						
TOTAL OPERATING		237.1	217.1	198.0	204.0	210.2
CAPITAL						
REVENUE						

FUNDING: (Thousands of Dollars)

GENERAL FUND		237.1	217.1	198.0	204.0	210.2
FEDERAL FUNDS						
OTHER						
TOTAL						

POSITIONS:

FULL-TIME		2	2	2	2	2
PART-TIME		1	1	1	1	1
TEMPORARY						

ANALYSIS: (Attach a separate page if necessary)

Please see attached analysis.

Richard I. Pegues

Prepared by: Richard I. Pegues, Director
Phone: 465-3672
Division: Administrative Services
Date: 3/11/87

Richard I. Pegues /for/

Approved by Commissioner: Grace Berg Schaible, Atty. Gen.
Date: 3/11/87
Agency: Department of Law

Distribution (by preparer):
- Legislative Finance
- Legislative Sponsor
- Requestor
- Office of Management and Budget
- Impacted Agency(ies)
- Senate Secretary

Dept. of Law

SB 32 is a blanket provision which would make possession or use of less than one-half pound of marijuana by anyone a class B misdemeanor. Some of the conduct which this bill would cover (such as use or display of any amount in a public place, possession of any amount while operating a motor vehicle, or possession of more than four ounces of marijuana anywhere) is a class B misdemeanor under existing law. See AS 11.71.060. Some of the conduct which this bill would make a crime (such as delivery of less than one-half ounce or possession of less than one ounce in public) is classified under current law as a "violation", punishable by a fine. See AS 11.71.070. The penalties under current law for other conduct such as delivery of one-half ounce or more, delivery to a minor, or possession of any amount on school grounds would not be altered. Penalties under existing law for these offenses range from A misdemeanor to B felony level. See AS 11.71.030, .040, and .050.

The passage of SB 32 would have fiscal impact on the Department of Law in three general areas: (1) the cost of defending the new law against constitutional challenge; (2) the cost of processing the resulting additional criminal cases; and (3) the cost of educating the public about the new law. These three areas are discussed separately below.

1. Defending the New Law

In 1975 the Alaska Supreme Court in the case of Ravin v. State, 537 P.2d 497 (Alaska 1975), ruled that under Art. I, Sec. 22 of the Alaska Constitution the state could not prohibit possession of marijuana by adults in their own homes for personal use. The court held that the state had not demonstrated the existence of a legitimate state interest which was strong enough to justify the regulation of this conduct.

Since passage of SB 32 would make it a crime for an adult to possess any amount of marijuana anywhere, including in his or her own home, the constitutionality of the new law is certain to be challenged. An appellate court will have to decide whether the state has proved that there is a "compelling state interest" in the prohibition of the use of marijuana which is sufficient to outweigh an individual's right to privacy under the state constitution. It is extremely important, therefore, that the legislature's consideration of this bill include extensive public hearings, debate on the social policy merits of the proposal, and the collection of the results of the most recent scientific, medical, and pharmacological studies regarding the physical, emotional, and social effects of marijuana usage.

In addition to the necessary legislative hearings, evidentiary hearings at the trial court level can be expected when a challenge to the new law is filed. Challenges to the new law will most likely arise in the context of a defendant's pretrial motion to dismiss a criminal prosecution. When responding to such a defense motion, the prosecutor would, in essence, have to convince a court to reverse the ruling in the Ravin case. In order to demonstrate that the result in Ravin is no longer correct, the prosecutor would have to present convincing, scientifically accurate, evidence that the effects of marijuana usage are so injurious to a person's mental and physical health as to justify the legislative decision to totally prohibit use of marijuana by anyone at any time (as opposed to use by minors or use by a person who is operating a motor vehicle--both of which are already prohibited under current law).

The presentation of this convincing evidence will require the prosecution to present expert testimony from authorities who have conducted recent research in this area. Out-of-state witnesses in medical and scientific fields charge a fee for their services. These fees will vary from individual to individual, but are expected to average at least $100 per hour. This would include services for consultation, witness preparation and actual testimony. Costs will be incurred for expert witness transportation, food and lodging, and other incidental expenses. Additionally, there will be some costs for preparation of exhibits and written reports. To the extent possible, the Department of Law would attempt to present written testimony in situations where it is not feasible to fly a person to Alaska to testify in person. We estimate that a minimum of six expert witnesses will be required to attempt to successfully defend the new law at the trial court level.

Hearings at the trial court level can reasonably be expected to take several days. A substantial commitment of attorney time will be required for scientific and legal research in preparation for the hearings, actual court time, legal briefing, and the preparation of proposed findings of fact. Since prosecutions under the new law will occur statewide, defense challenges may be raised at the same time in different parts of the state. The extensive hearings described above may have to be held in more than one judicial district in the state.

Regardless of which side prevails at the trial court level, the lower court ruling would almost certainly be followed by an appeal. At a minimum, such an appeal (or appeals) would required additional legal research, a thorough review of the record, the drafting of briefs, and oral argument before the appellate court.

2. New Criminal Cases

Although some of the conduct included within the scope of SB 32 is already against the law, much behavior which is now classified as a "violation" or which is not now an offense of any sort will become a misdemeanor crime. It is difficult to accurately predict in advance the impact which the passage of SB 32 will have on the criminal justice system.

Some law enforcement officers who work primarily in the drug enforcement area believe that the new law could potentially result in "thousands" of new misdemeanor cases a year. They believe that the bill would cause an increased enforcement effort both in the areas not now covered by existing law and against persons who commit minor offenses which are already against the law. A great number of the new cases would arise from situations where law enforcement officers now commonly discover small amounts of marijuana (as when an officer responds to a domestic disturbance call and sees some marijuana plants in a person's home, or when a person is arrested for a minor offense and a routine search for weapons reveals some marijuana cigarettes in the person's pocket, for example). Incidents of this sort occur frequently now, but do not generally result in any criminal prosecution for the marijuana possession. Many of these cases are likely to be referred for criminal prosecution if SB 32 becomes law.

Prosecutors generally predict a lesser number of new potential criminal cases under SB 32 than do police. Once the public becomes aware of the new law, people are likely to be more careful about not allowing marijuana or smoking paraphernalia to be exposed in plain view in their homes, for example. Judging from the number of minor marijuana offenses prosecuted prior to the Ravin decision in 1975, prosecutors expect a "few hundred" new criminal cases a year.

Cases which are accepted for prosecution will require attorney time both at trial and in preparation for trial (i.e., preparation of search warrants, response to defense motions, evaluation of results of laboratory analysis, pretrial witness preparation, etc.). To handle screening of the expected case referrals, and to prosecute the additional cases, the criminal division will require the addition of at least two Attorney III positions in Anchorage. It is anticipated that a half-time attorney will also be needed in the Fairbanks District Attorney's office.

This fiscal note reflects the fact that the pretrial diversion program will be entirely eliminated in FY 88. Anticipating that more than fifty per cent of defendants would qualify for diversion, we must prepare for a gross increase in the number of cases that will go to trial.

3. Public Education

In order to inform the public of the changes in the law, the Department of Law will develop and disseminate public notices explaining the new law. These notices will include newspaper ads and brochures, and will be modeled upon the public education notices which were distributed statewide in connection with the new drug law in 1982 and the new DWI and drinking age laws in 1983. Based upon experience with these earlier notices, approximately $18,000 will be needed to cover the costs of writing, layout, typesetting, publication, and distribution.

In addition to the costs explained above, it is anticipated that the passage of this bill will result in increased costs to other components of the criminal justice system, including law enforcement, the courts, the public defender agency, and corrections.

CONTINUATION of FISCAL NOTE ANALYSIS

For Bill/Resolution No. SB 32

Fiscal Analysis

1. Defending the New Law

Admin. & Support Component/Prosc. - BRU

Object	Total
Contractual Services -	
Professional fees scientific experts	
120 hrs. X \$100 = \$12,000	\$12,000
Experts' staff support, preparation of exhibits, written testimony	
50 hrs. X \$40 = \$2,000	2,000
Experts' travel to attend hearings and offer testimony	
6 trips X 4 days X \$80 = \$1,920 subsistence	1,920
6 trips X \$1,500 = \$9,000 travel	9,000
	\$24,920

This amount will be required for both FY 88 and FY 89, to cover both trials and appeals.

CONTINUATION of FISCAL NOTE ANALYSIS

For Bill/Resolution No. SB 3?

Fiscal Analysis - (cont'd)

2. New Criminal Cases

Third Judicial District - Anchorage

	Atty III (PFT)	Atty III (PFT)	Total
Personal Services	62.6	62.6	125.2
Travel - Witness travel subsistence, atty. travel	1.8	1.8	3.6
Contractual Services			
office commo. equip. repairs	2.4	2.4	4.8
copy - postage	1.2	1.2	2.4
			7.2
Commodities - Ongoing			
office consumables	1.8	1.8	3.6
Law library	1.2	1.2	2.4
Commodities - one time			
New position materials	1.2	1.2	2.4
			8.4
Equipment - one time			
New position equipment	1.5	1.5	3.0
	73.7	73.7	147.4

CONTINUATION of FISCAL NOTE ANALYSIS

For Bill/Resolution No. SB 32

Fiscal Analysis - (cont'd)

Fourth Judicial District - Fairbanks

	Atty. III (PPT)	Total
Personal Services	35.7	35.7
Travel - Witness travel		
subsistence, Atty. travel	1.8	1.8
Contractual Services		
office commo., equip. repair	2.4	2.4
copy - postage	1.2	1.2
		3.6
Commodities - Ongoing		
office consumables	1.8	1.8
Law library	1.2	1.2
Commodities - one time		
New position materials	1.2	1.2
		4.2
Equipment - one time		
New position equipment	1.5	1.5
		46.8

Fiscal Analysis - (cont'd)

3. Public Education

Admin. & Support Component/Prosc. BRU

Object	Total
Contractual Services - one time writing, layout, typesetting, publication and distribution of public notices and information brochures describing the changes in the law.	18.0 18.0
	18.0

Summary of Expenses

	Defending the new law	New Criminal Cases	Public Education	Total
Personal Services		160.9		160.9
Travel		5.4		5.4
Contractual	24.9	10.8	18.0	53.7
Commodities		12.6		12.6
Equipment		4.5		4.5
	24.9	194.2	18.0	237.1

Costs beyond FY 88 include a 3 per cent inflation factor, less one-time items. The costs for defending the new law will occur in both FY 88 and FY 89 and they will be eliminated thereafter.

Position Title	No. of Positions	Range/Step	Barg. Unit
Attorney III	2	22A	PX

Time Status	Staff Months	Location	Election District
PFT	24	EBA - Anchorage	8

Type of Expenditure:		Amount
1	2	3
Salary	98,380	
Benefits	26,834	
Premium Pay		
Other		
Total Personal Services		125,214
Travel		3,600
Contractual		7,200
Commodities		8,400
Equipment		3,000
Other		
Total Cost		147,414

Funding Source for Total Cost		
Federal Receipts	1002	
G. F. Match	1003	
General Fund	1004	147,414
I-A Receipts	1006	
CIP Receipts	1061	
Other		

Justification

These two full-time attorney positions are required at Anchorage to handle the influx of new cases that will result when marijuana violations, or any use of marijuana, which is not now a violation, become misdemeanor offenses. Prosecutors expect that at least a few hundred such offenses will occur each year as a result of the enactment of this bill. These positions will be responsible for prosecuting those new cases that are brought in the Third Judicial District and handling appellate briefs and appeals hearings. Because these new cases will be classed as misdemeanor offenses, allocation of the positions to the Attorney III level is appropriate.

Request For New Position

Agency: Department of Law
BRU: Prosecution
Component: Third Judicial District

Revised Date

FY 88

Position Title	Attorney III	No. of Positions	Range/Step	Barg. Unit
		1	22A	PX

Time Status	Staff Months	Location	Election District
PPT	12	JBA - Fairbanks	16

Type of Expenditure 1	2	Amount 3
Salary	28,128	
Benefits	7,576	
Premium Pay		
Other		
Total Personal Services		35,704
Travel		1,800
Contractual		3,600
Commodities		4,200
Equipment		1,500
Other		
Total Cost		46,804

Funding Source for Total Cost		
Federal Receipts	1002	
G. F. Match	1003	
General Fund	1004	46,804
I-A Receipts	1006	
CIP Receipts	1061	
Other		

Justification

This permanent part-time position at Fairbanks is required to handle the influx of new cases that will result when marijuana violations, or any use of marijuana, which is not now a violation, become misdemeanor offenses. Prosecutors expect that at least a few hundred offenses will occur each year as a result of the enactment of this bill. This position will be responsible for prosecuting those new cases that are brought in the Fourth Judicial District. Because these new cases will be classed as misdemeanor offenses, allocation of the position to the Attorney III level is appropriate.

Request For New Position

Agency: Department of Law
BRU: Prosecution
Component: Fourth Judicial District

Revised Date

FY 88

STATE OF ALASKA 1987 LEGISLATIVE SESSION
FISCAL NOTE

REQUEST: ____________________

Revision Date: ____________________
Title: "An Act relating to marijuana..."

Sponsor: Sen. Fischer, Sen Faiks
Requestor: Judiciary

Bill Version: SB32
Publish Date: ____________________

Agency Affected: Dept. of Administration
BRU: Public Defender Agency

Components: Third Judicial District
Fourth Judicial District

EXPENDITURES/REVENUES: (Thousands of Dollars)

OPERATING	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92
PERSONAL SERVICES		140.9	146.5	152.3	158.4	164.7
TRAVEL		-0-				
CONTRACTUAL		27.5	10.4	10.8	11.2	11.6
SUPPLIES		2.0	2.1	2.2	2.3	2.4
EQUIPMENT		3.0				
LAND & STRUCTURES						
GRANTS, CLAIMS						
MISCELLANEOUS						
TOTAL OPERATING	-0-	173.4	159.0	165.3	171.9	178.7

CAPITAL						

REVENUE						

FUNDING: (Thousands of Dollars)

GENERAL FUND	-0-	173.4	159.0	165.3	171.9	178.7
FEDERAL FUNDS						
OTHER						
TOTAL	-0-	173.4	159.0	165.3	171.9	178.7

POSITIONS:

FULL-TIME	-0-	2.0	2.0	2.0	2.0	2.0
PART-TIME						
TEMPORARY						

ANALYSIS: (Attach a separate page if necessary)

See attached analysis

Dana Fabe

Prepared by: Dana Fabe, Public Defender
Division: Public Defender Agency

Phone: 279-7541
Date: Feb. 20, 1987

Approved by Commissioner: Harvey Pesk[illegible]
Agency: ____________________

Date: 3/6/87

Distribution (by preparer):
- Legislative Finance
- Legislative Sponsor
- Requestor
- Office of Management and Budget
- Impacted Agency(ies)
- Senate Secretary

Public Defender Agency

CONTINUATION of FISCAL NOTE ANALYSIS

-For Bill/Resolution No. SB32

This bill would re-institute the prosecution of offenses relating to the possession of marijuana in any amount or location and would result in a significant number of new cases for the Department of Law, the Public Defender Agency and the Office of Public Advocate. The Department of Law is requesting 2.5 new attorney positions while the Public Defender Agency is requesting an Attorney III in Anchorage and an Attorney III in Fairbanks for a total of 173.4.

BUDGET ANALYSIS

100	Attorney III - Anchorage		66.1	
	Attorney III - Fairbanks		74.8	140.9
200	Travel			-0-
300	Contractual	- Space, phone, etc.	10.0	
		Litigation, one time	17.5	27.5
400	Supplies	- Law Library, office, etc.		2.0
500	Equipment	- One time		3.0
			Total	173.4

Position Title Attorney III			No. of Positions 1	Range/Step 22A	Barg. Unit PX	Gov.	Approv.	Disapp.
Time Status PFT	Staff Months 12.0	RP Number	Location Anchorage		Election District 92	Leg.		

Type of Expenditure 1	2	Amount 3
Salary	49,140	
Benefits	16,980	
Premium Pay		
Other		
Total Personal Services		66,120
Travel		-0-
Contractual		22,500
Commodities		1,000
Equipment		1,500
Other		
Total Cost		91,120

Receipt Code	Funding Source	
	Federal Receipts 1002	
	G. F. Match 1003	
	General Funds 1004	91,120
	I-A Receipts 1005	
	Program Receipts 1028	
	CIP Receipts 1061	
	Other	

For B&M Use Only
Key Number __ __ - __ __ - __ __ - __ __ - __ __

Justification

This bill would result in a significant increase in criminal prosecutions as it would apply to any amount of marijuana in any location. The Public Defender Agency is requesting an Attorney III for Anchorage plus an additional 17.5 (one time) in contractual to litigate the constitutionality of this bill.

Request For New Position

Agency Dept. of Administration
BRU Public Defender Agency
Component Third Judicial District

Page 3 of 4
Revised Date

FY 87

Position Title Attorney III			No. of Positions 1	Range/Step 22A	Barg. Unit 94	Gov.	Approv.	Disapp
Time Status PFT	Staff Months 12.0	RP Number	Location Fairbanks		Election District 94	Leg.		

Type of Expenditure 1	2	Amount 3
Salary	56,244	
Benefits	18,551	
Premium Pay		
Other		
Total Personal Services		74,795
Travel		-0-
Contractual		5,000
Commodities		1,000
Equipment		1,500
Other		
Total Cost		82,295

Receipt Code	Funding Source	
	Federal Receipts 1002	
	G. F. Match 1003	
	General Funds 1004	82,295
	I-A Receipts 1005	
	Program Receipts 1028	
	CIP Receipts 1061	
	Other	

For B&M Use Only
Key Number __ __ - __ __ - __ __ - __ __ - __ __

Justification

This bill would result in a significant increase in criminal prosecutions as it would apply to any amount of marijuana in any location. The Public Defender Agency is requesting an Attorney III for Fairbanks to respond to the anticipated increased caseload.

Request For New Position

Agency Dept. of Administration
BRU Public Defender Agency
Component Fourth Judicial District

Revised Date

FY 87

STATE OF ALASKA 1987 LEGISLATIVE SESSION
FISCAL NOTE

Bill Version : SB 32
Publish Date :

REQUEST:

Revision Date:
Title : "An Act relating to marijuana..."
Sponsor : Fischer, Faiks
Requestor : Senate Judiciary

Agency Affected : Administration
BRU : Office of Public Advocacy

Components :

EXPENDITURES/REVENUES: (Thousands of Dollars)

OPERATING	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92
PERSONAL SERVICES	-0-	93.4	97.1	101.0	105.0	109.2
TRAVEL		0	0	0	0	0
CONTRACTUAL		60.0	62.4	64.9	67.5	70.2
SUPPLIES		2.0	2.1	2.2	2.3	2.4
EQUIPMENT		9.3	0	0	0	0
LAND & STRUCTURES						
GRANTS, CLAIMS						
MISCELLANEOUS						
TOTAL OPERATING	-0-	164.7	161.6	168.1	174.8	181.8
CAPITAL						
REVENUE						

FUNDING: (Thousands of Dollars)

GENERAL FUND	-0-	164.7	161.6	168.1	174.8	181.8
FEDERAL FUNDS						
OTHER						
TOTAL	-0-	164.7	161.6	168.1	174.8	181.8

POSITIONS:

FULL-TIME		2.0	2.0	2.0	2.0	2.0
PART-TIME						
TEMPORARY						

ANALYSIS : (Attach a separate page if necessary)

Prepared by : Brant McGee, Public Advocate
Phone : 274-1684
Division : Office of Public Advocacy
Date : 2/23/87

Approved by Commissioner : Garrey Peska
Date : 3/6/87
Agency : Department of Administration

Distribution (by preparer) :
- Legislative Finance
- Legislative Sponsor
- Requestor
- Office of Management and Budget
- Impacted Agency(ies)
- Senate Secretary

↓ Public Advocacy

CONTINUATION of FISCAL NOTE ANALYSIS

For Bill/Resolution No. SB32

This bill will recriminalize the use or possession of marijuana at any location and would result in a significant increase in the number of prosecutions for such offenses.

The Department of Law has requested 2.5 attorney in Anchorage and Fairbanks in order to enforce this statute. The constitutionality of the statute, which appears to directly conflict with the Supreme Court's 1975 holding in Raven v. State, will undoubtedly be tested in extensive trial and appellate court proceedings.

The Office of Public Advocacy requests one new Attorney III position for Anchorage -- where the greatest number of prosecutions is likely to arise -- and $60,000 in contractual funds to pay for representation in other areas and for expert witness fees necessary for trial proceedings.

Personal Services

Anchorage

Attorney III Salary & Benefits	=	63,198	63.2
Legal Secretary I Salary & Benefits	=	30,184	30.2
Subtotal Personal Services			93.4

Contractual

Contract attorneys in rural areas and expert witnesses	=	60,000	60.0

Supplies

Stationary & library supplies for two new positions at 1,000 per position	=		2.0

Equipment

Office furniture & equipment for one professional position at 2,429 and one secretary at 6,838			9.3
Total:			164.7

Position Title		No. of Positions	Range/Step	Barg. Unit
Attorney III		1	22/A	X
Time Status	**Staff Months**	**Location**	**Election District**	
PFT	12	EBA-Anchorage	8	

Type of Expenditure 1	2	Amount 3
Salary	49,140	
Benefits	14,058	
Premium Pay		
Other		
Total Personal Services		63,198
Travel		
Contractual		
Commodities		
Equipment		
Other		
Total Cost		63,198

Funding Source for Total Cost		
Federal Receipts	1002	
G. F. Match	1003	
General Fund	1004	63,198
I-A Receipts	1006	
CIP Receipts	1061	
Other		

Justification

The Anchorage OPA office presently has 3 attorney positions devoted to criminal defense. These attorneys are also handling several major cases outside the Anchorage area as staff coverage and travel is more cost effective than contracting major cases to private attorneys in rural areas. Current caseloads indicate that these three attorneys cannot absorb the additional cases which would result from this legislation. It is necessary that an additional attorney be added to the Anchorage staff to cover the resultant increased caseload.

Request For New Position

Agency Administration

BRU Office of Public Advocacy

Component

Revised Date

FY 88

Position Title	Staff Months
Legal Secretary I	

Time Status	Staff Months
PFT	12

No. of Positions	Range/Step	Barg. Unit
1	10/A	G

Location	Election District
EBA-Anchorage	8

Type of Expenditure		Amount
1	2	3
Salary	22,020	
Benefits	8,164	
Premium Pay		
Other		
Total Personal Services		30,184
Travel		
Contractual		
Commodities		
Equipment		
Other		
Total Cost		30,184

Funding Source for Total Cost		
Federal Receipts	1002	
G. F. Match	1003	
General Fund	1004	30,184
I-A Receipts	1006	
CIP Receipts	1061	
Other		

Justification

The Anchorage OPA office presently has 3 legal secretary positions providing clerical support to 12 professional positions, 2 vista volunteers, and the VGAL program. The addition of an attorney with a full caseload necessitates the addition of a legal secretary. The present ratio of 4 professionals to each secretary is the maximum that each secretary can handle. The additional workload created by an additional attorney carrying a full caseload cannot be absorbed by the present secretarial staff.

Request For New Position

Agency Administration

BRU Office of Public Advocacy

Component

Revised Date

FY 88

BILL NO: CSSB 32 (HESS)

DATE: 4/6/87 APR 9 1987

TITLE: "An Act relating to marijuana; and providing for an effective date."

CONTACT: Major Walter J. Gilmour
Acting Director
Alaska State Troopers

FISCAL NOTE / DEPARTMENT OF / PUBLIC SAFETY

Provides for recriminalization of possession of marijuana and an effective date.

During past years, the crime of possession of marijuana has been a felony, a misdemeanor, a violation and presently, legal for possession of certain amounts in the home. The intent of this legislation is to recriminalize possession of any amount.

The limited manpower and capabilities of the Alaska State Troopers Drug Enforcement personnel requires that they concentrate enforcement efforts on the suppliers and dealers of the drug, leaving little time or resources to actively pursue small amount possession violators in the home. This makes sense since suppliers and dealers usually have on hand substantial amounts of marijuana which is destined for sale in small amounts to individuals anyway and by removing a substantial amount of the source, more of an effect is felt on the market than by seizing small amounts from individuals.

Since possession of any amount of marijuana in public, on a school ground or while operating a motor vehicle is presently a crime, as well as possession of any amount by a minor, the trooper on patrol or making traffic enforcement already has the vehicle with which to arrest and charge when confronted with these situations.

Although passage of this legislation would undoubtedly deter some people from possessing small amounts in the homes because it would be illegal, the enforcement efforts of the Alaska State Troopers probably would not change much from its present status, that being concentration on suppliers and dealers. Passage of this legislation would, however, bring Alaska's marijuana laws in line with federal laws, as well as the marijuana laws in the other states.

The Division of Alaska State Troopers is neutral on this legislation.

William R. Nix
Acting Commissioner

STATE OF ALASKA 1987 LEGISLATIVE SESSION
FISCAL NOTE

Bill Version: CSSB 32 (HESS)
Publish Date:

REQUEST
Revision Date:
Title: "An Act relating to the re-criminalization of marijuana.."
Sponsor: Sen. Fischer
Requestor: Senate Judiciary

Agency Affected: Public Safety
BRU: Alaska State Troopers
Components: Detachments & CIB Narcotics

EXPENDITURES/REVENUES: (Thousands of Dollars)

OPERATING	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92
PERSONAL SERVICES						
TRAVEL						
CONTRACTUAL						
SUPPLIES						
EQUIPMENT						
LAND & STRUCTURES						
GRANTS, CLAIMS						
MISCELLANEOUS						
TOTAL OPERATING		0	0	0	0	0
CAPITAL						
REVENUE						

FUNDING:: (Thousands of Dollars)

GENERAL FUNDS		0	0	0	0	0
FEDERAL FUNDS						
OTHER						
TOTAL						

POSITIONS:

FULL-TIME		0	0	0	0	0
PART-TIME						
TEMPORARY						

ANALYSIS: (Attach a separate page if necessary)

No fiscal impact is anticipated.

JNL 4/8/87

Prepared by: Francis C. Allan
Division: Alaska State Troopers
Phone: 269-5691
Date: 4/8/87

Approved by Commissioner: William R. Nix
Agency: Public Safety
Date: 4/8/87

Distribution (by preparer):
- Legislative Finance
- Legislative Sponsor
- Requestor
- Office of Management and Budget
- Impacted Agency(ies)
- Senate Secretary

page ____ of ____

STATE OF ALASKA 1987 LEGISLATIVE SESSION
FISCAL NOTE

REQUEST:

Bill Version: SB 32
Publish Date:

Revision Date:
Title: An act relating to marijuana

Agency Affected: Alaska Court System
BRU: Trial Courts

Sponsor: Fischer
Requestor: Senate Judiciary

Components:

EXPENDITURES/REVENUES: (Thousands of Dollars)

OPERATING	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92
Personal Services	....	143.6	143.6	143.6	143.6	143.6
Travel	....	....	....	....	....	....
Contractual	....	....	....	....	....	....
Supplies	....	....	....	....	....	....
Equipment	....	11.5	....	....	....	....
Land & Structures	....	....	....	....	....	....
Grants & Claims	....	....	....	....	....	....
TOTAL OPERATING	0.0	155.1	143.6	143.6	143.6	143.6
CAPITAL	....	....	....	....	....	....
REVENUE	....	....	....	....	....	....

FUNDING: (Thousands of Dollars)

	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92
General Funds	0.0	155.1	143.6	143.6	143.6	143.6
Federal Funds	....	....	....	....	....	....
Other	....	....	....	....	....	....
TOTAL	0.0	155.1	143.6	143.6	143.6	143.6

POSITIONS:

	FY 87	FY 88	FY 89	FY 90	FY 91	FY 92
Full-time	....	4.0	4.0	4.0	4.0	4.0
Part-time	....	1.0	1.0	1.0	1.0	1.0
Temporary	....	....	....	....	....	....

ANALYSIS: (Attach a separate page if necessary)

See attached fiscal analysis.

Prepared by: Karla Forsythe, General Counsel
Division: Alaska Court System
Phone: 264-8228
Date: 4-23-87

Stephanie J. Cole

Approved by: Stephanie J. Cole, Deputy Director
Agency: Alaska Court System
Date: 4-23-87

Distribution (by preparer):
- Legislative Finance
- Legislative Sponsor
- Requestor
- Office of Management & Budget
- Impacted Agency(ies)
- Senate Secretary

ALASKA COURT SYSTEM
SB 32 - Fiscal Analysis

The Court System's fiscal note is based on the assumption that this bill will be enforced if enacted into law. The fiscal note submitted by the Department of Law reports that enforcement personnel anticipate several thousand new cases. This figure does not include prosecution resulting from municipal enforcement. Municipal police will generate a significant volume of cases for the courts, since they are responsible for enforcement in Alaska's urban communities and are more likely to arrest a large number of individuals than state troopers who focus on organized drug activity.

Using a conservative estimate of 2,000 cases annually, it appears that the increased caseload could be absorbed with existing judicial resources, but additional clerical support would be needed to process the high volume of paperwork attributable to these new criminal offenses which will be entering the criminal justice system.

ALASKA COURT SYSTEM
SB 32 - Fiscal Analysis

Personal Services:

	Salary	Benefits	Total
2 - Court Clerk II, Range 10B, Anchorage, PFT - 12 months	$45,672	$16,580	$62,252
1 - Court Clerk II, Range 10B, Fairbanks, PFT - 12 months	25,740	8,936	34,676
1 - Court Clerk II, Range 10B, Juneau, PFT - 12 months	22,836	8,290	31,126
1 - Court Clerk II, Range 10B, Ketchikan, PPT - 6 months	11,418	4,145	15,563
Total Personal Services			143,617

Equipment: (one-time cost)

Desk, chair, typewriter, and filing cabinet for each new position	11,540
Total First-Year Cost	$155,157

Marijuana and Health

Report of a Study
by a Committee of the
INSTITUTE OF MEDICINE
Division of Health Sciences Policy

NATIONAL ACADEMY PRESS
Washington, D.C. 1982

NOTICE The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the Councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

The Institute of Medicine was chartered in 1970 by the National Academy of Sciences to enlist distinguished members of the appropriate professions in the examination of policy matters pertaining to the health of the public. In this, the Institute acts under both the Academy's 1863 Congressional charter responsibility to be an advisor to the federal government, and its own initiative in identifying issues of medical care, research, and education.

This study was supported by the National Institutes of Health, Contract No. NO1-OD-0-2114.

International Standard Book Number 0-309-03236-9

Library of Congress Catalog Card Number 81-86534

Available from:

NATIONAL ACADEMY PRESS
2101 Constitution Ave., N.W.
Washington, D.C. 20418

Printed in the United States of America

Study of the Health-Related Effects of
Cannabis and Its Derivatives

PANELS

Cardiovascular and Respiratory Issues

Alfred P. Fishman*, Chairman

Brian F. Hoffman
Professor and Chairman
Department of Pharmacology
Columbia University College
of Physicians and Surgeons

Gerard M. Turino
Professor of Medicine
Department of Medicine
Columbia University College
of Physicians and Surgeons

Jerome I. Kleinerman
Chairman
Department of Pathology
Mount Sinai School of Medicine

Neurobiological Issues

Irwin Feinberg*, Chairman

Edward F. Domino*

H. Craig Heller
Associate Professor of Biology
Department of Biological Sciences
Stanford University

Reese T. Jones*

Harold Kalant*

Irwin H. Krakoff
Director
Vermont Regional Cancer Center

A. Edward Maumenee
Professor of Ophthalmology
Wilmer Institute
Johns Hopkins Hospital

Robert Moore*

Charles P. O'Brien*

*Committee member.

INSTITUTE OF MEDICINE
Frederick C. Robbins
President

Study Staff

Enriqueta C. Bond, Director, Division of Health Sciences Policy

Linda S. Dujack, Study Director

Kathryn G. King, Research Associate

Caren M. Carney, Research Associate

Allyn M. Mortimer, Research Assistant

Roszel S. Thomsen II, Research Assistant

Linda A. DePugh, Administrative Secretary

Constance V. Shuck, Administrative Secretary

With the collaboration of the Director of the Division of Mental Health and Behavioral Medicine, Fredric Solomon, and the assistance of Institute of Medicine staff members Barbara Filner, Barbara Mandula, and Robert Field.

Consultants

Henry D. Abraham, Harvard University

Richard E. Belleville, Private Consultant

Kevin Fehr, Addiction Research Foundation

Herbert Moskowitz, Southern California Research Institute

Wendy Nelson, University of Pennsylvania

Oakley S. Ray, Veterans Administration Medical Center

Brian L. Strom, University of Pennsylvania

Denise Kandel
Professor of Public Health
Department of Psychiatry
Columbia University and
New York State Psychiatric
Institute

Barbara M. Korsch
Professor of Pediatrics
and Head
Division of General Pediatrics
Children's Hospital of
Los Angeles
University of Southern California
School of Medicine

Robert Y. Moore
Professor and Chairman
Department of Neurology
State University of New York
at Stony Brook

Robert F. Murray, Jr.
Professor of Pediatrics,
Medicine and Oncology
Chief, Division of Medical Genetics
Department of Pediatrics and Child
Health
College of Medicine
Howard University

Norton Nelson
Professor of Environmental
Medicine
New York University
Medical Center

Charles P. O'Brien
Professor of Psychiatry
University of Pennsylvania
School of Medicine and
Philadelphia Veterans Adminis-
tration Medical Center

Sheldon J. Segal
Director
Population Sciences Division
Rockefeller Foundation

Paul D. Stolley
Professor
Department of Medicine
University of Pennsylvania
School of Medicine

COMMITTEE TO STUDY THE HEALTH-RELATED EFFECTS
OF CANNABIS AND ITS DERIVATIVES

Arnold S. Relman, Chairman
Editor
The New England Journal of Medicine

Konrad E. Bloch
Professor
Department of Chemistry
Harvard University

Barton Childs
Professor of Pediatrics and Biology
The Johns Hopkins University School of Medicine

Michael I. Cohen
Chairman and Professor
Department of Pediatrics
Albert Einstein College of Medicine
Montefiore Hospital and Medical Center

P. B. Dews
Professor of Psychiatry and Psychobiology
Laboratory of Psychobiology
Harvard Medical School

Edward F. Domino
Professor
Department of Pharmacology
University of Michigan

Robert B. Edgerton
Professor
Departments of Psychiatry and Anthropology
University of California, Los Angeles

Daniel D. Federman
Dean for Students and Alumni
Harvard Medical School

Irwin Feinberg
Professor of Psychiatry
University of California, San Francisco and
Veterans Administration Medical Center, San Francisco

Alfred P. Fishman
Professor of Medicine
Director
Cardiovascular Pulmonary Division
Hospital of the University of Pennsylvania

Beatrix Hamburg
Associate Professor of Psychiatry
Department of Psychiatry and Department of Social Medicine and Health Policy
Harvard Medical School

H. Carl Haywood
Professor of Psychology and Neurology
Director
The John F. Kennedy Center for Research on Education and Human Development
Vanderbilt University

Reese T. Jones
Professor of Psychiatry
Langley Porter Psychiatric Institute
University of California, San Francisco

Harold Kalant
Professor
Department of Pharmacology
University of Toronto

Behavioral, Psychosocial, and Epidemiologic Issues

Charles P. O'Brien* and H. Carl Haywood*, Co-Chairmen

Michael I. Cohen*

Robert B. Edgerton*

Beatrix Hamburg*

Reese T. Jones*

Denise Kandel*

Barbara M. Korsch*

Paul D. Stolley*

Reproductive and Fetal Issues

Daniel D. Federman*, Chairman

F. Clarke Fraser
Director of Medical Genetics
Montreal Children's Hospital

Norton Nelson*

Sheldon Segal*

Genetic, Oncogenic, and Cytogenetic Issues

Barton Childs*, Chairman

Arthur D. Bloom
Professor of Pediatrics and of Human Genetics and Development
Director, Clinical Genetics
Columbia University College of Physicians and Surgeons

Dietrich Hoffmann
Associate Director
Naylor Dana Institute for Disease Prevention

Robert F. Murray, Jr.*

Norton Nelson*

Cell Biology, Pharmacology, and Immunological Issues

P. B. Dews*, Chairman

Konrad E. Bloch*

Reese T. Jones*

Louis Lemberger
Director of Clinical Pharmacology
Lilly Laboratory for Clinical Research

Peter H. Schur
Professor of Medicine
Harvard University
Brigham and Women's Hospital

*Committee member.

ACKNOWLEDGMENTS

Many persons outside the Institute of Medicine provided helpful suggestions, timely observations, and data bearing on the complex scientific, clinical, and societal issues that were being explored by the committee and staff. We wish especially to express our gratitude for contributions made by Monique Braude, Jacqueline Ludford, Robert Petersen, William Pollin, and Marvin Snyder of the National Institute on Drug Abuse; Edward Tocus and Stuart Nightingale of the Food and Drug Administration; the Interagency Committee to Monitor the Marijuana Study; Carl Leventhal of the National Institutes of Health and the chairman of the Interagency Committee; and Joseph Perpich of the National Institutes of Health, our project officer.

We wish also to acknowledge the many scientists and others who responded to specific requests to review informally a portion of the draft report and those who, in general, gave their active assistance and collaboration:

- C. Wayne Bardin, Population Council
- Neal Benowitz, Langley Porter Psychiatric Institute
- Albert Carlin, University of Washington
- Sidney Cohen, Alcohol Research Center
- Ellen Dempsey, McGill University
- Everett Ellinwood, Duke University Medical Center
- Keith Green, Medical College of Georgia
- Daniel Hoth, National Cancer Institute
- Lloyd Johnston, Institute for Social Research
- Louise Lev, National Cancer Institute
- Markku Linnoila, National Institute of Mental Health
- Oriana Kalant and the Documentation Center of the Addiction Research Foundation
- Edward Khantzian, Cambridge Hospital
- Kaye Kilburn, University of Southern California School of Medicine
- Warren Levinson, University of California, San Francisco
- Raphael Mechoulam, School of Pharmacy, The Hebrew University, Israel
- John Merritt, University of North Carolina

- Akira Morishima, College of Physicians and Surgeons, Columbia University
- Al Munson, Medical College of Virginia
- Gabriel Nahas, College of Physicians and Surgeons, Columbia University
- William Paton, University of Oxford
- Bruce Petersen, Lilly Laboratory for Clinical Research
- Steven Podas, the Mount Sinai Medical Center
- Lee Robins, Washington University Medical School
- Harris Rosenkrantz, EG&G Mason Research Institute
- Donald Tashkin, University of California, Los Angeles
- David Taylor, Centers for Disease Control
- Carlton Turner, Senior Policy Adviser for Drug Policy, Office of Policy Development
- Arthur Zimmerman, University of Toronto

PREFACE

This report is the work of the many people identified in the preceding pages, and to all of them I am very grateful. I particularly wish to thank my distinguished colleagues on the study committee, upon whose expert knowledge and critical judgment this report rests. They responded conscientiously to all the demands placed on them, and they did so with a promptness and grace that made my task easy.

No study of this kind can be carried out without the help of a skilled staff. We were fortunate to have had the assistance of a devoted and highly capable staff team led by Enriqueta C. Bond and Linda S. Dujack. They coordinated the efforts of the committee, the panel, the consultants, and the Institute of Medicine staff, and they played the key role in keeping everything on schedule. Moreover, they carried out this formidable task with tact and common sense. On behalf of the committee, I wish publicly to acknowledge our indebtedness to the IOM staff, and I also wish to express my personal thanks to Drs. Bond and Dujack for their unfailing support and cooperation.

Finally, I wish to acknowledge my appreciation of the editorial assistance of Wallace K. Waterfall, whose expert touch is evident throughout this document. Our aim was to write a report in "a clear and incisive form for the general public." Any success that we may have achieved is due in no small measure to his efforts.

Arnold S. Relman

Arnold S. Relman, M.D.
Chairman

CONTENTS

Marijuana and Health

SUMMARY

The Institute of Medicine (IOM) of the National Academy of Sciences has conducted a 15-month study of the health-related effects of marijuana, at the request of the Secretary of Health and Human Services and the Director of the National Institutes of Health. The IOM appointed a 22-member committee to:

- analyze existing scientific evidence bearing on the possible hazards to the health and safety of users of marijuana;
- analyze data concerning the possible therapeutic value and health benefits of marijuana;
- assess federal research programs in marijuana;
- identify promising new research directions, and make sugggestions to improve the quality and usefulness of future research; and
- draw conclusions from this review that would accurately assess the limits of present knowledge and thereby provide a factual, scientific basis for the development of future government policy.

This assessment of knowledge of the health-related effects of marijuana is important and timely because marijuana is now the most widely used of all the illicit drugs available in the United States. In 1979, more than 50 million persons had tried it at least once. There has been a steep rise in its use during the past decade, particularly among adolescents and young adults, although there has been a leveling-off in its overall use among high school seniors in the past 2 or 3 years and a small decline in the percentage of seniors who use it frequently. Although substantially more high school students have used alcohol than have ever used marijuana, more high school seniors use marijuana on a daily or near-daily basis (9 percent) than alcohol (6 percent). Much of the heavy use of marijuana, unlike alcohol, takes place in school, where effects on behavior, cognition, and psychomotor performance can be particularly disturbing. Unlike alcohol, which is rapidly metabolized and eliminated from the body, the psychoactive components of marijuana persist in the body for a long time. Similar to alcohol, continued use of marijuana may cause tolerance and dependence. For all these reasons, it is imperative that we have reliable and detailed information about the effects of marijuana use on health, both in the long and short term.

What, then, did we learn from our review of the published scientific literature? Numerous acute effects have been described in animals, in isolated cells and tissues, and in studies of human volunteers; clinical and epidemiological observations also have been reported. This information is briefly summarized in the following paragraphs.

EFFECTS ON THE NERVOUS SYSTEM AND ON BEHAVIOR

We can say with confidence that marijuana produces acute effects on the brain, including chemical and electrophysiological changes. Its most clearly established acute effects are on mental functions and behavior. With a severity directly related to dose, marijuana impairs motor coordination and affects tracking ability and sensory and perceptual functions important for safe driving and the operation of other machines; it also impairs short-term memory and slows learning. Other acute effects include feelings of euphoria and other mood changes, but there also are disturbing mental phenomena, such as brief periods of anxiety, confusion, or psychosis.

There is not yet any conclusive evidence as to whether prolonged use of marijuana causes permanent changes in the nervous system or sustained impairment of brain function and behavior in human beings. In a few unconfirmed studies in experimental animals, impairment of learning and changes in electrical brain-wave recordings have been observed several months after the cessation of chronic administration of marijuana. In the judgment of the committee, widely cited studies purporting to demonstrate that marijuana affects the gross and microscopic structure of the human or monkey brain are not convincing; much more work is needed to settle this important point.

Chronic relatively heavy use of marijuana is associated with behavioral dysfunction and mental disorders in human beings, but available evidence does not establish if marijuana use under these circumstances is a cause or a result of the mental condition. There are similar problems in interpreting the evidence linking the use of marijuana to subsequent use of other illicit drugs, such as heroin or cocaine. Association does not prove a causal relation, and the use of marijuana may merely be symptomatic of an underlying disposition to use psychoactive drugs rather than a "stepping stone" to involvement with more dangerous substances. It is also difficult to sort out the relationship between use of marijuana and the complex symptoms known as the amotivational syndrome. Self-selection and effects of the drug are probably both contributing to the motivational problems seen in some chronic users of marijuana.

Thus, the long-term effects of marijuana on the human brain and on human behavior remain to be defined. Although we have no convincing evidence thus far of any effects persisting in human beings after cessation of drug use, there may well be subtle but important physical and psychological consequences that have not been recognized.

EFFECTS ON THE CARDIOVASCULAR AND RESPIRATORY SYSTEMS

There is good evidence that the smoking of marijuana usually causes acute changes in the heart and circulation that are characteristic of stress, but there is no evidence to indicate that a permanently deleterious effect on the normal cardiovascular system occurs. There is good evidence to show that marijuana increases the work of the heart, usually by raising heart rate and, in some persons, by raising blood pressure. This rise in workload poses a threat to patients with hypertension, cerebrovascular disease, and coronary atherosclerosis.

Acute exposure to marijuana smoke generally elicits bronchodilation; chronic heavy smoking of marijuana causes inflammation and pre-neoplastic changes in the airways, similar to those produced by smoking of tobacco. Marijuana smoke is a complex mixture that not only has many chemical components (including carbon monoxide and "tar") and biological effects similar to those of tobacco smoke, but also some unique ingredients. This suggests the strong possibility that prolonged heavy smoking of marijuana, like tobacco, will lead to cancer of the respiratory tract and to serious impairment of lung function. Although there is evidence of impaired lung function in chronic smokers, no direct confirmation of the likelihood of cancer has yet been provided, possibly because marijuana has been widely smoked in this country for only about 20 years, and data have not been collected systematically in other countries with a much longer history of heavy marijuana use.

EFFECTS ON THE REPRODUCTIVE SYSTEM AND ON CHROMOSOMES

Although studies in animals have shown that Δ-9-THC (the major psychoactive constituent of marijuana) lowers the concentration in blood serum of pituitary hormones (gonadotropins) that control reproductive functions, it is not known if there is a direct effect on reproductive tissues. Delta-9-THC appears to have a modest reversible suppressive effect on sperm production in men, but there is no proof that it has a deleterious effect on male fertility. Effects on human female hormonal function have been reported, but the evidence is not convincing. However, there is convincing evidence that marijuana interferes with ovulation in female monkeys. No satisfactory studies of the relation between use of marijuana and female fertility and child-bearing have been carried out. Although Δ-9-THC is known to cross the placenta readily and to cause birth defects when administered in large doses to experimental animals, no adequate clinical studies have been carried out to determine if marijuana use can harm the human fetus. There is no conclusive evidence of teratogenicity in human offspring, but a slowly developing or low-level effect might be undetected by the studies done so far. The effects of marijuana on reproductive function and on the fetus are unclear; they may prove to be negligible, but further research to establish or rule out such effects would be of great importance.

Extracts from marijuana smoke particulates ("tar") have been found to produce dose-related mutations in bacteria; however, Δ-9-THC, by itself, is not mutagenic. Marijuana and Δ-9-THC do not appear to break chromosomes, but marijuana may affect chromosome segregation during cell division, resulting in an abnormal number of chromosomes in daughter cells. Although these results are of concern, their clinical significance is unknown.

THE IMMUNE SYSTEM

Similar limitations exist in our understanding of the effects of marijuana on other body systems. For example, some studies of the immune system demonstrate a mild, immunosuppressant effect on human beings, but other studies show no effect.

THERAPEUTIC POTENTIAL

The committee also has examined the evidence on the therapeutic effects of marijuana in a variety of medical disorders. Preliminary studies suggest that marijuana and its derivatives or analogues might be useful in the treatment of the raised intraocular pressure of glaucoma, in the control of the severe nausea and vomiting caused by cancer chemotherapy, and in the treatment of asthma. There also is some preliminary evidence that a marijuana constituent (cannabidiol) might be helpful in the treatment of certain types of epileptic seizures, as well as for spastic disorders and other nervous system diseases. But, in these and all other conditions, much more work is needed. Because marijuana and Δ-9-THC often produce troublesome psychotropic or cardiovascular side-effects that limit their therapeutic usefulness, particularly in older patients, the greatest therapeutic potential probably lies in the use of synthetic analogues of marijuana derivatives with higher ratios of therapeutic to undesirable effects.

THE NEED FOR MORE RESEARCH ON MARIJUANA

The explanation for all of these unanswered questions is insufficient research. We need to know much more about the metabolism of the various marijuana chemical compounds and their biologic effects. This will require many more studies in animals, with particular emphasis on subhuman primates. Basic pharmacologic information obtained in animal experiments will ultimately have to be tested in clinical studies on human beings.

Until 10 or 15 years ago, there was virtually no systematic, rigorously controlled research on the human health-related effects of marijuana and its major constituents. Even now, when standardized marijuana and pure synthetic cannabinoids are available for experimental studies, and good qualitative methods exist for the measurement of Δ-9-THC and its metabolites in body fluids, well-designed studies on human beings are relatively few. There are difficulties in studying the clinical effects of marijuana in human beings, particularly the effects of long-term use. And yet, without such studios the debate about the safety or hazard of marijuana will remain unresolved. Prospective cohort studies, as well as retrospective case-control studies, would be useful in identifying long-term behavioral and biological consequences of marijuana use.

The federal investment in research on the health-related effects of marijuana has been small, both in relation to the expenditure on other illicit drugs and in absolute terms. The committee considers the research particularly inadequate when viewed in light of the extent of marijuana use in this country, especially by young people. We believe there should be a greater investment in research on marijuana, and that investigator-initiated research grants should be the primary vehicle of support.

The committee considers all of the areas of research on marijuana that are supported by the National Institute on Drug Abuse to be important, but we did not judge the appropriateness of the allocation of resources among those areas, other than to conclude that there should be increased emphasis on studies in human beings and other primates. Recommendations for future research are presented at the end of Chapters 1-7 of this report.

CONCLUSIONS

The scientific evidence published to date indicates that marijuana has a broad range of psychological and biological effects, some of which, at least under certain conditions, are harmful to human health. Unfortunately, the available information does not tell us how serious this risk may be.

Our major conclusion is that what little we know for certain about the effects of marijuana on human health--and all that we have reason to suspect--justifies serious national concern. Of no less concern is the extent of our ignorance about many of the most basic and important questions about the drug. Our major recommendation is that there be a greatly intensified and more comprehensive program of research into the effects of marijuana on the health of the American people.

INTRODUCTION

The Institute of Medicine (IOM) of the National Academy of Sciences has undertaken this review and analysis of the health-related effects of marijuana* at the request of the Secretary of the Department of Health and Human Services (DHHS) and the Director of the National Institutes of Health (NIH).

Scientific controversy and public confusion about marijuana continue unabated and perhaps even are expanding, notwithstanding numerous reports on the topic from authoritative agencies and organizations (Fifth, Sixth, Seventh, and Eighth Annual Reports from the Secretary of Health, Education and Welfare to the Congress on Marijuana and Health; Fehr, et al., Cannabis: Adverse Effects on Health, 1980a; Tinklenberg, Marijuana and Health Hazards and Marijuana in the '80s, a report of the Council on Scientific Affairs, the American Medical Association, 1980). Increasing use of this substance and growing concern about its possible long- and short-term consequences for human health have added some urgency to the need for reassessment of the available data. Interest has been further heightened by recent suggestions that marijuana may also have some medical therapeutic value, which only intensifies the debate about what our public policy towards marijuana ought to be.

With this as background, the Secretary of Health, Education, and Welfare, Joseph A. Califano, Jr., in a press statement on April 18, 1979, announced the intention of his department to undertake a review that would ". . . assess the information and scientific work now available on the effects of marijuana." He followed that with a memorandum on May 16, 1979, to Donald S. Fredrickson, Director of NIH in which he further stated:

> This review must be undertaken by an independent scientific body that has not staked out a position in this highly controversial field. This review should be conducted by a

---

*The terms marijuana and cannabis will be used interchangeably in this report. Strictly speaking, they are not synonymous; cannabis is the more general term. (See Glossary, page 9.)

group of distinguished biomedical and clinical scientists and should involve thorough, systematic review and analysis of the research literature. . . . The report should identify the most urgently needed and promising lines of inquiry to build a firmer base for decision-making in years to come. The information should be available in a clear and incisive form for the general public.

While the Alcohol, Drug Abuse, and Mental Health Administration (ADAMHA) and its National Institute on Drug Abuse (NIDA) have provided leadership in research related to biological and health effects of marijuana, it is most important that we have a review by an independent nongovernmental body, such as the Institute of Medicine. In order to avoid even the appearance of a conflict of interest, inasmuch as this review will cover part of the research plan of ADAMHA-NIDA, I believe it is important that the National Institutes of Health serve as the responsible DHHS agency for seeing that such a review is conducted.

Following Mr. Califano's resignation, subsequent secretaries have confirmed to the Director of the NIH their desire to see this review carried forward. Accordingly, a contract between the NIH and the IOM was executed to provide for a study to commence September 30, 1980, and be completed by December 29, 1981.

THE COMMITTEE'S TASK

Under this contract, the IOM agreed to appoint a committee to:

1. analyze existing scientific evidence bearing on the possible hazards to the health and safety of users of marijuana;
2. analyze data concerning the possible therapeutic value and health benefits of marijuana;
3. assess federal research programs in this area;
4. identify promising new research directions, and make suggestions to improve the quality and usefulness of future research;
5. draw conclusions from this review that would accurately assess the limits of present knowledge and thereby provide a factual, scientific basis for the development of future government policy. Such an assessment also should be helpful to private citizens who want to make their own informed decisions about this subject.

The committee's charge specifically excluded the analysis or formulation of public policy.

PROCEDURE FOR THE STUDY

Primary responsibility for the conduct of the study was vested in a steering committee of 22 biologists, behavioral scientists, and clinicians. Although they all were experts in relevant disciplines, only a few had previously been involved in the study of marijuana or had taken public positions on the subject. The committee was divided into six panels, each concerned with major scientific areas: cardiovascular and respiratory system effects; neurobiological effects; epidemiological, behavioral, and psychosocial effects; reproductive biology and effects on the fetus; pharmacology, cell biology, and immunology; and genetic and oncogenic effects. Each panel was chaired by a member of the committee and usually had one or more additional committee members and several expert consultants, whose names appear in the front of this report. The committee also consulted with many other experts in the course of its work and received valuable help from many persons and organizations.

The full committee met five times to coordinate and assess its progress. In the intervals between these meetings, the panels held their own independent sessions and various ad hoc working groups met as necessary. The chairman and members of the committee staff were invited observers at the Conference on Adverse Health and Behavioral Consequences of Cannabis Use, which was sponsored by the Addiction Research Foundation (ARF) of Ontario and the World Health Organization (WHO) and held in Toronto, Canada, from March 30 to April 3, 1981. Other members of our committee served as working members of that conference. We were also fortunate in being able to work closely with members of the ARF/WHO conference staff and having access to all the documents prepared for the Canadian meeting as well as the revised draft of the summary report of the conference (1981).

The committee began by systematically reviewing all the literature published since 1975 on marijuana and related subjects, which had been collected by our staff through a Medline computer search. Earlier literature was selectively examined, as were a variety of other documents, reviews, and monographs on the subject. Our objective was not merely to compile and summarize, but also to evaluate the evidence critically and, with the aid of our consultants, form some judgment of the quality and reliability of the work. Our report is an assessment of what is and is not known, based on our best interpretations of the scientific literature. We confined our attention to published scientific articles as the primary sources of information, relying heavily on experts in each field to select the relevant papers and help us interpret the data.

To obtain additional information and opinions from the public and from professional groups on the health-related effects of marijuana, we solicited written responses in a notice in the <u>Federal Register</u> of February 24, 1981. Responses were received and incorporated into the records of the committee. (See Appendix A for a complete description.) The responses fell into three categories:

1. <u>The dangers of marijuana.</u> Letters in this category came from mothers whose children were using or had used marijuana. These parents believed that drug use by their children led to a lack of motivation and loss of interest in school and other activities. Letters about the harmfulness of the use of marijuana were also received from physicians and scientists.

2. The therapeutic potential of marijuana. Half of the responses were from people who used marijuana illegally for various medical problems and who urged that it be made easily available to patients. Several letters submitted by legislators and doctors described problems in obtaining marijuana for therapeutic use (see Appendix B). A group interested in the legitimate medical use of cannabis emphasized the need for continuing investigation into the numerous constituents of the marijuana plant for therapeutic uses.

3. Support of general use and legalization of marijuana. Letters were received from individuals and groups favoring the use of marijuana and actively promoting its legalization.

This report covers most of the concerns expressed by the public, except the question of legalization. The various statements included many opinions and much anecdotal evidence from laymen and scientists. The committee took note of this material, but has not cited any of it in this report unless it was supported by published data in the scientific literature.

THE ORGANIZATION OF THE REPORT

This report is divided into eight chapters and a summary. The summary includes the principal findings and conclusions of the study, together with suggestions for future research.

The first chapter reviews what is known about the chemistry and pharmacology of marijuana. Chapter 2 deals with the epidemiology and demography of the use of marijuana in the United States. The next three chapters discuss the effects of marijuana on cells, tissues, organs, and biological systems. Chapter 6 deals with behavioral and psychosocial effects. Chapter 7 discusses the present status of marijuana as a therapeutic agent. Chapter 8 describes and analyzes the federal research program on marijuana.

This report is intended to be intelligible to readers who are not expert on the subjects at hand. We have tried to use technical language only where accuracy would be compromised by less precise terms, and to keep the discussions as brief and as clearly stated as is consistent with our obligation to present a valid critique of the state of knowledge in this field. Although we have surveyed the literature as thoroughly as possible, our citations are selective rather than exhaustive, because they are intended to illustrate or document only the key points in the discussion. For comprehensive bibliographies, see Waller et al., 1976; Abel, 1979; and Kalant et al., 1980.

GLOSSARY OF TERMS FOR MARIJUANA-RELATED PRODUCTS

CANNABIDIOL (CBD) and CANNABINOL (CBN) are major cannabinoids generally present in cannabis (see CANNABIS and CANNABINOIDS).

CANNABINOIDS are a class of 21-carbon compounds present in Cannabis sativa. The basic structure contains a six-membered hydroaromatic ring and a benzene ring joined by a pyran moiety (see Figure 1-1 in Chapter 1). Derivatives include a number of carboxylic acids, their analogues, and transformation products.

CANNABIS is a general term for any of the various preparations of the plant Cannabis sativa and the cannabinoids obtained from it. "Cannabinoid" is a generic term for a class of compounds. Cannabis sativa, also called hemp, is an herbaceous annual plant that readily grows in temperate climates. Depending on the geographic region, and other considerations, the various natural preparations of cannabis possess different physical characteristics and concentrations of cannabinoids. Cannabis preparations may contain over 420 different compounds; of these, 61 have been identified as cannabinoids, many of which possess some biological activity. Marijuana, hashish, and tetrahydrocannabinol are examples of different forms or components of cannabis.

HASHISH is a resin, generally more potent than marijuana, which is obtained from Cannabis sativa by shaking, pressing, or scraping the leaves and flowers of the plant and usually contains some of the latter.

MARIJUANA is a general term for crude preparations obtained from the plant Cannabis sativa and is a mixture of crushed leaves, twigs, seeds, and sometimes the flowers of this plant. In the United States, the term "marijuana" has often been used interchangeably with cannabis to refer to any part of the plant or extract therefrom or any of the synthetic cannabinoids that induce somatic and psychic changes in man.

SINSEMILLA is a seedless variety of high-potency marijuana, originally grown in California.

TETRAHYDROCANNABINOL (THC) is one of the major groups of cannabinoids. Delta-9-THC is the principal active constituent in natural cannabis preparations. Delta-9-THC is also known as Δ-1-THC, by a different system of nomenclature. (In the United States, the Δ-9-THC content of marijuana ranges from unmeasurable amounts to about 6 percent.) Another active isomer, Δ-8-THC, is less often present in marijuana and typically occurs in minute amounts. Many derivatives of Δ-9-THC have been synthesized.

REFERENCES

Abel, E.L. A Comprehensive Guide to the Cannabis Literature Westport, Conn.: Greenwood Press, Inc., 1979.

American Medical Association. Marijuana in the '80s. Report of the Council on Scientific Affairs. Chicago Ill.: American Medical Association, 1980.

Fehr, K.O., Kalant, O.J., Kalant, H., and Single, E.W. Cannabis: Adverse Effects on Health. A statement prepared by the scientists of the Addiction Research Foundation of Ontario. Toronto: Addiction Research Foundation, 1980.

Kalant, O.J., Fehr, K.O., and Arras, D. Cannabis: Health Hazards: A Comprehensive Annotated Bibliography. Toronto: Addiction Research Foundation, 1980.

Report of Addiction Research Foundation/World Health Organization (ARF/WHO). Conference on Adverse Health and Behavioral Consequences of Cannabis Use. ARF/WHO, 1981.

Tinklenberg, J.R. (ed.) Marijuana and Health Hazards: Methodological Issues in Current Research. New York: Academic Press, Inc., 1975.

U.S. Department of Health, Education, and Welfare, Public Health Service. Marihuana and Health. Fifth Annual Report to the Congress from the Secretary of Health, Education, and Welfare, 1975. DHEW Publication No. (ADM)76-314. Washington, D.C.: U.S. Government Printing Office, 1976.

U.S. Department of Health, Education, and Welfare, Public Health Service. Marihuana and Health. Sixth Annual Report to the Congress from the Secretary of Health, Education, and Welfare, 1976. DHEW Publication No. (ADM)77-443. Washington, D.C.: U.S. Government Printing Office, 1977.

U.S. Department of Health, Education, and Welfare, Public Health Service. Marihuana and Health. Seventh Annual Report to the Congress from the Secretary of Health Education, and Welfare, 1977. DHEW Publication No. (ADM) 79-700. Washington, D.C.: U.S. Government Printing Office, 1979.

U.S. Department of Health, Education, and Welfare, Public Health Service. Marijuana and Health. Eighth Annual Report to the Congress from the Secretary of Health, Education, and Welfare, 1980. DHEW Publication No. (ADM) 80-945. Washington, D.C.: U.S. Government Printing Office, 1980.

Waller, C.W., Johnson, J.J., Buelke, J., and Turner, C.E. Marihuana: An Annotated Bibliography New York: Macmillan Information, 1976.

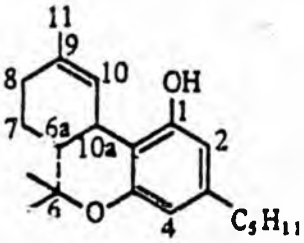
I

CHEMISTRY AND PHARMACOLOGY OF MARIJUANA

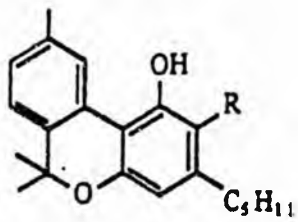
The cannabis plant (Cannabis sativa) thrives under a variety of growing conditions. It has been cultivated for centuries, mainly for hemp fiber, but also for its psychoactive and putative medicinal properties (Abel, 1980; Turner et al., 1980). Although the behavioral and psychological effects were well described in literature of the nineteenth century (Kalant and Kalant, 1968), the complex chemistry and pharmacology of the cannabis plant discouraged extensive investigation until about 15 years ago.

The most prominent effects of cannabis are on psychological phenomena and behavior. Psychopharmacology and behavioral pharmacology have developed as divisions of scientific inquiry only over the past 25 years; therefore, the older cannabis literature, no matter how valuable for observations on other matters, does not provide a basis for quantitative pharmacological analysis and evaluation.

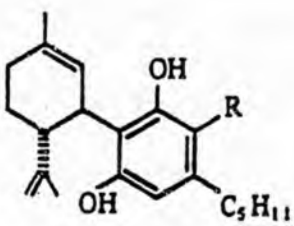
Early pharmacologists could work only with crude extracts of the plant. Although the general structure of the cannabinoids (Figure 1) was known by the turn of the century, the particular cannabinoids that were identified early and were available as pure substances were largely devoid of the characteristic psychoactive and other pharmacological effects of cannabis. Synthetic cannabinoids with cannabislike activity became available in the 1930s. It was not until 1964 that an active ingredient of cannabis was identified as Δ-9-tetrahydrocannabinol (THC) and synthesized (Figure 1) (Gaoni and Mechoulam, 1964; Mechoulam and Gaoni, 1965, 1967). In the mid-1960s, the isolation and synthesis of the main psychoactive component of cannabis and related cannabinoids, together with a rapid increase in the use of marijuana by middle class North American students, stimulated scientific activity (Waller et al., 1976; Waller et al., in press). This chapter, an overview of cannabis chemistry and pharmacology, emphasizes difficulties in the study of this drug (explored further in subsequent chapters) and in evaluating the literature.



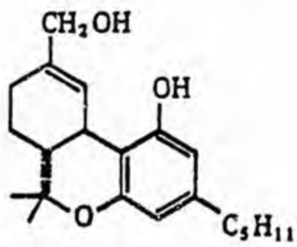
Δ-9-THC



Cannabinol



Cannabidiol



11-hydroxy-Δ-9-THC

FIGURE 1 Cannabinoid structures.

CANNABIS CHEMISTRY

Chemistry of the Plant

Cannabis, the crude material from the plant Cannabis sativa, contains hundreds of chemicals. Most of these are found in other plants, but 61, termed cannabinoids, are unique to the cannabis plant (Table 1). Natural and most synthetic cannabinoids are relatively insoluble in water, but dissolve in fats and fat solvents and are therefore called lipid soluble.

A single cannabinoid, Δ-9-THC, produces almost all the characteristic specific pharmacolo[illegible]fects of the complex, crude cannabis mixtures. A numb[illegible]etic cannabinoids have pharmacological effects similar to [illegible]. Other cannabinoids in the plant, for example, cannabinol (Figure 1), are almost inactive pharmacologically or [illegible] interact with Δ-9-THC to modify its actions. One cannabinoid, cannabidiol (CBD), can influence the metabolism of another, Δ-9-THC (Siemens et al., 1976). A few cannabinoids have effects quite different from Δ-9-THC. For example, cannabidiol (Figure 1) has relatively little psychoactive and cardiovascular effect but is an active anticonvulsant (Karler and Turkanis, 1981).

Investigators have chemically altered the Δ-9-THC molecule in an attempt to determine which of its structural elements are required to produce behavioral or other effects (Mechoulam et al., 1980). Studies of structure-activity relationships indicate that, to produce

TABLE 1 Chemical Constituents of Cannabis Preparations

1. Cannabinoids: 61 known
   - a. Cannabigerol (CBG) type: 6 known
   - b. Cannabichromene (CBC) type: 4 known
   - c. Cannabidiol (CBD) type: 7 known
   - d. Δ-9-Tetrahydrocannabinol (Δ-9-THC) type: 9 known
   - e. Δ-8-Tetrahydrocannabinol (Δ-8-THC) type: 2 known
   - f. Cannabicyclol (CBL) type: 3 known
   - g. Cannabielsoin (CBE) type: 3 known
   - h. Cannabinol (CBN) type: 6 known
   - i. Cannabinodiol (CBND) type: 2 known
   - j. Cannabitriol (CBT) type: 6 known
   - k. Miscellaneous types: 9 known
   - l. Other cannabinoids: 4 known
2. Nitrogenous compounds: 20 known
3. Amino acids: 18 known
4. Proteins, glycoproteins, and enzymes: 9 known
5. Sugars and related compounds: 34 known
6. Hydrocarbons: 50 known
7. Simple alcohols: 7 known
8. Simple aldehydes: 12 known
9. Simple ketones: 13 known
10. Simple acids: 20 known
11. Fatty acids: 12 known
12. Simple esters and lactones: 13 known
13. Steroids: 11 known
14. Terpenes: 103 known
15. Noncannabinoid phenols: 16 known
16. Flavanoid glycosides: 19 known
17. Vitamins: 1 known
18. Pigments: 2 known

SOURCE: Adapted from Turner, 1980.

effects on behavior, a pyran ring must be part of the three-ring system, a free phenolic hydroxyl on the aromatic ring at C-1, and a lipophilic side chain (C_5H_{11}) at C-3 (Figure 1). Understanding chemical structure-effect relationships is important to guide the synthesis of cannabinoids with differing pharmacological effects. Different effects of Δ-9-THC activity by chemical design will require further syntheses and pharmacological study of a large number of cannabinoids.

Chemistry of the Smoke

It is impossible to understand the effects of cannabis without quantitative control of the composition and the amount of the active substances, that is, control over the dose. Systematic pharmacology must therefore be performed using pure compounds. In the United States, cannabis usually is smoked, which complicates the pharmacology.

The smoke from any burning plant contains hundreds of chemicals that may have biological effects. This poses a dilemma for researchers, because consequences of smoking cannabis cannot be fully determined by studies only of the pure cannabinoids. Studies also are needed with doses of Δ-9-THC delivered, however imperfectly, by smoking.

The dose of Δ-9-THC obtained from smoking cannabis varies greatly, depending on many factors (Table 2). First, the content of Δ-9-THC depends on the genetic background or phenotype of the plant, the sex of the plant, conditions of growth and storage, and the plant preparation smoked. Second, much of the Δ-9-THC in fresh leaves that can be detected by gas-liquid chromatography (GLC) is in inactive carboxylated form. Decarboxylation to the active Δ-9-THC occurs slowly during storage and rapidly during heating, such as occurs in smoking or GLC analysis. Third, the way in which a cigarette is smoked can greatly affect how much of the Δ-9-THC content is absorbed by the smoker.

Cannabis smoke is similar to tobacco smoke in that it is a mixture of very small particles and a gas-vapor phase. Both the particulate and vapor phases contain many identified and probably some still unidentified constituents that, based on clinical experience with tobacco smoke, must be assumed to be potentially harmful (Leuchtenberger and Leuchtenberger, 1976). The amounts of some materials in tobacco cigarette and marijuana cigarette smoke are compared in Table 3. Toxic substances, such as carbon monoxide, hydrogen cyanide, and nitrosamines occur in similar concentrations in tobacco and marijuana smoke; so do the amounts of the particulate material known collectively as "tars."

It is not easy to compare the toxicity of a given number of marijuana cigarettes to a given number of tobacco cigarettes. There are general similarities in the composition of the smoke, but the variations in composition of both tobacco and marijuana cigarettes and differences in smoking techniques make simple extrapolations of risks of tobacco versus marijuana smoking not valid.

TABLE 2 Concentrations of Δ-9-THC in Different Varieties of Marijuana

Type	Percent Δ-9-THC (Percent by Weight)	Normalized Averages[e]
Nepal[c]	2.81	
Mexico[c]	1.68	1.00
Pakistan[c]	1.30	
Colombia[e]		3.00-3.50
India[f]	0.46 (grown above 2000 m)	
	1.39 (grown below 2000 m)	
Jamaica (Ganja)[h]	2.80 (mean)	
United States[c]	0.35	
Sinsemilla (fiber)[d]	0.21	
Sinsemilla (intermediate)[d]	3.58	
Sinsemilla (drug)[d]	6.28	3.00-11.00
Hashish (U.N. standard)[d]	2.22 (7.40)[b]	1.90
NIDA (cigarette 1)[d]	0.84	
NIDA (cigarette 2)[d]	1.86 (2.8)[g]	
Crude marijuana extract[g]	20.00	
Illicit hashish oil[g]	10.00-30.00 (up to 60)[a]	20.00
Research harvests[g]	0.90-2.80	

SOURCES: (a) Jones, 1980; (b) Braenden, 1972; (c) Turner, 1974; (d) Turner, 1980; (e) Turner, 1981; (f) Turner et al., 1979; (g) Rosenkrantz, 1981; (h) Marshman et al., 1976.

TABLE 3 Marijuana and Tobacco Reference Cigarette Analysis of Mainstream Smoke

	Marijuana Cigarette (85 mm)	Tobacco Cigarette (85 mm)
A. Cigarettes		
Average weight, mg	1115	1110
Moisture, percent	10.3	11.1
Pressure drop, cm	14.7	7.2
Static burning rate, mg/s	0.88	0.80
Puff number	10.7	11.1
B. Mainstream smoke		
I. Gas phase		
Carbon monoxide, vol. percent	3.99	4.58
mg	17.6	20.2
Carbon dioxide, vol. percent	8.27	9.38
mg	57.3	65.0
Ammonia, μg	228	199
HCN, μg	532	498
Cyanogen $(CN)_2$, μg	19	20
Isoprene, μg	83	310
Acetaldehyde, μg	1200	980
Acetone, μg	443	578
Acrolein, μg	92	85
Acetonitrile, μg	132	123
Benzene, μg	76	67
Toluene, μg	112	108
Vinyl chloride, ng[a]	5.4	12.4
Dimethylnitrosamine, ng[a]	75	84
Methylethylnitrosamine, ng[a]	27	30
pH, third puff	6.56	6.14
fifth puff	6.57	6.15
seventh puff	6.58	6.14
ninth puff	6.56	6.10
tenth puff	6.58	6.02
II. Particulate phase		
Total particulate matter, dry, mg	22.7	39.0
Phenol, μg	76.8	138.5
o-Cresol, μg	17.9	24
m- and *p*-Cresol, μg	54.4	65
Dimethylphenol, μg	6.8	14.4
Catechol, μg	188	328
Cannabidiol, μg	190	-
Δ^9-Tetrahydrocannabinol, μg	820	-
Cannabinol, μg	400	-
Nicotine, μg	-	2850
N-Nitrosonornicotine, ng[a]	-	390
Naphthalene, μg	3.0	1.2
1-Methylnaphthalene, μg	6.1	3.65
2-Methylnaphthalene	3.6	1.4
Benz(a)anthracene, ng[a]	75	43
Benzo(a)pyrene, ng[a]	31	21.1

[a]Indicates known carcinogens.
SOURCES: Hoffmann et al., 1975, 1976; Brunnemann et al., 1976, 1977.

Other Preparations

Besides the crude plant leaf material for smoking, usually called marijuana, resinous material from the plant, called hashish, and solvent extracts of the plant, termed hashish oil, sometimes appear on the illicit market. In many parts of the world, hashish is more commonly used than marijuana. As with all cannabis preparations, the Δ-9-THC content of hashish varies enormously, but the upper limits of Δ-9-THC content are usually much higher than for marijuana: 7 percent or higher and even higher for hashish oil (Table 2). However, even these generally more potent forms of cannabis may occasionally contain much less Δ-9-THC.

The mere designation of the nature of a cannabis preparation is an unreliable predictor of its Δ-9-THC content. The practical consequence of this for the clinical researcher is that the exposure to cannabis users is not known.

What Potency of Marijuana Is Available From Street Samples?

Because of the many confounding variables mentioned above, it is difficult to know what potency of psychoactive drug is in marijuana sold illicitly. The concentration of Δ-9-THC in a given sample will vary (Ritzlin et al., 1979). The content of Δ-9-THC from various street samples has been assayed. Marijuana from Drug Enforcement Administration confiscated samples; samples received through psychiatrists, police departments; and state crime laboratories, and fugitive* samples were quantitatively analyzed for Δ-9-THC and other cannabinoids. A physical description of the sample was made--e.g., buds, sinsemilla. The plants were also categorized by origin--where they were cultivated. The analysis showed that tremendous variability exists in the potency of Δ-9-THC on the street; normalised samples ranged from zero to 11 percent Δ-9-THC (Turner, 1981).

Analytic Methods

Detection and measurement of cannabinoids and their metabolites in body fluids is far more difficult than with such drugs as alcohol. The blood and tissue levels resulting from use of ordinary cannabis are very low--nanograms† per milliliter or lower. In addition, compounds like steroids, occurring normally in body fluids interfere with the measurement of cannabinoids in blood and can make the test much less sensitive than if pure cannabinoids in an uncontaminated

*Samples received, when no arrests were made.
†one billionth of a gram.

solution are being analyzed (Harvey et al., 1980; Harvey and Paton, 1980).

A combination of gas-liquid chromatography and mass spectrometry is the most sensitive direct method of measuring cannabinoids. That, however, requires skilled technicians and expensive equipment not readily available. Using modifications of this experimental technique, one can measure as little as 5 picograms* of Δ-9-THC in a milliliter of plasma (Harvey et al., 1980; Harvey and Paton, 1980). Radioimmunoassay and enzyme immunoassay techniques also are available, the lower limits of sensitivity of these methods now are not adequate for reliable measurements of Δ-9-THC in human blood more than a few hours after drug administration. A readily available enzyme immunoassay will detect cannabis metabolites in the urine for as long as a week after the smoking of a single marijuana cigarette. Thus, a positive urine test by this method is not necessarily indicative of use within the previous few hours and does not provide evidence of recent intoxication as a breath test does for alcohol. Assays for cannabinoids are likely to remain far more complicated than for alcohol and many other drugs.

PHARMACOLOGY OF CANNABIS

Implicit in a discussion of the effects of any drug is some determination of dose. The intensity and duration of effects in relation to drug dose must be determined or inferred from adequate pharmacologic study. The intensity and duration of a drug effect depends on at least three major factors:

1. The concentration of the drug at the sites of action in the body. This is determined by the dose, what the drug is dissolved in or mixed with, the route of administration, and the pharmacokinetics of the drug.
2. The sensitivity of the cells the drug acts upon.
3. The physiological state of the bodily systems being affected. This, in turn, depends on interactions with other systems and, especially for drugs with behavioral and psychological effects, as well as environmental and experiential factors, including the presence of other drugs.

With cannabis, many or even most of these factors are not always measurable or under the control of an investigator.

*1 pg = 10^{-12} grams.

Potency and Pharmacokinetic Considerations

Pharmacokinetic studies of the absorption, distribution, metabolism, and elimination of Δ-9-THC determine how long Δ-9-THC and its metabolites remain in the body. Pharmacokinetics vary with the route of drug administration and such factors as lipid solubility; Δ-9-THC tends to remain for long periods of time in fatty tissue.

When smoked, Δ-9-THC is rapidly absorbed by the blood in the lung. If taken orally, Δ-9-THC is not absorbed into the blood as rapidly. The rate of disappearance of Δ-9-THC from the blood varies with time (Lemberger et al., 1971a,b, 1972; Ohlsson et al., 1980). High blood levels fall rapidly for the first 30 minutes, as the Δ-9-THC distributes to tissues with high blood flow. After the initial distribution, the blood level falls much more slowly with a half-life* of 19 hours or more (Hunt and Jones, 1980). Metabolites† of Δ-9-THC have their own independent rates of elimination. Typically, metabolites are eliminated more slowly, having a half-life of approximately 50 hours (Hunt and Jones, 1980).

After an injection of a single dose of Δ-9-THC, approximately 25-30 percent of the compound and its metabolites remain in the body at 1 week (Lemberger et al., 1971b; Hunt and Jones, 1980). Essentially complete elimination of a single dose may take 30 days or longer (Jones, 1980). Thus, repeated administration of even small doses may lead to an accumulation of drug higher than levels reached at any time after a single dose.

Absorption

Inhaling smoke from a cannabis cigarette or pipe is pharmacokinetically different from ingesting cannabis. Smoking is a far more efficient way of delivering cannabinoids to the brain than ingestion because of the large surface area of the lungs. Inhaled, the cannabinoids in the smoke go rapidly from the lungs into the blood to the left side of the heart and are carried in seconds to the brain and other organs before passing through the liver. When smoked, a drug reaches the brain with relatively little time for metabolism or dilution. Many substances with high lipid solubility such as cannabinoids go quickly from blood into tissues, including brain tissues. Psychological and cardiovascular effects of cannabis are

---

*The half-life is a measure of how rapidly a drug is eliminated. It is the time required for the level of a drug to be reduced by one-half. If starting levels are ten units and the half-life is 24 hours, then 1 day after administration, the level will be 5 units, 2 days after administration 2.5 units, etc.

†There are more than 45 metabolites of major cannabinoids identified in different species, at least one of which, 11-OH-Δ-9-THC, is psychoactive.

evident within a few seconds of inhalation. Peak effects occur about the time smoking is completed.

When taken by mouth, cannabinoids usually are in solutions or suspensions. The material they are mixed with affects the rate of absorption. For example, blood levels of Δ-9-THC were higher and lasted longer when given in an oily solution than in an ethyl alcohol solution (Perez-Reyes et al., 1973). This suggests that cannabis eaten in food mixtures containing fat is better absorbed.

An important difference between smoking and ingestion is that when cannabinoids are absorbed from the gut, the blood containing them first goes directly through the liver. The liver rapidly clears the Δ-9-THC from the blood and enzymatically changes much of the Δ-9-THC to other metabolites before it reaches the brain (Hunt and Jones, 1980). A large amount is metabolized to 11-hydroxy-Δ-9-THC (Figure 1). It is unknown if the spectrum of effects of this metabolite is identical to that of Δ-9-THC. When taken by mouth, in contrast to when smoked, two or three times more Δ-9-THC is required to obtain equivalent acute psychological and physiological effects. After oral doses the effects develop more slowly, last longer, are more variable, and cannot be controlled by the recipient once the cannabis has been swallowed. In contrast, the smoker feels the effects quickly and can modify inhalation at any time, although overdosage is still possible. Unpleasant reactions to overdose are more common following ingestion than inhalation.

A variety of other routes of administration have been used experimentally in humans and in animals, including intravenous, intraperitoneal, subcutaneous, intramuscular, topical (on the skin), and into the conjunctival sac (eye). These various routes influence the time to onset of effect, duration and peak intensity, and the rate with which the effect disappears. Direct comparison of findings in studies using differing administration routes is difficult and must take these factors into consideration.

Human users of cannabis vary in their preferred routes of use. In some countries and cultures cannabis is mainly taken by ingestion (for example, India) and in others by inhalation (for example, the United States). Because of the effects of route of administration on pharmacology, it is reasonable to expect different health consequences of the different routes of administration; therefore, comparisons of health statistics among countries must be made with care.

Although smoking avoids many of the absorption problems discussed above, a host of other variables affecting dose are introduced, such as the size and packing of the cannabis cigarettes, the way the smoke is inhaled, the number of puffs and the interval between puffs, the temperature produced in the burning cigarette, and whether a cigarette is shared. Because of the progressive concentration of cannabis constituents in the cigarette butt, the last few puffs yield considerably more Δ-9-THC and particulate matter than do the earlier puffs. All these and other factors affect the dose received, and only rarely have they been measured. Only some of these factors are under the conscious control of the cannabis smoker. About half of the Δ-9-THC originally in a cannabis cigarette is lost by combustion, by butt entrapment, in smoke not inhaled, and in smoke exhaled (Fehr and Kalant, 1972; Rosenkrantz, 1981).

It has been reported that, like nonsmokers of tobacco, individuals in a poorly ventilated room where cannabis is smoked may passively inhale active components (Zeidenberg et al., 1977). Because only trace amounts of cannabinoid metabolites are present in urine of these passive inhalers, it is unlikely that the low levels of the absorbed cannabinoids from the ambient air account for the so-called "contact high." Experiencing subjective cannabis effects in the presence of cannabis smokers could be explained by psychologic factors in addition to any pharmacologic ones. But, because studies have shown that children of parents who smoke tobacco are more likely to have respiratory infections during the first year of life—which may be due to their being exposed to cigarette smoke in the atmosphere (U.S. Department of Health, Education, and Welfare, 1979)—the issue of passive inhalation of marijuana smoke is worth further study.

Distribution

The lipid solubility of Δ-9-THC and other cannabinoids, including those with highest pharmacologic activity, facilitates distribution readily into tissues and cells throughout the body so blood levels drop rapidly. Initially, cannabinoid concentrations are highest in such tissues as lung, liver, and kidney that have a high blood flow (Agurell et al., 1969, 1970; Klausner and Dingell, 1971). Delta-9-THC crosses the placenta and enters the fetus of experimental animals (Kennedy and Waddell, 1972). Cannabinoid levels in the human fetus have not been studied. Small amounts are also found in the milk of experimental animals and can be transferred to progeny (Jakubovic et al., 1973; Chao et al., 1976). After initial distribution, concentrations of cannabinoids in tissues, cells, and subcellular compartments are highly nonuniform, determined no doubt by solubility and other physicochemical characteristics. Therefore, blood concentrations do not reflect concentrations at pharmacologically active sites, as they do with alcohol.

Metabolism and Elimination

Elimination of drugs and their metabolites is mostly through excretion by the kidney into the urine or by the gall bladder via the bile into the intestine and out with the feces. Cannabinoids do not pass out of the blood into the lungs and do not appear in breath in appreciable quantities. Some cannabinoids going into the intestine with bile are reabsorbed. Some also diffuse back through the kidney tubules during the process of urine formation, so the amounts finally excreted per unit of time are small. The net result of this recycling is that the cannabinoids are only slowly eliminated from the body.

Studies of the disappearance of Δ-9-THC from human plasma have led to reports of values of half-lives that ranged from 19 hours in experienced users (Hunt and Jones, 1980) to 57 hours in naive users (Lemberger et al., 1971b). Whether this difference in half-life is due to the experience of the user has not been established. Because of their high lipid/water partition coefficients, Δ-9-THC and some of its metabolites can be sequestered in fatty tissues. Following the intravenous administration of radioactive Δ-9-THC to human volunteers, however, 67 percent of the radioactivity was excreted in 1 week, 22 percent in the urine and 45 percent in feces (Lemberger et al., 1971a). Almost no Δ-9-THC itself was excreted in the urine. There may be fairly rapid and complete metabolism of free Δ-9-THC followed by slow release and metabolism of sequestered Δ-9-THC and retained metabolites. Because no direct measurements of cannabinoid levels have been made in tissue samples from human cannabis users and the data are limited in experimental animals, one can only infer from blood levels what metabolites are accumulating and where.

In rats, after inhalation or intravenous administration of radioactive Δ-9-THC, radioactivity persisted in the brain for at least 7 days, mostly as metabolites (Ho et al., 1970). When given subcutaneously in rats, even at intervals as great as a day or two apart, Δ-9-THC will accumulate as metabolites (Kreuz and Axelrod, 1973). Accumulation of some cannabinoids with even less frequent intake appears likely. Although most metabolites are concentrated in fatty tissues, they will slowly pass into plasma and circulate though all parts of the body, particularly including such organs as the brain, and generally all membranes. The health consequences of the continued presence of such foreign molecules are not known. The marked persistence of the cannabinoids is quite unlike other widely consumed agents, such as alcohol, nicotine, and caffeine, that are rapidly metabolized and leave no trace a few hours after moderate intake.

WHAT IS A LARGE OR SMALL CANNABIS DOSE?

Large and frequent doses of any drug are more likely to produce adverse health effects than small infrequent doses of the drug. Thus, judgments of health consequences of the use of cannabis can only be made with implicit or explicit knowledge about dose. For the reasons discussed above, the range of cannabinoid doses consumed varies widely. Investigators usually report dose in terms of marijuana cigarettes per unit of time, or they give some estimate of the concentration of Δ-9-THC used for oral application. This is not an adequate way to quantify the amount of cannabinoids actually entering the body. Only one epidemiologic study provides a breakdown of varying dose levels in excess of one cannabis cigarette daily (Bachman et al., 1981). Epidemiologic surveys have not quantified Δ-9-THC levels. When reporting less frequent use patterns than one cigarette per day, investigators use measures that make it difficult to compare studies. In this report, any general or average dose estimates are approximations.

It is generally agreed that smoking five or six 1-gram cannabis cigarettes daily is a large dose (Dornbush et al., 1971; Rosenkrantz, 1981). Because of the variability of Δ-9-THC content of cannabis available from street samples, it would be more appropriate to consider this heavy use. The definition of a low dose is more controversial. Some consider one marijuana cigarette a day to be a large dose. Others think even one cigarette a week is regular, frequent, and a high dose.

With tobacco and alcohol, for which dose is easier to quantify, it took many years to establish what a small or large dose might be in terms of specifying doses that significantly increased the risk of various behavioral and health consequences. Even with those drugs, there is still disagreement as to precisely what a small and "safe" dose might be. There will be even more problems in specifying typical cannabis doses and predicting their likely health consequences.

In controlled laboratory conditions, ingested doses of more than 20 mg of Δ-9-THC generally are considered by both investigators and cannabis users to be large doses. Doses of less than 10 mg are considered small. Marijuana cigarettes containing more than 20 mg of Δ-9-THC seem to be a large dose, and those with 10 mg produce effects generally considered the result of a small dose. When volunteers were allowed to select their own self-determined smoked doses in controlled experiments, some smoked only one or two 20-mg cigarettes daily, while other similar volunteers smoked six to ten or more cigarettes per day. Variability in smoking patterns is great and not easily quantified; only broad range estimates of dose are possible.

GENERAL TOXICOLOGY

Delta-9-THC and related cannabinoids have very low lethal toxicity. That is, a very high single acute dose of Δ-9-THC is required to kill half of a population of experimental animals. This lethal dose for 50 percent of the animals is called the LD_{50}. The lack of well-authenticated cases of human deaths from acute Δ-9-THC or cannabis overdose is consistent with the experimental animal data. The lethal dose increases as the phylogenetic tree is ascended. The rat has an LD_{50} of 40 mg/kg intravenously, in contrast to a 125 mg/kg in the monkey (Rosenkrantz, 1981). Death is usually due to cardiac dysfunction. Delta-9-THC appears to be the most toxic of the cannabinoids.

Studies of chronic cannabis administration to animals have demonstrated delayed lethality. Animals die after several days of a repeated high dose (Rosenkrantz, 1981). The reason for this pattern is unclear. It could be related to accumulation of Δ-9-THC or metabolites in tissues.

A 1-year chronic treatment of rats with lower doses of cannabinoids produced a pattern of toxicity consisting of weight loss, pulmonary pathology when the drug is inhaled, and slowly developing behavioral toxicity characterized by hyperactivity, vertical jumping, fighting, and seizures (Rosenkrantz, 1981).

RELEVANCE OF NONHUMAN ANIMAL MODELS

Much of what is known about cannabis comes from experiments in animals. Some aspects of the pharmacology of any drug can only be studied in animals other than human beings. Findings from animal experiments have been criticized because of what were thought to be unreasonably high doses of cannabis given to the animals as compared with doses commonly used by human beings. Although extrapolation of human effects from animal data must be done with caution because of species differences in metabolic pathways and differing sensitivity and physiology, a blanket criticism of animal studies because of high doses is inappropriate. When an effect of a drug occurs consistently in several species, it is likely to occur in human beings. Comparisons of Δ-9-THC blood levels in human beings and in several species suggest roughly similar intensity of effects at similar blood levels in the various species (Rosenkrantz and Fleishman, 1979).

CANNABIS CONTAMINANTS

On occasion cannabis has been reported not only to contain the herbicide paraquat, but also salmonella bacteria and aspergillus fungus. Deliberate addition of such drugs as lysergic acid diethylamide (LSD), heroin, and phencyclidine (PCP) has been claimed. A plant material such as cannabis is not always handled in the most sanitary way, and a variety of contaminants are possible.

Paraquat

There is no question that large doses of paraquat by mouth or by aerosol can cause pulmonary fibrosis, but no cases in human beings have yet been proved to result from paraquat-contaminated cannabis. Few cannabis smokers are expected to be exposed to the large amounts of paraquat known to cause severe lung damage. This is not to say that no lung damage will occur from such exposure. A more extensive discussion of paraquat is in Appendix D.

Bacteria and Fungi

A few outbreaks of salmonellosis epidemiologically linked to marijuana use were reported from Ohio and Michigan (Schrader et al., 1981). Marijuana was found to be contaminated with the same type of salmonella that was obtained from the 62 patients experiencing diarrhea, fever, and abdominal pain.

Aspergillus, a fungus, is a common contaminant of some cannabis (Llewellyn and O'Rear, 1977; Llamas et al., 1978). The spores pass easily through contaminated marijuana cigarettes and when smoked are presumed to enter the body.

CELLULAR TOXICITY

A variety of effects on cellular processes have been reported, usually based on studies of *in vitro* systems. The low water solubility of the cannabinoids and the need to add solvents and emulsifiers, along with a common tendency to use higher *in vitro* concentrations than occurs in living animals, makes interpretation of such experiments difficult.

In related studies, Δ-9-THC alters the actions of a number of intracellular enzyme systems. The biological relevance of these drug/enzyme interactions is still unclear at this time, but, together with the cytotoxicity, it suggests that Δ-9-THC is producing marked effects on cell membranes and intracellular processes.

Almost nothing is known of the molecular mechanisms by which cannabinoids produce their effects in cells.

TOLERANCE AND DEPENDENCE

Repeated administration of most psychoactive drugs leads to the development of tolerance. This state of increased drug resistance results from two general mechanisms (Kalant et al., 1971):

- Dispositional tolerance resulting from lower drug concentrations at sites of action, usually because of increased rates of drug metabolism or elimination
- Functional tolerance arising from decreased sensitivity of the target cells.

Tolerance to most cannabinoid effects has been demonstrated both in animals and human beings (Jones, 1981). Tolerance can develop rapidly after only a few small doses. It disappears at an equally rapid rate for many effects, although after large doses in experimental animals some tolerance may persist for long periods (Jones, 1981). Systematic studies of tolerance loss have rarely been done. Many characteristics of tolerance to Δ-9-THC, particularly its pattern of rapid acquisition and loss, are similar to that occurring with opiates, nicotine, and cocaine (Jones, 1981). Most evidence suggests functional rather than dispositional means of acquiring tolerance.

The development of such tolerance to cannabis does not necessarily have health implications. However, if tolerance should lead to higher or more frequent doses, adverse consequences, e.g., respiratory effects, associated with higher usage could result.

Physical dependence, manifested by withdrawal signs and symptoms, can develop rapidly in animals and in human beings (Jones, 1981). The withdrawal syndrome is not life threatening. It is similar in many respects to the mild dependence produced by low doses of other sedatives. Withdrawal symptoms can include restlessness, irritability, mild agitation, insomnia, and sleep EEG disturbance.

Cannabis dependence does not mean the same thing as cannabis addiction. Dependence means only that a withdrawal syndrome can occur when drug taking is stopped. Addiction implies compulsive behavior to acquire the drug. The relationship between dependence and increased drug seeking or drug using is more theoretical than well documented, particularly in experiments with human beings. Given the appearance of tolerance and dependence with almost any psychoactive drug, it would be unusual not to find tolerance and dependence with the right dose and dosage schedule of cannabis. Good studies of the relationship of dependence, if any, to persistent drug use are important.

DRUG INTERACTIONS

Because cannabis often is consumed with other drugs, interactions can be expected. Other illicit drugs, tobacco, caffeine, alcohol, and over-the-counter or prescribed medications should be studied in combination with cannabis, because Δ-9-THC and its first metabolite are strongly bound to proteins in the plasma (Garrett and Hunt, 1974) and may interact with other drugs similarly bound. Cannabis and many other drugs share disposition by the hepatic metabolic enzyme systems, and there are possible interactions at the drug metabolism level. For example, drugs such as alcohol or pentobarbital can inhibit metabolism of Δ-9-THC by enzyme substrate competition. Or, if after a period of inhibition one drug is removed, the enzyme activity can increase so that faster than expected metabolism follows. If given simultaneously with other drugs, Δ-9-THC can slow metabolism of drugs such as theophyllin, antipyrine, ethanol, and pentobarbital (Benowitz and Jones, 1977; Jusko, 1979). Cannabidiol can also inhibit the metabolism of a variety of drugs normally metabolized by the shared hepatic enzyme systems.

Drug interactions also can occur by means of functional mechanisms. These can be additive, resulting in enhancement or prolongation of behavioral and psychological effects by cannabis when combined with other central nervous system depressant drugs, such as alcohol and barbiturates. Animals less tolerant to cannabis will also be less sensitive to other central nervous system depressants. This phenomenon is known as cross-tolerance. Drug interactions will be mentioned in subsequent chapters.

SUMMARY AND CONCLUSIONS

Cannabis is not a single drug, but a complex preparation containing many biologically active chemicals. The psychological and physiological effects produced by Δ-9-THC probably result from actions at sites within the central nervous system and elsewhere in the body, leading to the likelihood of complicated effects depending on dose, duration of use, and many other considerations.

The intensity of effect an individual experiences varies considerably according to the cannabis preparation and the amount taken, route of administration, frequency of use, and probably other not-well-recognized biological considerations. Dose variability must be considered both in conducting and in interpreting any studies of the effects of cannabis, particularly when trying to predict health consequences.

In research the use of pure Δ-9-THC avoids some problems of dose control but cannot provide a complete picture of cannabis effects, because the effects of Δ-9-THC in crude preparations of the plant may be influenced by other components. Other consequences of cannabis use, for example, exposure to harmful components in its smoke, will have deleterious health consequences in addition to anything produced by the Δ-9-THC.

The long persistence of cannabinoid metabolites in the body may have delayed effects or health implications not yet recognized, because, even with relatively infrequent use, there is chronic exposure to biologically unknown materials. In this respect, cannabis differs fundamentally from such drugs as alcohol, nicotine, and caffeine, which are rapidly metabolized and eliminated from the entire body.

Cannabinoid effects can be modified by many events, including interaction with other drugs and the development of tolerance. Both tolerance and dependence develop to many effects of the drug. The health significance of tolerance and dependence, particularly their importance in drug-seeking and drug-using behavior, has not been studied properly.

It is unlikely that adequate epidemiologic data will be available (soon) to enable good estimation of the health consequences of various usage levels.

A prerequisite is that adequate chemical analytical methods be applied on a large-scale basis to monitor actual exposures. Continued studies in experimental animals will play an essential role in the assessment of the health risks of cannabis. For example, the biological activities of Δ-9-THC metabolites can be assessed in experimental animals, but these tests are technically more difficult to do in human beings.

RECOMMENDATIONS FOR RESEARCH

Several research priorities are identified by the preceding discussion:

• Cannabinoids and their metabolites persist for relatively long periods in the body. More information is needed on the biological significance of that persistence in human beings. As a first step, the toxicological effects of the various metabolites need to be determined.

• Drug interactions alter the actions of cannabis. Cannabis use alters other drug effects. More information is necessary to make the combined effects of cannabis and other licit and illicit drugs more predictable, especially with respect to behavioral impairment and toxicity to lungs, liver, and other organs.

• Studies of the mechanism of action of cannabis should continue. Knowledge of mechanism is likely to provide powerful insights into the potential health effects.

• Improved chemical analytical methods are necessary. Epidemiologic appraisal of the health effects of cannabinoids requires methods suitable for wide-scale assays of exposures. Pharmacological verification of the self-reported extent of use will make experimental and clinical results much easier to interpret. A chemical "marker" of the frequent user would be useful. Screening techniques for the purpose of identifying and discouraging cannabis-impaired driving would also be valuable.

• Characterization of the toxicological significance of common cannabis contaminants such as paraquat and other chemicals, fungi, and bacteria should be continued.

• The development of tolerance is a factor that potentially modifies the expression of all psychoactive drug effects. Additional studies on the rates of acquisition and loss of tolerance and the relationship of these phenomena to dependence are necessary. The biological significance of the changes that underlie the development of tolerance should be established. The relationship, if any, between tolerance and dependence and drug-seeking behavior should be established.

• Cannabis products are variable and complex. More information on the amount, nature, and potency of the various preparations used around the world would facilitate calculations of exposures to its constituents. For example, what is the biological and toxicological significance of the minor components of cannabis smoke?

REFERENCES

Abel, E.L. Marihuana: The First Twelve Thousand Years. New York: Plenum Press, 1980.

Agurell, S., Nilsson, I.M., Ohlsson, A., and Sandberg, F. Elimination of tritium-labelled cannabinols in the rat with special reference to the development of tests for the identification of cannabis users. Biochem. Pharmacol. 18:1195-1201, 1969.

Agurell, S., Nilsson, I.M., Ohlsson, A., and Sandberg, F. On the metabolism of tritium-labelled delta-1-tetrahydrocannabinol in the rabbit. Biochem. Pharmacol. 19:1333-1339, 1970.

Bachman, J.G., Johnston, L.D., and O'Malley, P.M. Monitoring the Future. Questionnaire Responses from the Nation's High School Seniors, 1980. Ann Arbor, Mich.: Institute for Social Research, 1981.

Benowitz, N.L. and Jones, R.T. Effects of delta-9-tetrahydrocannabinol on drug distribution and metabolism. Clin. Pharmacol. Ther. 22:259-268, 1977.

Braenden, O.J. United Nations reference samples of cannabis, p. 193. In Paton, W.D.M. and Crown, J. (eds.) Cannabis and Its Derivatives. London: Oxford University Press, 1972.

Brunnemann, K.D., Lee, H.C., and Hoffmann, D. Chemical studies on tobacco smoke. XLVII. On the quantitative analysis of catechols and their reduction. Anal. Lett. 9:939-955, 1976.

Brunnemann, K.D., Yu, L., and Hoffmann, D. Chemical studies on tobacco smoke. XLIX. Gas chromatographic determination of hydrogen cyanide and cyanogen in tobacco smoke. J. Anal. Toxicol. 1:38-42, 1977.

Chao, F., Green, D.E., Forrest, I.S., Kaplan, J.N., and Winship-Ball, A. The passage of 14-C-Δ-tetrahydrocannabinol into the milk of lactating squirrel monkeys. Res. Commun. Chem. Path. Pharmacol. 15:303-317, 1976.

Dornbush, R.L., Fink, M., and Freedman, A.M. Marijuana, memory, and perception. Am. J. Psychiatry 128:194-197, 1971.

Fehr, K.O. and Kalant, H. Analysis of cannabis smoke obtained under different combustion conditions. Can. J. Physiol. Pharmacol. 50:761-767, 1972.

Gaoni, Y. and Mechoulam, R. Isolation, structure, and partial synthesis of an active constituent of hashish. J. Am. Chem. Soc. 86:1646-1647, 1964.

Garrett, E.R. and Hunt, C.A. Physicochemical properties, solubility and protein binding in delta-9-tetrahydrocannabinol. J. Pharm. Sci. 63:1056-1064, 1974.

Harvey, D.J. and Paton, W.D.M. Identification of in vivo liver metabolites of Δ-6-tetrahydrocannabinol produced by the mouse. Drug Metab. Disposition 8:178-186, 1980.

Harvey, D.J., Martin, B.R., and Paton, W.D.M. Identification of in vivo liver metabolites of delta-1-tetrahydrocannabinol, cannabidiol, and cannabinol produced by the guinea pig. J. Pharm. Pharmacol. 32:267-271, 1980.

Ho, B.T., Fritchie, G.E., Kralik, P.M., et al. Distribution of tritiated-1-delta-9-tetrahydrocannabinol in rat tissues after inhalation. J. Pharm. Pharmacol. 22:538-539, 1970.

Hoffmann, D., Brunnemann, K.D., Gori, G.B., and Wynder, E.L. On the carcinogenicity of marijuana smoke, pp. 63-81. In Runeckles, V.C. (ed.) Recent Advances in Phytochemistry. New York: Plenum Publishing Corp., 1975.

Hoffmann, D., Patrianakos, C., Brunneman, K.D., et al. Chromatographic determination of vinyl chloride in tobacco smoke. Anal. Chem. 48:47-50, 1976.

Hunt, A. and Jones, R.T. Tolerance and disposition of tetrahydrocannabinol in man. J. Pharmacol. Exp. Ther. 215:35-44, 1980.

Jakubovic, A., Hattori, T., and McGeer, P.L. Radioactivity in suckled rats after giving 14C-tetrahydrocannabinol to the mother. Eur. J. Pharmacol. 22:221-223, 1973.

Jones, R.T. Human effects: An overview, pp. 54-80. In Petersen, R.C. (ed.) Marijuana Research Findings: 1980. NIDA Research Monograph 31. DHHS Publication No. (ADM)80-1001. Washington, D.C.: U.S. Government Printing Office, 1980.

Jones, R.T. In Report of an Addiction Research Foundation/World Health Organization (ARF/WHO) Scientific Meeting on Adverse Health and Behavioral Consequences of Cannabis Use. ARF/WHO, Toronto, 1981.

Jusko, W.J. Influence of cigarette smoking on drug metabolism in man. Drug Metab. Rev. 9:221-236, 1979.

Kalant, O.J. and Kalant, H. Marihuana and its effects: An assessment of current knowledge. Addictions 15:1-7, 1968.

Kalant, H., LeBlanc, A.E., and Gibbons, R.J. Tolerance to, and dependence on, some non-opiate psychotropic drugs. Pharmacol. Rev. 23:135-191, 1971.

Karler, R. and Turkanis, S.A. Cannabinoids as potential antiepileptics. J. Clin. Pharmacol. 21:437S-448S, 1981.

Kennedy, J.S. and Waddell, W.J. Whole-body autoradiography of the pregnant mouse after administration of ^{14}C-Δ-9-THC. Toxicol. Appl. Pharmacol. 22:252-258, 1972.

Klausner, H.A. and Dingell, J.V. The metabolism and excretion of delta-9-tetrahydrocannabinol in the rat. Life Sci. 10:49-59, 1971.

Kreuz, D.S. and Axelrod, J. Delta-9-tetrahydrocannabinol: Localization in body fat. Science 179:391-393, 1973.

Lemberger, L., Axelrod, J., and Kopin, I.J. Metabolism and disposition of tetrahydrocannabinols in naive subjects and chronic marijuana users. Ann. N.Y. Acad. Sci. 191:142-154, 1971a.

Lemberger, L., Tamarkin, N.R., Axelrod, J., and Kopin, I.J. Delta-9-tetrahydrocannabinol: Metabolism and disposition in long-term marihuana smokers. Science 173:72-74, 1971b

Lemberger, L., Weiss, J.L., Watanabe, A.M., et al. Delta-9-tetrahydrocannabinol. Temporal correlation of the psychologic effects and blood levels after various routes of administration. N. Engl. J. Med. 286:685-688, 1972.

Leuchtenberger, C. and Leuchtenberger, R. Cytological and cytochemical studies of the effects of fresh marihuana cigarette smoke on growth and DNA metabolism of human lung cultures, pp. 595-612. In Braude, M.C. and Szara, S. (eds.) Pharmacology of Marihuana. New York: Raven Press, 1976.

Llamas, R., Hart, D.R., and Schneider, N.S. Allergic bronchopulmonary aspergillosis associated with smoking moldy marihuana. Chest 73:871-872, 1978.

Llewellyn, G.C. and O'Rear, C.E. Examination of fungal growth and aflatoxin production on marihuana. Mycopathologia 62:109-112, 1977.

Marshman, J.A., Popham, R.E., and Yawney, C.D. A note on the cannabinoid content of Jamaican ganja. Bull. Narcotics 26:63-68, 1976.

Mechoulam, R. and Gaoni, Y. A total synthesis of Δ-1-tetrahydrocannabinol, the active constituent of hashish. J. Am. Chem. Soc. 87:3273-3275, 1965.

Mechoulam, R. and Gaoni, Y. The absolute configuration of Δ-1-tetrahydrocannabinol, the major active constituent of hashish. Tetrahedron Lett. 12:1109-1111, 1967.

Mechoulam, R., Lander, N., Varkony, T.H., et al. Stereochemical requirements for cannabinoid activity. J. Med. Chem. 23:1068-1072, 1980.

Ohlsson, A., Lindgren, J.E., Wahlen, A., et al. Plasma delta-9-tetrahydrocannabinol concentrations and clinical effects after oral and intravenous administration and smoking. Clin. Pharmacol. Ther. 28:409-416, 1980.

Perez-Reyes, M., Lipton, M.A., Timmons, M.C., et al. Pharmacology of orally administered delta-9-tetrahydrocannabinol. Clin. Pharmacol. Ther. 14:48-55, 1973.

Ritzlin, R.S., Gupta, R.C., and Lundberg, G.D. Delta-9-tetrahydrocannabinol levels in street samples of marijuana and hashish: Correlation to user reactions. Clin. Toxicol. 15:45-53, 1979.

Rosenkrantz, H. The Immune response and marihuana, pp. 441-456. In Nahas, G.G., Paton, W.D.M., and Idanpaan-Heikkila, J.E. (eds.) Marihuana: Chemistry, Biochemistry, and Cellular Effects. New York: Springer-Verlag, 1976.

Rosenkrantz, H. In Report of an Addiction Research Foundation/World Health Organization (ARF/WHO) Scientific Meeting on Adverse Health of Behavioral Consequences of Marijuana Use. ARF/WHO, Toronto, 1981.

Rosenkrantz, H. and Fleischman, R.W. Effects of cannabis on lungs, pp. 279-299. In Nahas, G.G. and Paton, W.D.M. (eds.) Marihuana: Biological Effects. Analysis, Metabolism, Cellular Responses, Reproduction and Brain Oxford: Pergamon Press, 1979.

Schrader, J., Steris, C., Halpin, T. et al. Salmonellosis traced to marijuana--Ohio, Michigan. MMWR 30:77-79, 1981.

Siemens, A.J., Kalant, H., and deNie, J.C. Metabolic interactions between Δ-9-tetrahydracannabinol and other cannabinoids in rats, pp. 77-93. In Braude, M.C. and Szara, S. (eds.) Pharmacology of Marihuana. New York: Raven Press, 1976.

Turner, C.E. Active substances in marijuana. Arch. Invest. Med. Suppl. 5:135-140, 1974.

Turner, C.E., Cheng, P.C., Lewis, G.S., et al. Constituents of Cannabis sativa. XV. Botanical and chemical profile of Indian variants. Planta Med. 37:217-225, 1979.

Turner, C.E. Chemistry and metabolism, pp. 81-97. In Petersen, R.C. (ed.) Marijuana Research Findings: 1980. NIDA Research Monograph 31. DHHS Publication No. (ADM)80-1001. Washington, D.C.: U.S. Government Printing Office, 1980.

Turner, C.E. Director, Research Institute of Pharmaceutical Science, University of Mississippi, Oxford, Mississippi. Personal communication, 1981.

Turner, C.E., Elsohly, M.A., and Boeren, E.G. Constituents of Cannabis sativa L. XVII. A review of the natural constituents. J. Natural Prod. 43:169-234, 1980.

U.S. Department of Health, Education and Welfare. Smoking and Health: A Report of the Surgeon General. DHEW Publication No. (PHS) 79-50066. Washington, D.C.: U.S. Government Printing Office, 1979.

Waller, C.W., Johnson, J.J., Buelke, J., and Turner, C.E. Marihuana: An Annotated Bibliography. New York: Macmillan Information, 1976.

Waller, C.W., Nair, R.S., McAllister, A.F., et al. Marihuana: An Annotated Bibliography. Volume 2 New York: Macmillan Information (in press).

Zeidenberg, P., Bourdon, R., and Nahas, G.G. Marijuana intoxication by passive inhalation: Documentation by detection of urinary metabolites. Am. J. Psychiatry 134:76-78, 1977.

2

USE OF MARIJUANA IN THE UNITED STATES

Epidemiologic studies provide information on the use of drugs in various subgroups of the population and on the changes in patterns of use over time. The epidemiologic approach is particularly useful in defining patterns of use of marijuana in American society and in describing and analyzing the behavioral and psychosocial antecedents and consequences of that use. One of the more difficult questions is whether particular behavior or effects that are associated with use of a drug are the consequences of that use, or whether attitudes, values, and behavior develop about the use of drugs to constitute factors that may actually lead to the use of drugs. One of the more useful epidemiologic study designs is a cohort study that follows the same individual with repeated observations at regular intervals over time. Such longitudinal studies have the potential for obtaining the most compelling evidence on the antecedents of known patterns of use of marijuana, as well as possible long-term psychosocial and biological outcomes for these individuals.

The committee, with the help of consultants, sought answers in the epidemiologic literature to the following five questions:

1. What are important patterns of use of marijuana in the American population including special groups?
2. What are the general characteristics of users of marijuana?
3. What is the profile of a user of marijuana on a "daily"* basis?
4. What is known about the antecedents of use of marijuana?
5. How is use of marijuana related to the use of other drugs?

The epidemiologic and survey literature have been extensively reviewed and the major longitudinal studies are summarized in a table in Appendix C. Much of our recent knowledge derives from two well-designed major, continuing nationwide monitoring efforts

*When placed in quotation marks, "daily" is used as defined by Johnston et al. (1980b), i.e., those individuals using marijuana 20 or more times in the preceding 30 days.

sponsored by the National Institute on Drug Abuse. One is based on general household population samples, the National Household Surveys. The second is based on populations of high school seniors and is called Monitoring the Future.

The National Household Surveys of the general population are conducted on an annual or biannual basis by Response Analysis Corporation and The George Washington University (Fishburne et al., 1980). There have been six cross-sectional studies since 1971. The latest one was in the winter of 1979-1980, and the next one will be initiated in 1982. The subjects are classified as youth (12-17), young adults (18-25), and older adults (26 and older). The questions relate to marijuana and other psychoactive drugs, including inhalants, hallucinogens, cocaine, heroin, stimulants, sedatives, and analgesics. Samples vary from about 3,000 to more than 7,200 new respondents at each survey. These are samples that document patterns of use of drugs in the specified populations at a given time.

Monitoring the Future (Johnston et al., 1980b) uses a cohort-sequential longitudinal design, in which a new cohort of high school seniors is surveyed each year, and a representative panel selected from that senior class is also followed over time in successive annual or biannual testings. The earliest panel has now been reinterviewed six times. This survey design makes it possible to disentangle antecedents from consequences of use as well as to distinguish changes due to increased age from changes due to cohort peculiarities or historical circumstances. Initiated in 1975 by the Survey Research Center of the University of Michigan, and directed by Lloyd Johnston and Jerald Bachman, the survey involves a questionnaire self-administered each year by more than 16,000 high school seniors in 130 public and private schools throughout the United States, and longitudinal mail follow-ups of about 2,000 former students drawn, as panels, from each of the previously participating senior classes (Johnston et al., 1979a,b; 1980a,b).

Because the National Household Surveys and Monitoring the Future are surveys of persons in households or in high school, they exclude persons most likely to be using drugs—the transients, those without regular addresses, the school absentees or drop-outs, or those living in institutions or group quarters. These persons constitute a small proportion of the general population, and their exclusion does not significantly bias the epidemiologic estimates reported for the total population (Kandel, 1975a). However, data on the very heavy use of drugs may be underrepresented.

PATTERNS AND TRENDS OF USE OF MARIJUANA

General Population

The National Household Surveys found that marijuana was the most commonly used of all the nonlegal psychoactive drugs investigated, including inhalants, hallucinogens, cocaine, heroin, stimulants, sedatives, tranquilizers, and analgesics (Fishburne et al., 1980).

In 1979 more than 50 million persons had tried marijuana at least once in their lives: 68.2 percent of young adults (18-25), or about 21 million; 30.9 percent of youth (12-17), or more than 7 million; and 19.6 percent of older adults (26 and older), or 25 million. The young adult age-group (18-25 years) has consistently showed the highest rates of current use (used in past month) and ever use (lifetime prevalence), and the older adult groups (26 and older) had the lowest user rates. Male users outnumbered females in all age groups. Between 1977 and 1979, significant increases in current use and ever use of marijuana were observed among the young adult and older adult cohorts (Figure 2). In 1979, in the young adult cohort, the most significant increases in use in the past month were found in males, whites, high school nongraduates, people in the southern United States, and those living in nonmetropolitan areas. In the older adult groups, the most significant recent increase in current use of marijuana was observed in males, whites, college graduates, and people living in the southern states (Miller and Cisin, 1980).

In the early 1960s, illicit drug use in the United States was chiefly a phenomenon of large coastal cities. But since then, rates in other regions of the country and in cities of all sizes have rapidly increased until patterns of use are becoming increasingly comparable for all sectors in the United States. At current levels of use, some experience with marijuana in adolescence is becoming the norm rather than the exception throughout the United States. Other major survey studies have confirmed the findings of the National Household Survey for comparable cohort populations (Gallup Opinion Index, 1976; O'Donnell et al., 1976).

Military Personnel

Much attention has recently been focused on what appear to be high rates of use of illicit drugs among military personnel. Studies of drug use among male army veterans of the Vietnam War in 1972 showed that marijuana was the most commonly used illicit drug before and after the war (Robins, 1974). A random sample of 470 men was selected from the 13,760 enlisted men who returned to the U.S. in September 1971. Of the 451 men who were interviewed, 69 percent had used marijuana while in Vietnam, with 28 percent stating this was their first use of the drug. The lifetime prevalence of use of marijuana was 41 percent prior to Vietnam; 45 percent of the veterans reported using marijuana in the 10 months following return to the United States. Among this group the prevalence of weekly use doubled from 12 percent prior to Vietnam to 25 percent following the war.

A worldwide survey of nonmedical use of drugs and alcohol among U.S. active duty military personnel was conducted in 1980 under the sponsorship of the U.S. Department of Defense (Burt et al., 1980). In an anonymous, self-administered questionnaire given to a representative sample of more than 16,000 persons, marijuana was found to be the most commonly used illicit drug. Twenty-six percent admitted to having used "marijuana/hashish" within the past 30 days and 35

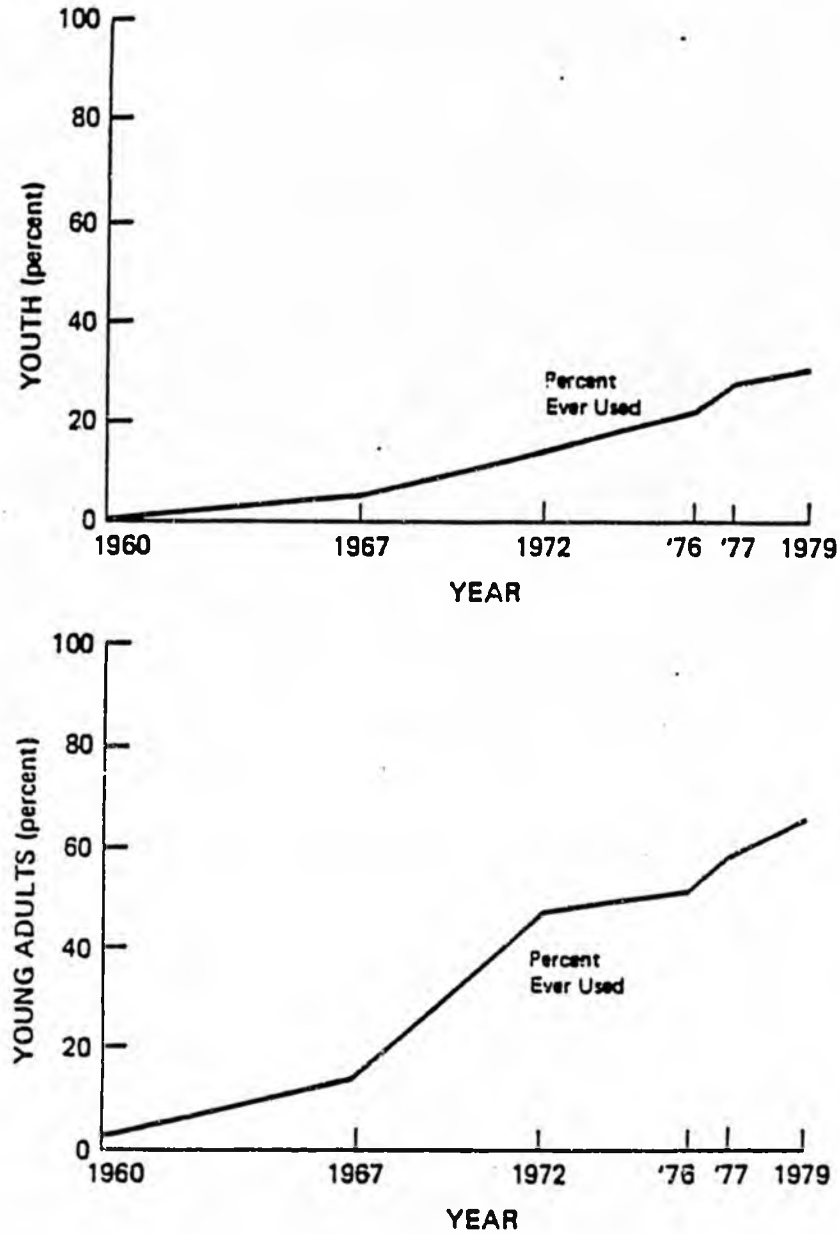


FIGURE 2 Marijuana: trends in lifetime experience, youth, and young adults. Adapted from J.D. Miller and I.H. Cisin. Highlights from the National Survey on Drug Abuse: 1979. Washington, D.C.: U.S. Government Printing Office, 1980. Youth = 12 to 17 years old; young adults = 18 to 25 years old.

percent to having used it in the past 12 months. Five percent of the sample reported use of marijuana daily.

When users of drugs were itemized according to military pay classifications, the largest percentage of current use of marijuana was in the lowest ranks of the military.

Adolescents and Young Adults

Patterns and Trends

One of the compelling reasons to focus on adolescence in studying marijuana is the pervasive and increasing use by this age group. As was mentioned earlier, in 1980 all geographical regions of the United States and all socioeconomic classes had high and increasingly comparable involvement in use of marijuana.

The year 1960 has been taken as a baseline year that represents the stable level of overall use of marijuana that had characterized the United States for most of its history. Figure 2 shows the trends for use of marijuana from 1960 through 1979, revealing the sharp upward climb of use of marijuana starting in 1967. The dramatic rise in use of marijuana by adolescents has recently slowed, and the lifetime prevalence rates (ever use) of marijuana have remained at approximately 60 percent of all high school seniors for the years 1979 and 1980 (Figure 3). To put it another way, in 1979 over 2.5 million high school seniors had tried or were users of marijuana. (This figure is derived from calculations based on 1979 Census Bureau data that give a figure of 4,276,000 for number of 18-year-olds in the population. The committee is aware that all 18-year-olds are not high school seniors and that such a calculation may underreport the numbers of users of marijuana, particularly heavy users who have been shown to be more likely to have dropped out of school. Similar calculations have been attempted throughout this chapter.)

The use of other types of drugs by young people also increased beginning in 1967 (Miller and Cisin, 1980). Figure 4 gives the most recent nationwide figures for use of 11 types of drugs among American high school seniors (average age 18 years). With the exception of negligible use of heroin, the figures for use of all other drugs are substantial. Increases in patterns of use have not been as dramatic for other drugs (except for recent cocaine increases) as they have been for marijuana. Use of marijuana, tobacco, and alcohol far outstrips that of all other drugs. In 1980 the lifetime prevalence (ever use) for these substances by high school seniors was marijuana--60 percent, tobacco--71 percent, and alcohol--93 percent.

Of even greater interest are the percentages of high school seniors who use the 11 types of drugs "daily." In 1980 marijuana was used "daily" by 9.1 percent (about 390,000), alcohol by 6.0 percent (about 256,000), and tobacco cigarettes by 21.3 percent (about 900,000) of high school seniors (Johnston et al., 1980a). No other substance was used that frequently by as many as 1 percent of the

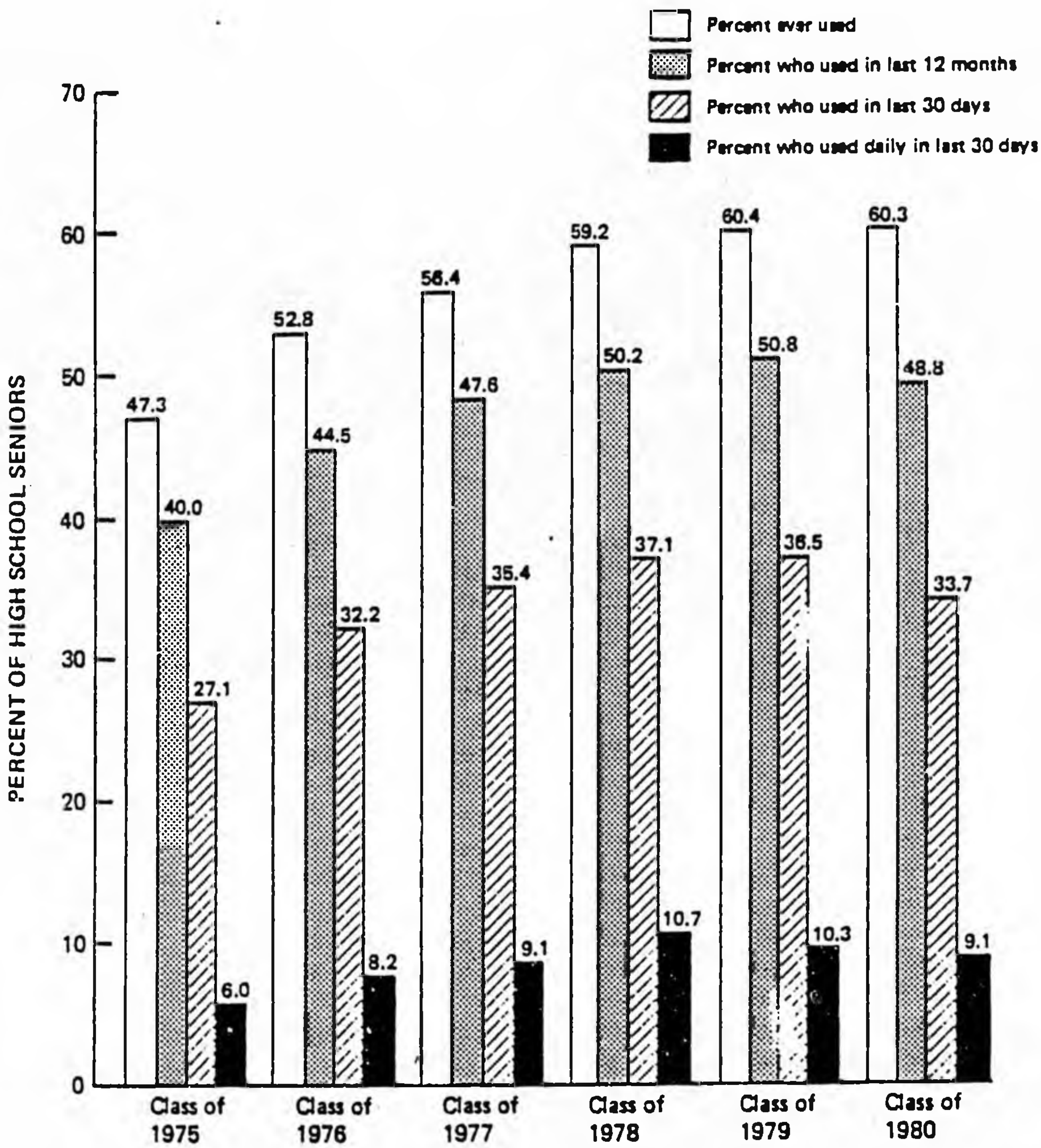
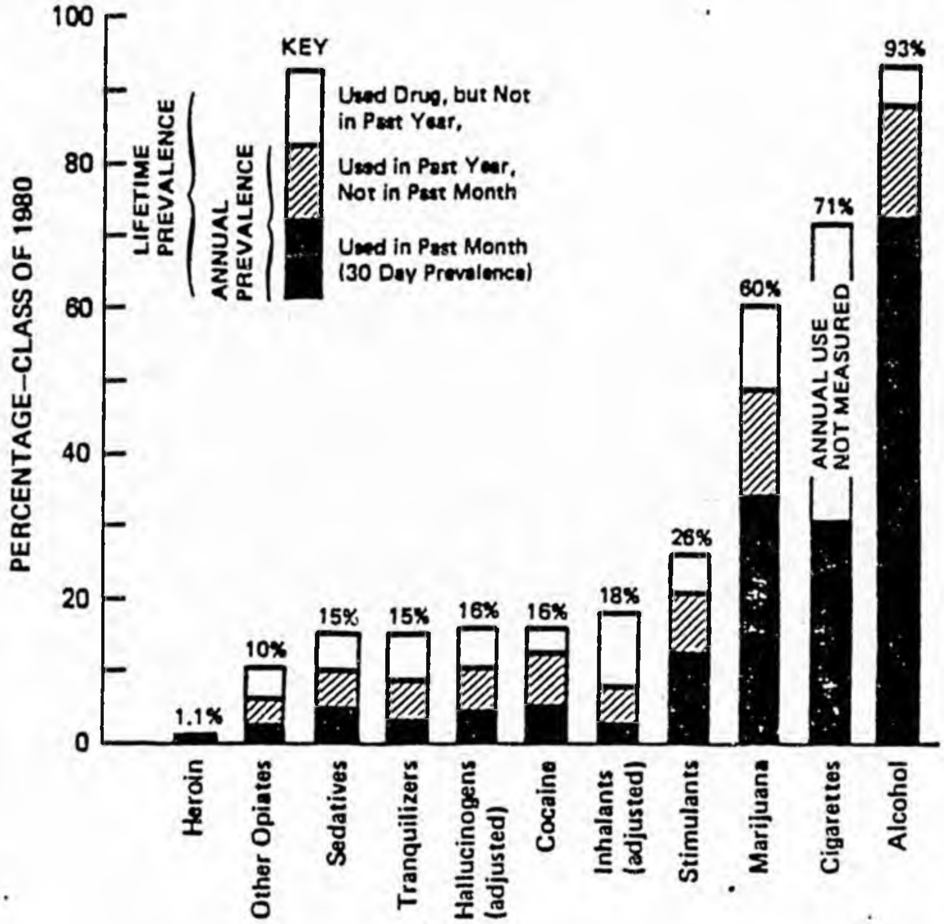


FIGURE 3 Trends in prevalence of marijuana use by high school seniors, 1975-1980 (in school). Adapted from L.D. Johnson, J.G. Bachman, and P.M. O'Malley, Highlights from Student Drug Use in America, 1975-1980. DHHS Publication No. (ADM) 81-1066. Washington, D.C.: U.S. Government Printing Office, 1980a.



NOTE: The bracket near the top of a bar indicates the lower and upper limits of the 95% confidence interval.

FIGURE 4 Prevalence and recency of use. Eleven types of drugs, class of 1980. SOURCE: Johnson, L.D., Bachman, J.G., and O'Malley, P.M. Highlights from Student Drug Use in America, 1975-1980. DHHS Publication No. (ADM) 81-1066. Washington, D.C.: U.S. Government Printing Office, 1980a.

students. These figures show that legal (for adults) drugs are used much more frequently than illegal ones. Reports of illegal use of drugs show that experimentation with marijuana has, by far, the highest prevalence. It should be noted, also, that "daily" use of marijuana (9 percent) among high school seniors is now more prevalent than "daily" drinking (6 percent) of alcoholic beverages.

In 1980, for the first time since 1975, when the Monitoring the Future data collection began among high school seniors, the percentage of "daily" users of marijuana among seniors in high school declined significantly from 10.3 percent in 1979 to 9.1 percent in 1980 (Figure 3), and there was a leveling of lifetime prevalence at approximately 60 percent. Furthermore, the proportion of current users among those who ever used marijuana also showed a statistically significant decline in 1980 as compared to 1979, from 60 percent to 56 percent. However, "daily" users may be increasingly underrepresented in recent senior high school classes due to absenteeism and drop-out associated with increasingly earlier and extensive involvement in use of marijuana. The extent to which long-term "daily" users have dropped out of school by the senior year of high school cannot be ascertained from monitoring the future. Kandel (1975a) found that absentees differed from students attending school regularly. Fifty-six percent of absentees reported use of marijuana as compared to 38 percent of in-class students. Studies that document the patterns of marijuana use in school drop-outs are needed.

Correlates of Use

Overall levels of use of marijuana have been shown to correlate with patterns of use of the drug.

1. Increased prevalance is associated with younger age of initiation into use of marijuana. As successive cohorts of high school seniors have shown increasingly higher levels of experience with marijuana from 1975 through 1980, these cohorts also report increasingly earlier ages at first use of marijuana. For example, in the senior class of 1980, which had a lifetime prevalence of 60 percent by senior year, 25 percent of those using marijuana had begun in the eighth grade (average age 14) or below. In 1975 when lifetime prevalence was 47 percent, 15.3 percent of marijuana users had begun in eighth grade or below. It is of some interest to compare reported age of use of marijuana by grade for the senior class of 1980 (lifetime prevalence 60 percent) and alcohol (lifetime prevalence 93.2 percent). The more prevalent drug, alcohol, is used at earlier ages than marijuana. Thirty-three percent of alcohol users had started at eighth grade as compared to 21.5 percent of marijuana users (Johnston et al., 1980a).

2. Earlier onset of use of any drug is associated with greater involvement in use of all other drugs. The earlier the introduction to legal (for adults) drugs, the greater the probability that the adolescent will also experiment with illicit drugs. For example, among young adults 18-25 years of age surveyed from the general population in 1979-1980, the proportion who had experimented with any illicit drug other than marijuana ranged from 87 percent among those who reported having first tried alcohol or marijuana at ages 13 or 14, to 47 percent among those who first tried these drugs at ages 15-17, and 5 percent among those who first experimented at age 18 or over (Rittenhouse, 1980). The finding that the earlier the experimentation with marijuana, the greater the intensity of involvement and the greater the likelihood of using more serious drugs has been confirmed in many studies (e.g., Miller and Cisin, 1980; Johnston et al., 1980a; Kandel et al., 1981).

3. Greater overall prevalence of use of marijuana is associated with greater persistence of use of marijuana into later years of adult life. The current prevalence rates for use of marijuana by persons in their mid-30s are increasing (Cisin et al., 1978). Many

studies have not sampled this population in the belief that use of marijuana drops off sharply in the mid-20s. Among males, the prevalence rate for use of marijuana in the past month for over-26-year olds went from 4 percent in 1977 to 9 percent in 1979. It will be exceedingly important to monitor the trends in all older adult age groups.

Marijuana and the Use of Other Drugs

ne of the key questions asked over the years is, does marijuana lead to the use of other drugs. In any population, the use of various drugs appears interrelated and users of any type of drug, whether legal or illegal, are much more likely to use other types of drugs than nonusers. For example, young people who smoke tobacco are also much more likely to have used alcohol or marijuana than nonsmokers (Fishburne et al., 1980). Similarly, there is a strong association between the use of marijuana and of other illicit drugs. Young people who use marijuana are more likely to be consuming other substances, such as alcohol and tobacco, as well as other illicit drugs (Johnston et al., 1980b). The association increases with extent of marijuana involvement and is especially striking among those young people who use marijuana on a "daily" basis, as will be discussed below.

Results from the National Household Surveys and from samples of high school seniors had indicated that the ratio of rates of use of illicit drugs other than marijuana to use of marijuana declined through 1979 (Kandel, 1980; Miller and Cisin, 1980). In 1980, however, the ratio started to rise again. Thus, in 1980, 65 percent of marijuana users among the high school seniors had also used other illicit drugs as compared to 61 percent in 1979 (Johnston et al., 1980a).

"Daily" Users in High School

Because any health risks resulting from the use of marijuana would be most likely to appear first in chronic users of the drug, the young persons who are chronic and heavy users are of special interest. The committee reports in some detail the findings on this group. The ranks of "daily" users are large. In 1980 they represented more than 9 percent of high school seniors or over 390,000 18-year-olds in the United States. One out of 11 seniors fitted the definition of "daily" users (20 or more occasions of reported use within the preceding 30 days). Collection of systematic data on such users began in 1975 with the annual monitoring of in-school high school seniors. There are many gaps in our knowledge about this group, but sufficient data have been accumulated that it is now possible to describe many of the behavioral attributes of the "daily" users. Most of these data come from Monitoring the Future. Some of the findings recently reported by Johnston (1980, 1981) and Bachman et al. (1981) are as follows:

Demographic Findings

Rates of "daily" use do not vary among regions of the country, but "daily" use shows a strong positive relationship to the size of the community and is more prevalent in urban areas. Males are "daily" users at almost double the rate of females (13 percent versus 7 percent). "Daily" use among white students is double that for blacks (11 percent versus 5 percent). "Daily" use is spread evenly across socioeconomic levels as defined in terms of parents' education. "Daily" use is only slightly higher among those from homes in which one or both parents are absent.

Academic Performance and Goals

"Daily" use is associated with poor school achievement. Among non-college-bound seniors the rate of "daily" use is almost double that found among the college-bound (13 percent versus 7 percent). There are strong and positive correlations of "daily" use and cutting classes, school absences, and truancy.

Much of "daily" use takes place within the school setting. A statewide study of seventh through twelfth grade pupils in New York, conducted in 1978 by the New York State Drug Abuse Commission, found that 50 percent of those using marijuana within the last 6 months had been intoxicated one or more times while in class (Johnson and Uppal, 1980). In contrast, alcohol tends to be used most frequently after school and on weekends.

Religious Commitment

A commitment to religion and self-ratings of strong belief in law-abiding behavior are associated with lower than average rates of "daily" use.

Dating and Social Life

Dating and social life show strong relationships with "daily" use of marijuana. Those who spend more time on dates have the highest rates of "daily" use of marijuana. Among those students who go out 6 or 7 nights a week and are practically never at home, 34 percent are "daily" marijuana users.

Use of Other Drugs

"Daily" marijuana users are much more likely than their peers to be extensive users of other drugs. Thus, of seniors in the class of 1979, 27 percent of "daily" users of marijuana drank alcohol as frequently, versus 7 percent for the age-group as a whole; and 59 percent of "daily" users of marijuana smoked cigarettes as frequently versus 25 percent for the group as a whole (Johnston et al., 1980b).

With respect to use of other illicit drugs, the rates for "daily" users of marijuana generally run five to seven times the average for the age group as a whole; 47 percent of "daily" users are current* users of amphetamines; 31 percent of cocaine; and their current usage figures run from 15 to 17 percent for barbiturates, for lysergic acid diethylamide (LSD), for phencyclidine (PCP), for methaqualone, and for tranquilizers. Since nearly two-thirds of daily marijuana users (64 percent) are current users of hashish, they have substantial exposure to a high-potency form of marijuana.

We also know from data on age at first use that many of these "daily" marijuana users began their use of cigarettes, alcohol, and various other illicit drugs at quite an early age. To illustrate, by the end of eighth grade 40 percent of them had smoked cigarettes "daily" and 50 percent had taken their first drink. Just about half of them (48 percent) first tried marijuana by the eighth grade, and most of the remainder (another 30 percent) started in ninth grade. These are very early ages of initiation for all three drugs. Similarly, these youngsters tend to take up the other illicit drugs at an earlier than average age--though most of that use still is initiated after ninth grade. "Daily" use tends to persist longer into adult life than anticipated. In 1979, 4 years after graduation from high school, 51 percent of marijuana users of the senior class of 1975 were still "daily" users and an additional 34 percent were current although not "daily" users (Johnston, 1980).

"Daily" Users After High School

Using a national sample of 19- to 22-year-olds derived from the follow-up surveys of Monitoring the Future, Johnston (1981) reported on "daily" use of marijuana after high school. (These findings are reproduced nearly verbatim below.)

College Student Status

Student status after high school correlates negatively with "daily" use; that is, full-time college students have the lowest rate (8 percent), part-time students the next lowest (10 percent), and nonstudents the highest rate (13 percent). However, although full-time students have a lower than average rate of "daily" use, they showed the greatest increase after high school (up from 4.5 to 8.3 percent): they simply started from a very low level and in a sense were "catching up."

---

*A current user is one who has used the drug in the thirty days preceding the surveys.

Living Status

Young people who are living away from home have a higher proportion of "daily" use than those still living with their parents (12 percent versus 10 percent), probably reflecting the result of reduced social control by parents. Those who remained living with their parents (nearly half) showed relatively little increase in use (up 1.3 percent), while those who moved out increased their daily use rate substantially (up 3.9 percent).

Marital Status

Those who are single are almost twice as likely to be "daily" users as those who are married (11.4 percent versus 6.6 percent), and those without children are somewhat more likely to use marijuana than those with children (11 percent versus 8 percent). It appears that these role responsibilities have a dampening effect on use. In the face of an overall 2.6 percent increase in "daily" prevalence after high school for the whole sample, those who were married showed virtually no increase (up 0.2 percent) and those with children actually had a decline in use (down 1.5 percent).

Type of dwelling

"Daily" use is highest for those living in a rented room (14 percent) or apartment (12 percent), and lowest for those living in a college dorm (8 percent). Obviously one's dwelling arrangement is highly correlated with his or her major activity after high school, as these differences reflect.

Employment

Employment status is unrelated to "daily" use. For those in military service, "daily" use dropped slightly after high school (from 13.4 percent to 12.4 percent). The activity group with by far the lowest "daily" use rate are the full-time homemakers (4 percent), which certainly occurs, in part, because they nearly all are female, married, and in many cases have young children.

Reasons for Using or Abstaining

Reasons for "Daily" Use of Marijuana

What reasons do "daily" users give for their use of marijuana? They tend to use marijuana to produce an intoxicated feeling, to cope psychologically with feelings of distress, to augment the effects of other drugs, and to participate in drug-using friendships. On a checklist of 13 possible reasons, nearly all of the seniors who were "daily" users checked "to feel good or get high" (94 percent) and "to have a good time with my friends" (79 percent). Two-thirds said they used it to relax (67 percent) and nearly half said they used it to relieve boredom (45 percent). Roughly a quarter of the "daily" users checked each of the following: "to get away from my problems" (27 percent), "because of anger or frustration" (23 percent), and "to get through the day" (22 percent). These psychological coping motives in particular seem to distinguish the "daily" users from the less frequent users. A fairly high proportion (30 percent) also said that they used marijuana to increase the effects of other drugs, while only 10 percent of the other current users gave this reason. Only 11 percent of the "daily" users, or 1 percent of the total sample, stated that they used it because they felt "hooked" or had to have it. All of these responses for seniors were closely replicated among the "daily" users in the 19- to 22-year-old sample (Johnston, 1981).

Nearly all "daily" users (over 85 percent), whether in high school or past high school, say (1) that most or all of their friends smoke marijuana, (2) that most or all of their friends drink alcohol, (3) that more than a few of their friends get drunk every week, (4) that more than a few of their friends smoke cigarettes, and (5) that at least a few of their friends use a number of other illicit drugs. This degree of immersion in a drug-using friendship circle contrasts sharply to what we observe for their peers, even those who are current but less frequent users of marijuana. Clearly the social supports and the social pressures are there, both during and after high school, for the "daily" user to continue his or her habit.

Reasons for Quitting and Abstaining

A number of users of marijuana stop using the drug (Johnston, 1981). Among students (in the classes of 1978 through 1980 combined), those who have used marijuana 40 or more times but have stopped by their senior year give as their most commonly mentioned reason on a comprehensive list of 17 reasons that "they don't feel like getting high" (56 percent mentioned). Also frequently mentioned, however, are concerns about possible physical effects (41 percent); concern about possible psychological effects (38 percent); and, more specifically, concern about loss of energy or ambition (41 percent). These reasons also ranked high among those young people who smoked less than 40 times before they stopped, as did two additional reasons—concern about parental disapproval and finding that use of marijuana was not intrinsically enjoyable.

Concern about possible health effects appears to play a role in young people's giving up the drug and is mentioned considerably more often among quitters now than in 1976. Concern about physical health increased substantially between 1976 and 1980 among all high school seniors, from 35 percent to 57 percent, while concern about psychological damage went from 34 percent to 53 percent. A similar analysis of the reasons given for abstaining by the minority (about

40 percent) of seniors who have never tried marijuana reveals concern about physical (71 percent) and psychological (68 percent) consequences, which are mentioned far more often than any other type of reason. Social or ideological constraints or disinterest in getting high are infrequently mentioned. There also has been a significant increase in health concerns among the abstaining segment since 1976, though not as large as among quitters.

In summary, many "daily" users themselves see some negative consequences of their habit, and there perhaps are some consequences of which they are unaware. The fact that the "daily" smoking of marijuana is proving to be more enduring and stable than many may have thought increases the probability of cumulative, long-term effects. The fact that so many young people are becoming "daily" users now puts a substantial number of people at risk of whatever the long-term consequences may prove to be.

Sequence of Drug Use

Regardless of the age of onset, there is a predictable sequence in the patterns of initiation into the use of available drugs. Independent longitudinal studies have confirmed and identified a stable sequence of drug use (Hamburg et al., 1975; Kandel, 1975b; Kandel and Faust, 1975). The legal drugs for adults, such as alcohol and tobacco, are an early, integral, and crucial part of the sequence. Their use precedes the use of all illicit drugs. At least four distinct successive stages of adolescent involvement with drugs can be identified: (1) use of beer or wine, (2) use of tobacco cigarettes or hard liquor, (3) use of marijuana, and (4) use of other illicit drugs (Kandel, 1975b). A fifth stage, problem drinking, may take place between marijuana and other illicit drugs (Jessor et al., 1980). Adolescents rarely proceed from beer and wine to illicit drugs without use of either hard liquor or tobacco cigarettes as an intermediate step. Furthermore, there is an additive effect such that the highest proportion of adolescents who move to marijuana are those who have experience with both hard liquor and tobacco. For example, among 12- to 17-year-olds in the general population, the proportion who have ever experimented with marijuana is 81 percent among current tobacco cigarette smokers as compared to 24 percent among nonsmokers (Fishburne et al., 1980). However, position on a particular point in the sequence does not indicate that the young person will necessarily progress to other drugs higher up in the sequence. Participation in each stage is a necessary but not sufficient condition for participation in a later stage. There is no evidence to support the belief that the use of one drug will inevitably lead to use of any other drugs. In other words, persons at the top of the ladder of use of drugs typically will have used all substances at lower levels, including marijuana. However, those at lower rungs may stay there and not move to higher rungs of the ladder.

For example, data from the National Household Surveys (Fishburne et al., 1980) indicate that of those 18-25 years old who have tried marijuana, almost all are users of tobacco or alcohol; however, only slightly more than one-fourth of this 18- to 25-year-old population report having gone on to try any illegal drug other than marijuana. Of those who try other illegal drugs, only a very small percentage report being current users (Fishburne et al., 1980).

Although it is of great interest, relatively little is known about the factors that determine which persons will choose to go through the sequence of drug use or the rapidity with which they will do so. Existing research gives us some clues that users of illicit drugs possess some distinguishing features.

There are four clusters of variables--parental influences, peer influences, adolescent involvement in deviant behaviors, and adolescent beliefs and values--that assume differential importance for predicting involvement at each stage of drug behavior (Kandel et al., 1978a,b).

Involvement with drugs legal for adults is the earliest level of drug use. Adolescents who start to drink are exposed to peers and parents who drink, suggesting that these youths learn drinking patterns from their parents. Adolescents who have engaged in a number of delinquent or deviant activities, and who seek high levels of sociability with their peers are likely to become involved with alcohol. Similar patterns are found with tobacco smoking, also one of the earliest drugs to be tried.

The use of marijuana follows that of alcohol and tobacco. It is preceded by acceptance of a cluster of beliefs and values that often reflect disavowal of many standards upheld by adults. Involvement in a marijuana-using peer environment strongly predisposes to its use and is the best predictor (Becker, 1953; Goode, 1970). Participation in minor forms of deviant behaviors, such as those that also precede the use of hard liquor, is also an important precursor.

Antecedents of Adolescent Use of Marijuana

When use of marijuana first came under research scrutiny in the late 1960s, very few youths had experimented with illicit drugs. Much was made of the deviant status of use of marijuana and of the counter-cultural and rebellious meaning that came to be attached to using the drug (Suchman, 1968). Yet even today, when over 60 percent of all high school seniors have used marijuana, those youths who use marijuana are quite different from nonusers. The marijuana users in 1979 show the same patterns of disaffection from major institutions that characterized the users in 1967. The most recent data show that marijuana users perform more poorly in school, are less religious, have performed more delinquent acts, are in trouble with the law, have more traffic accidents, and use more illicit drugs than nonusers. Those persons who also use several illicit drugs show the highest involvement in deviant behaviors. There is a linear relationship with degree of involvement with illicit drugs, such that persons using marijuana exclusively are only quantitatively different from those who have also used harder drugs (Johnston et al., 1980b).

In two cross-sectional national samples of high school students, surveyed in 1974 and 1978, Jessor et al. have found that not only are the patterns of association between use of marijuana and deviant characteristics similar in both surveys, but also that the strength of the associations, as reflected in the sizes of the correlation coefficients, are almost identical. The very same conclusions derive from analyses based on five successive cohorts of high school seniors, sampled at yearly intervals in Monitoring the Future (Bachman et al., 1981).

Longitudinal studies of students aged 12-21 have done much to extend our understanding of the precursors of using various forms of drugs. Studies have been reviewed in detail by Kandel (1978a,b; 1980a; also see Appendix C) and document that many of the factors found to be associated with use of drugs at one point in time, such as low academic performance, crime, low self-esteem, depressive mood, rebelliousness, and other personality characteristics, precede the use of drugs (see in particular Mellinger et al., 1976; Jessor and Jessor, 1977; Johnston et al., 1978; Kandel, 1978a; Kandel et al., 1978b,c; Kaplan and Pokorny, 1978; Smith and Fogg, 1978; Wingard et al., 1979; Kaplan, 1980). Some of the predictive factors can be identified in childhood, such as aggressiveness with or without association with shyness (Kellam et al., 1980, in press) and rebelliousness (Smith and Fogg, 1978).

Other longitudinal studies also document that many of the factors found to be associated with use of drugs at one point in time, such as low academic performance, delinquency, low self-esteem, and depressive mood actually precede the use of drugs (O'Malley, 1975; Mellinger et al., 1976; Jessor and Jessor, 1977; Johnston et al., 1978; Kandel et al., 1978a; Kaplan and Pokorny, 1978; Wingard et al., 1979; Kaplan, 1980).

One study shows not only that certain behaviors predict use of marijuana, but also that drugs may aggravate or exaggerate certain behaviors. A cohort of high school students was followed at annual intervals throughout the four years of high school (Jessor and Jessor, 1977). During this time annual scores for various attributes were charted in four groups of students distinguished by differing drug histories: veteran users, who used drugs pre-high school; early initiates, who began relatively early in their high school career, i.e., between the first and second year of testing; late initiates, who began relatively late, i.e., between the second and the third year; and nonusers, who had not started to use marijuana at the last testing in the senior year of high school (Jessor and Jessor, 1977, 1978). These four groups of students differed on measures, such as general deviant behavior (a 12-item scale measuring frequency of involvement in stealing, fighting, property destruction, truancy, or other delinquent activities in the last year) or value on academic achievement (a five-item scale, measuring the value placed on the attainment of success in school work), at the beginning of the study. Scores predicted if and when students initiated use of marijuana. Those students already involved in use of drugs before high school scored highest on deviance and lowest on achievement motivation at initial testing and throughout subsequent retests. The scores of all groups of users converged over time so that all three groups increased in deviance scores and decreased in their achievement orientation over the four years. The sharpest changes in scores occurred in the year preceding the drug use.

Peer Influences

The most consistent and reproducible finding in drug research is the strong relationship between an individual's drug behavior and the concurrent use of drugs by his friends. The relationship is stronger when based on adolescents' perceptions of the friends' behavior than on the friends' self-reports (Goode, 1970; Johnson, 1973; Kandel, 1973; Goldstein, 1975; O'Donnell et al., 1976; Brook et al., 1977; Jessor and Jessor, 1977; Kandel et al., 1978a; Orcutt, 1978; Smart et al., 1978; Huba et al., 1979). On no other characteristic except age and sex is the similarity within adolescent friendship pairs as high as it is for use of marijuana (Kandel, 1978c). Such similarity results not only from socialization, the influence of one friend on the other, but also from a process of interpersonal selection (assortive pairing), in which adolescents with similar values and behavior seek each other out as friends. Longitudinal data on the formation and dissolution of friendships indicate that selection and socialization contribute about equally to the similarity in values and behaviors (Kandel, 1978d). Available data on sex differences in peer influence indicate that females are more susceptible than males to such influence (Jessor et al., 1973; Margulies et al., 1977). Susceptibility to peer influence is related to involvement in peer-related activities, e.g., dating or getting together with friends, and to degree of attachment to and reliance on peers rather than parents (Jessor and Jessor, 1978; Kandel et al., 1978a; Brook et al., 1980). Contact with other users increases the likelihood that the individual will have increased opportunities to get the drug. Peer-mediated approaches have been shown to be an effective vehicle for interventions to prevent smoking of tobacco in adolescents (Evans, 1977; McAlister, 1979). The powerful role of peer influence on the use of marijuana would seem to suggest that it would be also useful for preventive marijuana programs.

SUMMARY

There has been a steep rise in the use of marijuana and other illicit drugs in the past decade. So far it is primarily a youth phenomenon. Since 1971 there has been at least a doubling of lifetime experience with marijuana in every cohort in the 12- to 24-year age group. Of all psychoactive drugs investigated (including inhalants, hallucinogens, cocaine, heroin, stimulants, sedatives, and tranquilizers), marijuana is by far the most commonly used illicit drug. Legal drugs for adults, such as alcohol and tobacco, are the most widely used of all drugs among adolescents. Although substantially more students have ever used alcohol in their lifetime than have ever used marijuana, more high school seniors use marijuana on a "daily" basis (9 percent) than use alcohol that frequently (6 percent). "Daily" users report the use of marijuana in school, whereas daily use of alcohol tends to occur after school and on weekends.

Some trends in use of marijuana are apparent. The continuing dramatic rise in the use of marijuana has recently slowed. It is too early to tell whether this decrease will continue or is merely a pause in the rise. The overall prevalence of use of marijuana has remained at approximately 60 percent of high school seniors for the years 1978, 1979, and 1980. Between 1975 and 1978 there was an almost twofold increase in "daily" use of marijuana from 6 percent in 1975 to a peak rate of 11 percent in 1978. In 1980 the "daily" use rate of high school seniors dropped by 1.2 percentage points, or more than 10 percent. This may signal a reversal of the upward trend in "daily" use unless higher absenteeism and school drop-out of daily users are significant factors in the decline. Multiple sources suggest that out-of-school age mates are heavier users than those in school. Other trends have not slowed. There was a continuing rise in 1980 of the proportion of high school seniors who during the year had used some illicit drug other than marijuana, from 28 percent in 1979 to 30 percent in 1980.

Throughout the 1970s, as a correlate of continuing rise in prevalence rates, there was a trend toward younger ages of first use of all of these drugs. For marijuana this age trend continues but has slowed somewhat. In 1979, 23 percent of seniors who had used marijuana started their use in the eighth grade or below as compared to 25 percent in 1980.

"Daily" use of marijuana in high school and in early adult life is very high and merits special attention. Drawing on data from Monitoring the Future, characteristics of "daily" users were described. For high school seniors the rate of "daily" marijuana use in 1980 was 9.1 percent. Such users have very high involvement with other drugs and begin their use of drugs at very early ages. "Daily" users are predominantly urban although rates do not vary by geographical regions of the country, whereas use among white students is double that for blacks. "Daily" use is only slightly higher in disrupted or single parent homes than in nuclear families, and use is associated with poor school achievement, absenteeism, and dropout. Non-college-bound students are twice as likely to be "daily" users as were students planning to attend college. Religious commitment and self-ratings of strong belief in law-abiding behavior are associated with lower "daily" use rates. "Daily" users are involved in more automobile accidents and delinquency.

Post-high school "daily" user rates are lowest among full-time college students and those living in a college dormitory. "Daily" use among non-college students was not related to joblessness, employment, or military service. Single persons are twice as likely as married persons to be "daily" users. Among the married, those with children had very low rates of "daily" use. The "daily" use habit has a remarkable stability. By 4 years after high school, 85 percent of "daily" using seniors in the class of 1975 were still using marijuana, with 51 percent of them continuing to be "daily" users.

In these studies, students report reasons for using marijuana: to have a good time with friends, to get "high," to relieve boredom, to enhance the effects of other drugs, and to cope with stress. "Daily" users are deeply immersed in a drug-using circle of friends.

Some "daily" users have discontinued their habit. Reasons given for stopping use of marijuana are loss of interest in getting "high," concern about harmful physical or psychological effects, and concern about their loss of energy or ambition.

More is known about the antecedents of using marijuana than is known about the consequences of using marijuana (to be discussed further in the chapters that follow). Longitudinal studies have established that use of marijuana is preceded by acceptance of a cluster of beliefs and values that are favorable to use of marijuana and also by the adoption of deviant behaviors. The deviant psychosocial attributes of marijuana users that were described almost a decade ago, when use of marijuana was a rare event, are just as characteristic of marijuana users today, when 60 percent of all high school seniors report some experience with the use of marijuana. Daily users show the extremes of these deviant behaviors but less deeply involved users also exhibit some deviancy. Friendship patterns and peer influence play a uniquely powerful role in determining youthful marijuana use. Negative parental relationships do not appear to be associated as an antecedent to use of marijuana.

RECOMMENDATIONS FOR RESEARCH

Additional research needed includes (1) epidemiologic studies on patterns of use of drugs among young adolescents, including those who leave school, (2) longitudinal studies to investigate the antecedents and consequences of use of marijuana, and (3) studies of the effects of marijuana in combination with use of other drugs.

Because samples of high school seniors exclude youths most at risk for high marijuana involvement, namely adolescents not regularly attending the high school, additional cohort-sequential epidemiologic surveys beginning with prepubertal children are needed in order to follow development and behavior from early in life. An all-conclusive approach would be both a prospective (concurrent) cohort study and a retrospective case-control study of possible outcomes of and risk factors for marijuana use (this recommendation is described in detail in Chapter 6).

"Daily" users have been understudied and may have the most severe risk in terms of loss of learning potential, biological risk, and psychosocial handicap. Studies should be undertaken to predict who among the large numbers of young people who try marijuana are at risk of becoming "daily" users.

Research on the factors involved in cessation of the use of marijuana should also be carried out. Tobacco smoking is declining among youth (National Institute of Education, 1979). The reasons for this decline could be applicable to marijuana use and should be sought.

Studies should be undertaken to learn how peer influence can be reliably used to moderate or prevent marijuana use in young adolescents.

Properly planned longitudinal cohort studies should be conducted on both the behavioral and physiological antecedents and consequences of the use of marijuana. Detailed and continuing medical and psychosocial data are needed on the life careers of American adults who use marijuana "daily." Retrospective studies of middle-aged and elderly persons who have a history of chronic heavy use of marijuana would be systematically studied for medical and psychosocial attributes and for effects on job performance. These are especially needed for urban industrialized populations.

Little is known about the consequences of using marijuana in combination with other drugs. Inasmuch as the rates of use of other drugs are so high, this is of great salience. Interdisciplinary and collaborative efforts are crucial if the complexities of multiple drugs and intercorrelated behaviors are to be disentangled.

REFERENCES

Bachman, J.G., Johnston, L.D., and O'Malley, P.M. Smoking, drinking, and drug use among American high school students: Correlates and trends, 1975-1979. *Am. J. Public Health* 71:59-69, 1981.

Becker, S. Becoming a marihuana user. *Am. J. Sociol.* 54:235-242, 1953.

Brook, J.S., Lukoff, I.F., and Whiteman, M. Peer, family, and personality domains as related to adolescents' drug behavior. *Psychol. Rep.* 41:1095-102, 1977.

Brook, J.S., Lukoff, I.F. and Whiteman, M. Initiation into adolescent marihuana use. *J. Gen. Psychol.* 137:133-142, 1980.

Burt, M.R., Biegal, M.M., Carnes, Y., and Farley, E.C. *Worldwide Survey of Nonmedical Drug Use and Alcohol Use Among Military Personnel: 1980.* Bethesda, Md.: Burt Associates, Inc., 1980.

Cisin, I., Miller, J.D., and Harrell, A. *Highlights from the National Survey on Drug Abuse: 1977.* Washington, D.C.: U.S. Government Printing Office, 1978.

Evans, R.I., Hansen, W.B., and Mittlemark, M.B. Increasing the validity of self-reports of behavior in smoking in children investigation. *J. Appl. Psychol.* 62:521-523, 1977.

Fishburne, P.M., Abelson, H.I., and Cisin, I. *National Survey on Drug Abuse: Main Findings: 1979*. DHHS Publication No. (ADM) 80-976. WAshington, D.C.: U.S. Government Printing Office, 1980.

Gallup Opinion Index, pp. 1-11. Report No. 143. *Marijuana in America*, 1976.

Goldstein, J.W. Assessing the interpersonal determinants of adolescent drug use, pp. 47-52. In Lettieri, D.J. (ed.)

Predicting Adolescent Drug Abuse: A Review of Issues, Methods and Correlates. DHEW Publication No.(ADM)76-299. Washington, D.C.: U.S. Government Printing Office, 1975.

Goode, E. The Marijuana Smokers New York: Basic Books, Inc., 1970.

Hamburg, B.A., Kraemer, H.C., and Jahnke, W. A hierarchy of drug use in adolescence: Behavioral and attitudinal correlates of substantial drug use. Am. J. Psychiatry 132:1155-1163, 1975.

Huba, G..J., Wingard, J.A., and Bentler, P.M. Beginning adolescent drug use and peer and adult interaction patterns. J. Consult. Clin. Psychol. 47:265-276, 1979.

Jessor, R. and Jessor, S.L. Problem Behavior and Psychosocial Development: A Longitudinal Study of Youth. New York: Academic Press, 1977.

Jessor, R. and Jessor, S.L. Theory testing in longitudinal research on marihuana use, pp. 41-71. In Kandel, D. (ed.) Longitudinal Research on Drug Use: Empirical Findings and Methodological Issues. Washington, D.C.: Hemisphere Publishing Corp., 1978.

Jessor, R., Jessor, S.L., and Finney, J. A social psychology of marijuana use: Longitudinal studies of high school and college youth. J. Pers. Soc. Psychol. 26:1-15, 1973.

Jessor, R., Donovan, J.E., and Widmer, K. Psychosocial Factors in Adolescent Alcohol and Drug Use: The 1978 National Sample Study, and the 1974-78 Panel Study. Final Report. Boulder, Colo.: University of Colorado Institute of Behavioral Science, 1980.

Johnson, B.D. Marijuana Users and Drug Subcultures New York: John Wiley, 1973.

Johnson, B.D. and Uppal, G.S. Marihuana and youth: A generation gone to pot, pp. 81-108. In Scarpitti, F.R. and Datesman, S.K. (eds.) Drugs and the Youth Culture. Beverly Hills, Calif.: Sage Publications, 1980.

Johnston, L.D. The daily marijuana user. Paper presented at the Meeting of the National Alcohol and Drug Coalition, Washington, D.C., September 18, 1980.

Johnston, L.D. Frequent marijuana use: Correlates, possible effects, and reasons for using and quitting. Paper presented at a Conference on Treating the Marijuana Dependent Person, sponsored by the American Council on Marijuana and Other Psychoactive Drugs, Bethesda, Md., May 4, 1981.

Johnston, L.D., O'Malley, P. and Eveland, L. Drugs and delinquency: A search for causal connections, pp. 137-156. In Kandel, D.B. (ed.) Longitudinal Research on Drug Use: Empirical Findings and Methodological Issues. Washington, D.C.: Hemisphere Publishing Corporation, 1978.

Johnston, L.D., Bachman, J.G., and O'Malley, P.M. Drugs and the Class of '78: Behaviors, Attitudes, and Recent National Trends DHEW Publication No.(ADM)79-877. Washington, D.C.: U.S. Government Printing Office, 1979a.

Johnston, L.D., Bachman, J.G., and O'Malley, P.M. 1979 Highlights. Drugs and the Nation's High School Students. Five Year National Trends. DHHS Publication No.(ADM)81-930. Washington, D.C.: U.S. Government Printing Office, 1979b.

Johnston, L.D., Bachman, J.G., and O'Malley, P.M. Highlights from Student Drug Use in America, 1975-1980. DHHS Publication No. (ADM)81-1066. Washington, D.C.: U.S. Government Printing Office, 1980a.

Johnston, L.D., Bachman, J.G., and O'Malley, P.M. Monitoring the Future. Questionnaire Responses from the Nation's High School Seniors 1979 Ann Arbor: Survey Research Center, The University of Michigan, 1980b.

Kandel, D. Adolescent marihuana use: Role of parents and peers. Science 181:1067-1070, 1973.

Kandel, D. Reaching the hard-to-reach: Illicit drug use among high school absentees. Addict. Dis. 1:465-80, 1975a.

Kandel, D. Stages in adolescent involvement in drug use. Science 190:912-914, 1975b.

Kandel, D. and Faust, R. Sequence and stages in patterns of adolescent drug use. Arch. Gen. Psychiatry 32:923-932, 1975.

Kandel, D.B. (ed.) Longitudinal Research on Drug Use: Empirical Findings and Methodological Issues. Washington, D.C.: Hemisphere Publishing Corp., 1978a.

Kandel, D.B. Convergences in prospective longitudinal surveys of drug use in normal populations, pp. 3-38. In Kandel, D.B. (ed.) Longitudinal Research on Drug Use: Empirical Findings and Methodological Issues. Washington, D.C.: Hemisphere Publishing Corp., 1978b.

Kandel, D.B. Similarity in real-life adolescent friendship pairs. J. Pers. Soc. Psychol. 36:306-312, 1978c.

Kandel, D.B. Homophily, selection, and socialization in adolescent friendships. Am. J. Sociol. 84:427-436, 1978d.

Kandel, D.B. Drug and drinking behavior among youth. Ann. Rev. Sociol. 6:235-285, 1980.

Kandel, D., Kessler, R., and Margulies, R. Antecedents of adolescent initiation into stages of drug use: A developmental analysis, pp. 73-99. In Kandel, D.B. (ed.) Longitudinal Research on Drug Use: Empirical Findings and Methodological Issues. Washington, D.C.: Hemisphere Publishing Corp., 1978a.

Kandel, D.B., Margulies, R.Z., and Davies, M. Analytical strategies for studying transitions into developmental stages. Sociol. Educ. 51:162-176, 1978b.

Kandel, D.B., Kessler, R.C., and Margulies, R.Z. Antecedents of adolescent initiation into stages of drugs use: A developmental analysis. J. Youth and Adolescence 7:13-40, 1978c.

Kandel, D.B., Adler, I., and Sudit, M. The epidemiology of adolescent drug use in France and Israel. Am. J. Public Health 71:256-265, 1981.

Kaplan, H.B. Deviant Behavior in Defense of Self New York: Academic Press, 1980.

Kaplan, H.B. and Pokorny, A.D. Alcohol use and self-enhancement among adolescents: A conditional relationship, pp. 51-75. In Seixaz, F.A. (ed.) Currents in Alcoholism. Volume IV: Psychiatric, Psychological, Social and Epidemiological Studies. New York: Grunne and Stratton, 1978.

Kellam, S.G., Ensminger, M.E., and Simon, M.B. Mental health in first grade and teenage drug, alcohol and cigarette use. J. Drug Alcohol Dependence May:273-304, 1980.

Kellam, S., Simon, M., and Ensminger, M.E. Antecedents in first grade of teenage drug use and psychological well-being: A ten year community-wide prospective study. In Ricks, D. and Dohrenwend, B. (eds.) Origins of Psychopathology: Research and Public Policy. Cambridge University Press (in press).

Margulies, R.Z., Kessler, R.C., and Kandel, D.B. A longitudinal study of onset of drinking among high-school students. J. Stud. Alcohol 38:897-912, 1977.

McAlister, A.L. Tobacco, alcohol, and drug abuse: Onset and prevention, pp. 197-206. In Healthy People: The Surgeon General's Report on Health Promotion and Disease Prevention, Background Papers, 1979. DHEW(PHS) Publication No. 79-55071A. Washington, D.C.: U.S. Government Printing Office, 1979.

Mellinger, G.D., Somers, R.M., Davidson, S.T., and Manheimer, D.I. The amotivational syndrome and the college student. Ann. N.Y. Acad. Sci. 282:37-55, 1976.

Miller, J.D. and Cisin, I.H. Highlights from the National Survey on Drug Abuse: 1979. DHHS Publication No. (ADM)80-1032. Washington, D.C.: U.S. Government Printing Office, 1980.

National Institute of Education. Teenage Smoking: Immediate and Long Term Patterns. Washington, D.C.: U.S. Government Printing Office, 1979.

O'Donnell, J.A., Voss, H.L., Clayton, R.R., et al. Young Men and Drugs--A Nationwide Survey NIDA Research Monograph 5. DHEW Publication No. (ADM)76-311. Washington, D.C.: U.S. Government Printing Office, 1976.

O'Malley, P.M. Correlates and Consequences of Illicit Drug Use. Ph.D. Thesis. University of Michigan, Ann Arbor. 326 pp. 1975.

Orcutt, J.D. Normative definitions of intoxicated states: A test of several sociological theories. Soc. Probl. 25:385-396, 1978.

Rittenhouse, J.D. Learning Drug Use: From "Legal" Substance to Marijuana and Beyond. Paper presented at the American Psychological Association Annual Convention, Montreal, Canada, September 1980.

Robins, L.N. The Vietnam Drug User Returns. Final Report. Special Action Office Monograph Series A, No. 2. Washington, D.C.: U.S. Government Printing Office, 1974.

Smart, R.G., Gray, G., and Bennett, C. Predictors of drinking and signs of heavy drinking among high school students. Int. J. Addict. 13:1079-1094, 1978.

Smith, G.M. and Fogg, C.P. Psychological predictors of early use, late use, and nonuse of marihuana among teenage students. pp. 101-113. In Kandel, D.B. (ed.) Longitudinal Research on Drug Use: Empirical Findings and Methodological Issues Washington, D.C.: Hemisphere Publishing Corp., 1978.

Suchman, E.A. The "hang-loose" ethic and the spirit of drug use. J. Health Soc. Behav. 9:146-155, 1968.

Wingard, J.A., Huba, G.J., and Bentler, P.M. The relationship of personality structure to patterns of adolescent substance use. Multivariate Behav. Res. 14:131-143, 1979.

3

EFFECTS OF MARIJUANA ON THE RESPIRATORY AND CARDIOVASCULAR SYSTEMS

RESPIRATORY SYSTEM

Performance (Pulmonary Function)

Th[illegible] are the natural target for the harmful effects of smoked materials. This is as true for marijuana as for tobacco. In both instances, smoke is drawn into the lungs where it can harm not only the cells that line the airways (trachea, nasopharynx, bronchi, and alveoli) and constitute the lung tissue, but also impair such cells as lung macrophages, which are part of the immune system. As a result, the smoke may inflict injury directly on parts of the system and also make the lungs vulnerable to agents that normally are held at bay by self-cleansing and self-protecting mechanisms.

Different effects would be expected from tobacco and marijuana smoking because of the striking differences in the way in which the two substances are smoked: marijuana smoke usually is drawn deeply into the lungs by one or a few deliberately deep breaths, whereas tobacco smoking is generally more automatic, repetitive, and variable in pattern. Moreover, because marijuana is a "street drug," it not only is inconsistent in its content but also is subject to contamination. Also, filters are not usually used by marijuana smokers, although water pipes are used occasionally. Consequently, under natural conditions it is difficult to judge dosage of active ingredients, to sort out the influence of contaminants, and to compare the consequences of marijuana and tobacco smoke.

Experience over the years with cigarette smoking has shown that continued exposure to tobacco smoke entails the risk of producing chronic bronchitis and/or carcinoma of the lung. But, although cannabis products have been smoked for centuries, remarkably little is recorded about their effects on the lungs. Whatever contemporary information exists is confounded by the fact that most marijuana smokers are also tobacco smokers.

In recent years, interest has heightened in the smoking of marijuana as a therapeutic measure. The inhalation route takes advantage of the large surface area afforded by the lungs for administering the effective constituents of marijuana. However, this practice entails the disadvantage of administering a therapeutic agent in a cloud of air pollutants.

In brief, our appraisal must assess the impact of chronic bronchial irritation and inflammation on the airways and gas-exchanging surfaces of the lungs.

Acute Effects

Marijuana affects the control of the breathing pattern in different ways depending upon the dose, the preparation, and its psychotropic effect on the consumer. [redacted] (Vachon et [redacted]). On the other hand, [redacted] of smoked marijuana [redacted] ventilation and responsiveness to the CO_2 stimulus (Weil et al., 1968; Bellville et al., 1975). [redacted]

Much more consistent and predictable is the effect of marijuana on the [redacted] The inhalation of small amounts of marijuana smoke [redacted] (Tashkin et al., 1973; Vachon et al., 1973). [redacted] bronchodilation is easily demonstrable; the inhalation [redacted] isoproterenol (1250 µg), a potent bronchodilator, caused less of an improvement in airways conductance than the peak effect observed after smoking 2 percent marijuana (Tashkin et al., 1973). Ingestion of Δ-9-THC is less effective than smoking marijuana in producing bronchodilation; [redacted]. [redacted]olized Δ-9-THC has a local irritating effect on the airways, which often overrides the bronchodilating effect to the point of making it unsuitable for therapeutic purposes (Tashkin et al., 1977a).

[redacted]76). [redacted] weeks [redacted].

Acute [redacted] by [redacted]ctor (Shapiro et al., 1976a). The mechanism by which bronchodilation is effected is not clear, but does not involve stimulation of beta-adrenergic receptors or blockade of muscarinic receptors in airway smooth muscle (Shapiro et al., 1976a). Adding to the difficulties of interpretation are the psychotropic effects of marijuana: four of the individuals who had previously used cannabis could distinguish the marijuana cigarette from the placebo on the basis of the intoxicating experience afforded by the marijuana smoke. Although the four subjects without previous cannabis experience did not experience any central nervous system effects, they did note mild somnolence or light-headedness after marijuana use.

Among the experiments with induced asthma were some that employed the inhalation of cannabinoid-free marijuana smoke (Tashkin et al., 1975). The results indicate that the smoke of the marijuana cigarette does not prevent methacholine-induced bronchospasm (Tashkin et al., 1976). Smoking of marijuana did not aggravate or perpetuate bronchoconstriction in stable asthmatics, and it promptly reversed experimentally induced bronchospasm (Tashkin et al., 1978). Addition of Δ-9-THC to placebo smoke caused a prompt, complete, and sustained reversal of methacholine-induced bronchospasm. Although ingestion of Δ-9-THC in a sesame oil vehicle has produced bronchodilation in asthmatic patients, less dilation was noted than after smaller doses of Δ-9-THC delivered by smoking (Tashkin et al., 1974).

Although it appears that the mechanism of Δ-9-THC-induced bronchial dilation is mediated by the autonomic nervous system, the process of dilation is not understood (Gill and Paton, 1970; Cavero et al., 1972; Shapiro et al., 1973).

Subacute Effects

Pulmonary function tests in 28 healthy young experienced cannabis users before and after a 47-59-day period of heavier than customary marijuana usage (group daily average of 5.2 cigarettes, with a daily mean range of 1.7 to 10 cigarettes per subject) disclosed the development of mild but significant decreases in specific airway conductance and forced expiratory flow as well as in diffusing capacity (Tashkin et al., 1976). Cessation, by reduction in smoking, gradually restored the tests toward normal. The clinical significance of these abnormalities is uncertain. The marijuana smoked and the impairment in pulmonary function, coupled with the observation that reversibility of function was incomplete 1 week after marijuana smoking had stopped, suggests that heavy marijuana smoking over a still longer period could lead to clinically significant and less readily reversible impairment of pulmonary function.

Chronic Effects

A study of 31 American soldiers stationed in West Germany who smoked large quantities of hashish (100 grams or more per month for periods of 6 to 15 months) found their ailments to be principally respiratory, including bronchitis, sinusitis, asthma, and rhinopharyngitis (inflammation of the nasopharynx) (Tennant et al., 1971). In one-third of the soldiers, sputum-producing coughs, difficulty in breathing, and wheezing followed 3 to 4 months of regular use of hashish. However, they had a normal chest radiograph and normal sputum. Antibiotics failed to relieve the symptoms. The symptomatic patients could not work and four required hospitalization. An unspecified decrease in hashish consumption improved their symptoms.

Pulmonary function tests in these individuals showed mild airway obstruction after 3 days of lessened hashish intake. Moreover, the response of these individuals to isoproterenol suggested that reversible bronchospasm and/or the accumulation of fluid in the bronchi was involved in the pathogenesis of the airway obstruction. Patch and serological tests failed to implicate allergy as a cause of the upper respiratory symptoms and signs.

In Jamaica (Hall, 1975), where marijuana usage is heavy, chronic bronchitis is frequent. However, marijuana smoking is usually associated with tobacco smoking, which confounds interpretation of the effects of marijuana alone. Adding to the uncertainty about the effects of marijuana as a cause of chronic regulatory abnormalities are two other studies, one in Jamaica (Rubin and Comitas, 1975) and the other in Costa Rica (Hernandez-Bolanos et al., 1976), which failed to find any difference in the prevalence of chronic respiratory disease between smokers and nonsmokers of marijuana. These results cannot be accepted as conclusive, because in each study the number of marijuana smokers was small, the subjects were not randomly selected, and the use of tobacco was not taken into account.

Much more convincing is a recent study (Tashkin et al., 1980) of 74 persons who smoked marijuana for 2 to 5 years, typically as frequently as several times per day, 3 to 6 days per week. Care was taken to obtain proper control groups. The results indicated that habitual smoking of marijuana causes a mild but significant increase in resistance to airflow in the large airways without an appreciable effect on conventional tests.

Another study was of 200 American soldiers stationed in West Germany who voluntarily sought medical attention for such respiratory symptoms as pharyngitis, sinusitis, bronchitis, and asthma related to chronic heavy hashish smoking (Henderson et al., 1972). Analysis of the hashish available and in use in the locale of this study showed concentrations of 5 to 10 percent Δ-9-THC. Two to 3 percent of samples were contaminated with cocaine, opium, morphine, spices, or feces. Two aspects of hashish smoking are relevant to the question of lung injury produced by hashish: 1) hashish is usually smoked in a pipe (occasionally in a water pipe), although it is occasionally eaten, drunk as a tea, or rolled into a cigarette and smoked, and 2) hashish smoke generally is regarded by users as burning much hotter than tobacco smoke.

Soldiers with pharyngitis usually smoked less than 25 grams of hashish monthly; those with bronchitis and asthma consumed more than 50 grams per month. The common complaint of sore throat in these heavy hashish smokers occurred most often in those who smoked hashish in a pipe without a screen or cotton filter; in them, the roof of the mouth and the back of the throat were inflamed. Persistent rhinitis (inflammation of the nasal mucous membranes) was present in 26 patients. As a rule, allergy could not be implicated in the nasopharyngeal manifestations. Treatment with antibiotics, decongestants, and phenylephrine (a vasoconstrictor) relieved the symptoms, but they recurred in those who continued smoking hashish.

Twenty high-dose hashish smokers (more than 50 grams/month) had chronic bronchitis as manifested by a chronic sputum-producing cough, shortness of breath, and decreased exercise tolerance. On physical examination, abnormal respiratory sounds—rhonchi, wheezes, and rales—were present. Chest radiographs were consistently normal, but pulmonary function was abnormal; the vital capacity (the maximum volume of gas taken in) was 15 to 40 percent below normal. In six of these subjects who smoked 50 or more grams per month, biopsy of bronchial mucosa revealed changes that resembled the abnormalities that occur in older heavy smokers of tobacco (Auerbach et al., 1961). The biopsies also turned up atypical cells not found in tobacco smokers.

The study of a respiratory disease in hashish or marijuana smokers is difficult because the great majority also smoke tobacco cigarettes. Also, the illegality of marijuana smoking prevents people from volunteering information and cooperating in experimental studies. Baseline physiological or clinical studies are difficult, because the subject is not identified until he seeks medical help.

Rats (Fleischman et al., 1979) and dogs (Roy et al., 1976) have been exposed experimentally to marijuana smoke over long periods (1 year and 900 days, respectively) to determine its morphological effects on the lungs. At autopsy, the animals demonstrated damage of the airways and also of the lung substance. However, it is difficult to relate the results of these animal experiments, in which the artificial pattern of smoking differed markedly from that of the human smoker, to the effects that chronic marijuana smoking might elicit in man.

Defense Mechanisms (Alveolar Macrophages)

Little is known about the effects of marijuana on the defense mechanisms of the lungs. Although some observations have been made on the alveolar macrophage, an important element in this system, the results have been inconsistent. For example, some studies of the rat lung found that macrophages obtained by washing out the lung and exposing them to marijuana smoke manifested a depression in bactericidal activity (Huber et al., 1975, 1979a,b, 1980). On the other hand, another report failed to disclose a significant effect, not only of marijuana, but also of tobacco smoke on the bactericidal activity of macrophages (Drath et al., 1979). Finally, others have found that alveolar macrophages differ slightly in their morphological responses to tobacco and to marijuana smoke. The significance of these differences, especially in terms of their long-term effect on pulmonary defense mechanisms, remains to be defined.

Explants of lung have also been examined after exposure in culture to marijuana smoke (Leuchtenberger et al., 1973a,b; Leuchtenberger and Leuchtenberger, 1976). Striking changes have been observed in the appearance and growth characteristics of exposed cells.

Carcinoma of the Lung

The effect of marijuana as a carcinogen for lung, airways, and upper respiratory organs has not been systematically explored. Evaluating the carcinogenicity of marijuana is difficult, because most marijuana smokers also are tobacco cigarette smokers and because such carcinogenicity could have a long period of latency; studies of tobacco carcinogenesis indicate that 20 to 30 years of exposure must occur before tumors appear in the lung. It is understandable that information concerning the carcinogenic properties of marijuana are not yet available, particularly in the United States, where the agent has come into extensive use only during the past two decades. An important problem in evaluating carcinogenicity is the fact that the leaf is used by igniting it and the inhaled products of its combustion may be carcinogenic, as in the case of tobacco products. Even if it proved to be carcinogenic, the question would still remain as to what constituent in marijuana smoke was at fault.

The potency of a substance as a mutagen (ability to change genetic material) can provide a clue as to its possible role as a carcinogen. Induction of genetic mutations by a substance in test strains of bacteria correlates with induction of tumors in test animals. Fractions from extracts of marijuana smoke particulates ("tar") have been found to produce dose-related mutations in four out of five test strains of bacteria (Busch et al., 1979; Seid and Wei, 1979; Wehner et al., 1980). By itself, Δ-9-THC was not active as a mutagen in bacterial strains (Glatt et al., 1979) or in mammalian test systems (van Went, 1978).

The extent to which marijuana smoke differs from tobacco smoke is discussed in detail in Chapter 1. In general, except for the presence of cannabinoids in one and tobacco alkaloids (nicotine) in the other, the combustion products of tobacco and marijuana are qualitatively similar. On occasion, however, differences that may be meaningful have been found. For example, one study (Hoffmann et al., 1975) reports that tobacco smoke contains more isoprene and volatile phenols, whereas marijuana smoke contains about 50 percent more carcinogenic hydrocarbons.

Tumorigenicity of marijuana and tobacco smoke condensates on mouse skin have been reported. In mice painted three times weekly with a tar suspension of smoke condensate, survival at 74 weeks was better in the marijuana group than in the tobacco group. Six of 100 mice painted with marijuana condensate developed skin tumors, all of which were benign, whereas 14 of 100 in the tobacco condensate group developed tumors, two of them malignant (Hoffman et al., 1975).

Because marijuana smoke has adverse actions similar to tobacco smoke on cell function in the respiratory and cardiovascular systems, it has been proposed that marijuana smoke, rather than only the cannabinoid, should be used to obtain information about effects on cell injury and response (Leuchtenberger and Leuchtenberger, 1971). Exposure of human lung cells in culture to freshly generated marijuana smoke for up to 2 months resulted in increased mitotic indices, stimulation of DNA synthesis, and an increase in the population of cells with four times the DNA content of control cells or those exposed to tobacco smoke (Leuchtenberger et al., 1973a,b). Long-term exposure of hamster lung cells to the smoke of either marijuana or tobacco led to abnormal proliferation and malignant transformation within 3 to 6 months of exposure (Leuchtenberger and Leuchtenberger, 1976). Since malignant transformation was also noted in unexposed lung cells after 12-24 months of culture, it appears that the smoke of marijuana or tobacco accelerates, rather than initiates, the malignant change.

Although no instance of human lung carcinoma attributable solely to marijuana smoking has yet been reported, abnormalities suggestive of cancerous lesions have been recorded. For example, in several of the U.S. servicemen who smoked 50 grams of hashish or more per month and developed upper respiratory disorders, mucosal biopsy showed extensive cellular abnormalities, including loss of cilia, proliferation of basal epithelial cells, and atypical cells (Tennant et al., 1971; Henderson et al., 1972). Comparison of 30 American hashish smokers (25-150 grams/month for 3-24 months; 23 also smoked tobacco and 7 did not), 3 tobacco smokers (1.6 packs/day for 11.3 years) who did not smoke marijuana and 3 nonsmokers of tobacco or hashish, indicated exposure to combined marijuana and tobacco smoke produced more harmful effects than that produced by either substance alone (Tennant et al., 1980). In the hashish smokers who did not smoke tobacco, abnormalities in the tracheal biopsies were no more frequent or severe than in those persons who smoked only tobacco.

Exception has been taken to the idea of an additive effect of tobacco and hashish smoke. A Greek study that compared chronic hashish and tobacco users with tobacco smoking controls found that although the hashish smokers had considerably more throat irritation and cough, the prevalence of bronchitis in both groups was about the same (Boulougouris et al., 1976); no biopsies were taken. The differences between the Greek and American studies may reflect differences between the two populations: The American study, done in Germany, favored inclusion of men with severe respiratory disturbances (Tennant et al., 1980), whereas the Greek study (Boulougouris et al., 1976) appears to have included persons with less severe illness.

The finding of known carcinogens in marijuana smoke and the presence of epithelial abnormalities known to be the precursors of lung cancer in heavy smokers of tobacco suggest the possible development of lung cancer in chronic, heavy users of marijuana and/or hashish after a prolonged period of use, especially if they are also smokers of tobacco. However, evidence to support this hypothesis is not available. Because marijuana smoking is an ancient custom in Asia and the Middle East, lung cancer would be expected to be more prevalent in these parts of the world if a causal relationship did exist. Unfortunately, no reliable data have been gathered to settle this question. Heavy smoking of marijuana, in quantities comparable to that of tobacco, has been relatively uncommon in the United States. Therefore, the contribution of marijuana smoking to the incidence of primary lung cancer cannot yet be answered with any authoritative data.

Summary: Respiratory System

Lung Function and Defense Mechanisms

The most important question about the effects of marijuana on the health of the respiratory system is whether acute or chronic marijuana smoking cause detectable structural or functional impairment of the lungs. Mild but measurable airway obstruction, affecting both large and small airways, can be shown to exist after 6 to 8 weeks of smoking marijuana daily, averaging five marijuana cigarettes a day; this decrement in function is reversible, but does not return to normal within one week of abstaining from smoking.

In persons with histories of heavy smoking, particularly of hashish, chronic inflammatory changes are seen in the bronchi and uvula, often in association with chronic sinusitis. These manifestations of upper respiratory disturbance have been described in individuals with histories of marijuana smoking usually in excess of 3 years and are reversible when marijuana smoking is stopped.

Acute exposure of alveolar macrophages in vitro to marijuana smoke causes a reduction in phagocytic activity, a cell defense mechanism. The agents responsible for this change in macrophage function are in the vapor phase of marijuana smoke and are not related to the presence of Δ-9-THC. Also, lung explants exposed to marijuana smoke in vitro show changes in the chromosomal structure of nuclei.

There is as yet no information about the effects of prolonged smoking of marijuana, that is, beyond 5 years. Although some populations have been examined for the effects of chronic marijuana smoking, controlled studies are sparse and populations exposed to marijuana smoke only—without exposure to tobacco—apparently are not available. Particularly conspicuous is the lack of information about the effect of chronic marijuana smoking begun in late childhood or adolescence and continued to adulthood. Such studies would require morphological examination of biopsy material from the bronchi and respiratory passages to determine the presence of structural changes that indicate the development of chronic bronchitis and/or lung cancer. Morphological changes associated with smoking marijuana could be compared with the morphological abnormalities associated with chronic tobacco smoking.

The acute response to inhalation of marijuana is an appreciable bronchodilation, both in normal subjects and in individuals with bronchial asthma. However, the bronchodilator effects of marijuana are a response to acute exposure; chronic exposure usually evokes bronchoconstriction.

With respect to therapeutic application, the effects of smoking marijuana in producing bronchial dilatation do not exceed those that follow the inhalation of beta-agonist drugs. Moreover, the doses required for bronchodilatation usually elicit the psychotropic effects of marijuana and may be associated with changes in the structure of bronchial and parenchymal lung cells, the significance of which remains to be assessed. For these reasons therapeutic usefulness as a bronchodilator drug is open to serious question (see Chapter 7).

Carcinoma of the Lung

One of the great uncertainties about marijuana smoking is its neoplastic potential. No reliable data are available concerning the incidence of carcinoma of the lungs and upper respiratory passages in long-term users of cannabis.

But a variety of experimental studies has sounded the alert that marijuana smoking--just as tobacco smoking--may be carcinogenic and that a combination of tobacco and marijuana smoke may have greater neoplastic potential than either one alone. Although the experimental observations have raised the suspicion, long-term observations on human subjects--and possibly on smoking animals--will be necessary to settle the issue.

Recommendations for Research

Lung Function and Defense Mechanisms

With respect to the performance and defenses of the lungs, these studies would be informative:

- the physiological, biochemical, and morphological interactions of combined exposures of the respiratory tract to tobacco and marijuana smoke;
- the interactions of cannabis and alcohol on the function of the respiratory tract;
- the long-term effects, i.e., 10 to 30 years, of exposure of the respiratory tract to frequent use of cannabis in the absence and pressure of exposure to tobacco smoke (for this purpose, large-scale epidemiological studies may be required);
- the physiological effects and clinical consequences of exposure of alveolar macrophages and other lung cells to long-term exposure to marijuana smoke;
- the immunologic effects of marijuana smoke exposure on cells and on the entire body.

Carcinoma of the Lung

With respect to carcinoma of the lung, these studies seem essential:

- an epidemiological survey to determine over the next 20 to 30 years if there will be an increased incidence of primary lung, laryngeal, oropharyngeal, esophageal, nasal, or sinus cancer in chronic marijuana smokers;
- epidemiologic and pathological studies in humans and experimental studies in animals to evaluate the carcinogenic potential of chronic marijuana smoking on the lung, larynx, oropharynx, nasal, and sinus epithelium.

CARDIOVASCULAR SYSTEM

Normal Heart and Circulation

Heart (Direct Effects)

With respect to the heart and circulation, the most evident effect in human beings of smoking marijuana, or of ingesting the active ingredient (Δ-9-THC), is a brisk increase in heart rate (tachycardia). Although this is not threatening to the normal heart, the rapid heart action can be harmful to the heart in which the circulation is compromised by atherosclerosis or is on the verge of failing.

The responses of the cardiovascular system to acute exposure to marijuana differ between human beings and most other mammals in that the human subject typically responds with an increase in heart rate (Bright et al., 1971; Beaconsfield et al., 1972; Perez-Reyes et al., 1973), whereas most mammals show a slowing in rate (bradycardia) (Cavero et al., 1973; Graham and Li, 1973; Rosenkrantz and Braude, 1974; Vollmer et al., 1974; Adams et al., 1976; Hardman and Hosko, 1976; Kawasaki et al., 1980). Human blood pressure usually increases moderately on acute administration of Δ-9-THC, but in monkeys and dogs acute administration is followed by a decrease in systemic arterial pressure. Typical effects on heart rate and blood pressure have been attributed to altered autonomic function (Loewe, 1944; Joachimoglu, 1965; Ames, 1968; Gill and Paton, 1970).

Effects on the cardiovascular system are to some extent a function of dose, route of administration, and duration of exposure. Tolerance to some of the cardiovascular effects in human beings develops with chronic use (Benowitz and Jones, 1975, 1977a,b; Nowlan and Cohen, 1977), but continued use does not result in any persistent alteration in cardiovascular function after cessation of exposure (Dornbush and Kokkevi, 1976).

<u>Effects on Heart Rate</u> In healthy young adults, acute administration of marijuana by smoking (10 mg total dose) causes a prompt increase in heart rate (increasing by up to 90 beats/minute) for about 1 hour.

The change in heart rate caused by Δ-9-THC appears to result from alterations in both sympathetic and parasympathetic efferent activity to the normal cardiac pacemaker (Beaconsfield et al., 1972; Martz et al., 1972; Sulkowski et al., 1977). The results of studies designed to determine whether beta-adrenergic stimulation is responsible for the tachycardia have not been consistent: In one series of reports, prior administration of propranolol,* in a dose sufficient to block the heart's beta-adrenergic receptors, prevented the increase in heart rate (Bright et al., 1971; Beaconsfield et al., 1972; Perez-Reyes et al., 1973), whereas in other reports, propranolol failed to block the marijuana-induced tachycardia (Kanakis et al., 1976; Tashkin et al., 1978). Although part of the discrepancy may be attributable to differences in dosages, not all of it can be rationalized this way, leaving an unexplained disparity.

Hemodynamic Effects Effects of marijuana on blood pressure and cardiac output, as mentioned above, are a function of the nature of exposure (acute or chronic), of the dose, and of the body position; also, there are differences among human beings and a number of mammalian species. In human beings lying supine, acute exposure to Δ-9-THC typically causes a modest increase in blood pressure, although in some instances no significant change in pressure has been observed (Beaconsfield et al., 1972; Kanakis et al., 1976; Benowitz et al., 1979). On assuming the upright posture, blood pressure may drop considerably. Cardiac output, in the supine position following an injection of Δ-9-THC, has been found to increase by as much as 30 percent (Malit et al., 1975; Tashkin et al., 1977b). The increase in cardiac output in the face of only a modest increase in blood pressure clearly results in a substantial decrease in peripheral vascular resistance. The change in resistance varies among the different vascular beds, being greatest in the vessels to the skeletal muscles.

Chronic administration of quite large oral doses of Δ-9-THC exerts different effects (than the acute) on the circulation (Bernstein et al., 1974; Benowitz and Jones, 1975; Benowitz et al., 1979). Systolic and diastolic pressure usually fall slightly, but these changes are not always sustained. As the blood pressure falls, the heart rate slows from the high levels caused by initial marijuana administration. The decrease in blood pressure can be accentuated if the subject assumes an upright posture. The extent to which it drops appears to be a reciprocal function of the extent to which plasma volume has increased.

Effects on Heart Muscle Data about changes in human left ventricular function caused by marijuana are not entirely convincing because most studies have relied on noninvasive measurements and

*Propranolol is an agent that blocks beta-adrenergic neurotransmitters and is used in treatment of cardiac arrhythmias.

because it has not been possible to control separately the several variables that modify left ventricular function and are changed by administration of Δ-9-THC. Changes in heart rate, afterload (systemic vascular resistance, blood pressure), or preload (plasma volume, venous return) individually can cause changes in heart size and ventricular performance. In spite of these limitations, conclusions can be drawn from the observations on human beings. Definitive animal studies of Δ-9-THC effects on ventricular performance have not been done.

Indices of cardiac performance usually improve after marijuana or Δ-9-THC. Almost invariably this improvement can be attributed to the increase in heart rate (Gash et al., 1978). The acute administration of Δ-9-THC (25 μg/kg intravenously) to healthy young males elicits, in association with the increase in heart rate, changes in the ventricular contraction periods (an increase in ejection time and shortening of the preinjection period), while systemic arterial pressure is unaffected (Weiss et al., 1972; Kanakis et al., 1976). Beta-adrenergic blockade by propranolol is followed by less striking changes in the contraction time intervals. Another study of 17 subjects who smoked two to three cigarettes (20 mg Δ-9-THC per cigarette) found cardiac output increased by 28 percent and heart rate by 30 percent, in conjunction with a slight decrease in stroke volume, which affects pulse pressure (Tashkin et al., 1977b).

Autonomic Nervous System

Marijuana could influence autonomic function in several ways: (1) by changing the sensitivity of reflexes that influence and control cardiovascular function; this effect could result either from changes in the processing of nerve impulses in the central nervous system or autonomic ganglia (a group of nerve cells outside the central nervous system), from changes in the liberation or metabolism of transmitters at the autonomic nerve terminals, or from changes in the sensitivity of the pre- or postjunctional receptors; (2) by a change in the levels of neurotransmitters, the catecholamines (norepinephrine, epinephrine) in the blood as a result of actions on the adrenal medulla, which secretes these neurotransmitters; activation of the adrenals could be a direct effect or by reflexes or by a central action of Δ-9-THC; and (3) by exerting effects on dopamine activity (an intermediate product in the synthesis of norepinephrine) either in the central nervous system or periphery.

Unfortunately, it is unclear how the effects of Δ-9-THC are exerted on the autonomic nervous system (Truitt and Anderson, 1971; Beaconsfield et al., 1972; Weiss et al., 1972; Englert et al., 1973; Ho et al., 1973; Howes and Osgood, 1974; Ho and Johnson, 1976; Huot, 1976; Benowitz and Jones, 1977a,b; Gash et al., 1978; Stefanis, 1978). The data are insufficient to determine if the effects come by way of the central nervous system, or by peripheral neural structures, or by the adrenal medulla. It is also difficult to assess the role of reflex adjustments in the heart and systemic circulation. Finally, other possibilities, such as desensitization or blockade of peripheral adrenergic receptors, have not been examined.

Although the data on human beings are not adequate to determine how marijuana influences autonomic function, evidence that it does has been obtained. For example, Δ-9-THC appears to reduce a number of autonomic reflexes: After marijuana, the typical changes in heart rate and blood pressure elicited by the Valsalva maneuver (a forced exhalation effort against the closed glottis) are decreased, and so are the reflex circulatory responses to immersion of the hand in cold water (Beaconsfield et al., 1972; Benowitz et al., 1979). However, during chronic administration of Δ-9-THC, no change occurs in the reflex decrease in heart rate caused by infusion of a dose of the vasoconstrictor phenylephrine sufficient to increase the blood pressure (Benowitz and Jones, 1975; Benowitz et al., 1979).

Exercise

Acute exposure to Δ-9-THC modifies exercise performance by human beings. Smoking (20 mg of Δ-9-THC) decreased the duration of exercise but caused no change in any cardiopulmonary parameter at any work load except for heart rate, which increased (Shapiro et al., 1976b).

Other Effects (Plasma Volume, Sodium Retention)

Acute administration of Δ-9-THC would not be expected to have prominent effects on sodium balance or plasma volume. Chronic administration, on the other hand, has distinct effects. With chronic ingestion of large doses of Δ-9-THC there is a consistent gain in body weight and plasma volume, the latter caused by sodium retention (Benowitz and Jones, 1975, 1977a,b). The change in plasma volume seems to be causally related to the decrease in orthostatic hypotension during chronic exposure. The mechanisms responsible for the retention of salt and water have not been explored and may include changes in renal perfusion, inhibition of prostaglandin (a substance that affects blood pressure) synthesis by Δ-9-THC (Burstein and Raz, 1972; Howes and Osgood, 1976), or some modification in pituitary-adrenal function (Birmingham and Bartova, 1976).

Abnormal Heart and Circulation

Although smoking marijuana or the introduction of Δ-9-THC into the body is apparently without deleterious effect on the normal heart and circulation, the possibility is great that the abnormal heart and circulation will not be as tolerant of an agent that speeds up the heart, sometimes unpredictably raises or drops the blood pressure, and modifies the activities of the autonomic nervous system. Therefore, it is pertinent to examine the prospects that marijuana (or Δ-9-THC) may be harmful in individuals with coronary heart disease, cerebrovascular disease, hypertension, and heart failure. Moreover, it may be important to determine if Δ-9-THC interacts in its effects on the abnormal heart or circulation with other agents that are being administered for therapeutic purposes.

Coronary Heart Disease

Data on this topic are sparse, presumably because of the relatively short time that marijuana has been available in this country. Those who have smoked marijuana are just entering the age when coronary atherosclerosis is common. However, it has been shown both in normal individuals and in individuals with coronary artery disease that the acute administration of Δ-9-THC by smoking or injection can cause changes in the electrocardiogram (ECG) (Johnson and Domino, 1971; Beaconsfield et al., 1972; Kochar and Hosko, 1973). Premature beats have also been noted. The reasons for the changes are unclear. Also not understood is the contribution of the increase in heart rate itself to the ECG changes and to the premature beats.

In some patients with coronary artery disease, increased catecholamines can induce arrhythmias. It seems likely that in such patients Δ-9-THC could have the same effect. Also, in patients with coronary artery disease a large increase in heart rate can induce angina (pain) and even ischemic damage from insufficient oxygen as a result of an obstructed blood vessel. If Δ-9-THC were to increase heart rate markedly in such patients, and at the same time increase the need for cardiac perfusion because of the increased cardiac work and because of the intensified effect of catecholamines on the heart, it seems reasonable that there could be induction of angina and potentially precipitation of ischemic damage. Furthermore, if Δ-9-THC dulled the appreciation of pain and the appropriate responses to pain, the patient might not take suitable measure to relieve the angina, thereby increasing the risk of damage or arrhythmias.

A decrease in oxygen-carrying capacity of blood because of formation of carboxyhemoglobin could also be troublesome. Exercise tolerance has been reported to decrease in individuals with angina after smoking marijuana; this decrease is in contrast to the unaffected exercise tolerance after smoking a placebo marijuana cigarette (Aronow and Cassidy, 1974). Oral ingestion of Δ-9-THC or smoking marijuana apparently can cause marked hypertension in association with an increase in systemic vascular resistance (Benowitz et al., 1979), which would place the heart with coronary artery disease at risk of damage.

These observations concur in indicating that marijuana and Δ-9-THC increase the work of the heart, often in many ways. The conclusion seems inescapable that this increased work, coupled with stimulation by catecholamines, may tax the heart to the point of clinical hazard.

Cerebrovascular Disease

There are few, if any, indications that Δ-9-THC has direct effects on the cerebral circulation that would be important in patients with cerebrovascular disease. In the occasional patient who develops hypertension after smoking, there would be an increased risk of a cerebral vascular accident (stroke). Also, because Δ-9-THC administered after atropine can cause marked increases in blood pressure, this combination would place the patient with cerebrovascular disease at risk, as would smoking after ingestion of other muscarinic blockers. In some patients, postural hypotension could be a problem, not only for persons with abnormal cerebral circulations, but also with abnormal coronary circulations.

Hypertension

The factors that act to intensify angina would be of importance in hypertensive patients. Although data are lacking on the magnitude of change in blood pressure caused by Δ-9-THC in hypertensives, it seems reasonable to assume that hypertensives smoking marijuana might have a greater increase in blood pressure than normals do. The increase in plasma volume and sodium retention that are associated with chronic exposure to Δ-9-THC could increase blood pressure in hypertensives and the mechanisms responsible for these changes very likely would interfere with the action of a number of antihypertensive medications.

Heart Failure

Because marijuana can cause tachycardia, a decrease in systemic vascular resistance (required for increased cardiac output to sustain blood pressure) and salt and water retention might place patients with severe heart failure at a disadvantage by exposure to Δ-9-THC. Data on such patients are lacking. In older patients treated by Δ-9-THC or who have smoked marijuana for glaucoma or cancer, orthostatic hypotension has been both disabling and a threat of cardiovascular complications (Merritt et al., 1980). However, tolerance to orthostatic hypotension seems to develop during continued intake of Δ-9-THC or continued smoking of marijuana. Dehydration, as during vomiting or diuretic therapy, predisposes to the orthostatic hypotensive effects and resists the development of tolerance because it prevents expansion of blood volume.

Interactions with Cardioactive Drugs

Few studies evaluate interactions between Δ-9-THC and other drugs that act directly or indirectly on the heart. Propranolol usually attenuates the increase in heart rate caused by Δ-9-THC. Atropine can greatly potentiate the ability of Δ-9-THC to increase systemic arterial pressure (Benowitz and Jones, 1977a,b). A number of possible interactions can be imagined. If a patient were taking a drug that blocked uptake of catecholamines by nerve terminals, then those effects of Δ-9-THC that are mediated by catecholamines would be intensified. Because a great many psychotropic and antihypertensive drugs modify metabolism of neurotransmitters in the central nervous system and periphery, a wide variety of interactions with Δ-9-THC seems possible.

Summary: Cardiovascular System

The smoking of marijuana causes changes in the heart and circulation that are characteristic of stress. But there is no evidence to indicate that it exerts a permanently deleterious effect on the normal cardiovascular system. Neither is there convincing evidence that marijuana would be of particular benefit in treating any of the major forms of cardiovascular disease.

The situation is quite different for those with an abnormal heart or circulation. Evidence abounds that marijuana increases the work of the heart, usually by increasing heart rate, and in some persons by increasing blood pressure. This increase in workload poses a threat to patients with hypertension, cerebrovascular disease, and coronary atherosclerosis. The magnitude and incidence of the threat remains to be determined because marijuana smoking has largely been confined to younger adults who are only now entering the age of serious complications of atherosclerosis on the heart, brain, and peripheral vessels.

Marijuana also can cause postural hypotension. This drop in blood pressure could be hazardous in those individuals with compromised blood flow to the heart or brain, especially if they are volume-depleted (dehydrated) or if other drugs have impaired reflex control of their blood vessels.

Marijuana appears to intensify the effects of the sympathetic nervous system on the heart, an undesirable consequence in patients with coronary artery disease and in those susceptible to arrhythmias. Many of the undesirable effects of marijuana on the cardiovascular system seem to become less severe following chronic exposure. Whether the relative paucity of reports of the ill-effects of marijuana on the abnormal cardiovascular system is a consequence of adaptation to chronic usage or to lack of exposure to marijuana of a population that is sufficiently advanced in years to be susceptible to its untoward effects remains to be determined.

Recommendations for Research

Additional studies are needed both (1) to provide information on the mechanisms responsible for the observed effects of marijuana on the cardiovascular system and (2) to provide new data on the effects of marijuana in patients with known forms of cardiovascular disease.

• The manner in which Δ-9-THC acts on the heart to change the rate and force of contraction needs clarification. Direct effects on the heart are not likely to differ among species, and thus experiments can be planned for a "standard" heart preparation.

• Direct effects on electrical activity, which might relate to reports of changes in electrical activity and production of premature impulses as well as changes in sinus rate, should be evaluated with standard methods and standard preparations.

• Direct effects of Δ-9-THC on vascular smooth muscle should be explored. For this purpose, it would be essential to use some vessels that did, and others that did not, have functioning nerve terminals. It would be important here to include studies on selected coronary vessels and on vessels which play a dominant role in the regulation of systemic vascular resistance.

• A number of related studies are needed before the effects on humans can be explained in full, particularly the effects of Δ-9-THC on the renin-angiotensin system in the kidney, which provides control of arterial pressure, and on the several sequences of prostaglandin metabolism.

Studies also are indicated to obtain new data about the effects of marijuana on:

• persons with hypertension, coronary artery disease, and cerebrovascular disease;

• increases in systemic arterial pressure in low- and high-renin hypertension and the interactions between Δ-9-THC and several classes of antihypertensive medications;

• the interactions between the salt and water-retaining effect of Δ-9-THC and diuretics that could be employed both in hypertensives and those with heart failure.

Additionally, studies should be done on the use of standard monitoring techniques to quantify any effect of marijuana smoking on tendencies toward arrhythmias, and on interactions of Δ-9-THC with drugs that modify synaptic transmission in the central nervous system.

REFERENCES

Adams, M.D., Earnhardt, J.T., Dewey, W.L., and Harris, L.S. Vasoconstrictor actions of Δ-8- and Δ-9-tetrahydrocannabinol in the rat. J. Pharmacol. Exp. Ther. 196:649-656, 1976.

Ames, F. A clinical and metabolic study of acute intoxication with cannabis sativa and its role in the model psychoses. J. Ment. Sci. 104:972-999, 1968.

Aronow, W.S. and Cassidy, J. Effect of marihuana and placebo-marihuana smoking on angina pectoris. N. Engl. J. Med. 291:65-67, 1974.

Auerbach, O., Stout, A.P., Hammond, E.C., and Garfinkel, L. Changes in bronchial epithelium relation to cigarette smoking and in relation to lung cancer. N. Engl. J. Med. 265:253-267, 1961.

Beaconsfield, P., Ginsburg, J., and Rainsbury, R. Marihuana smoking: Cardiovascular effects in man and possible mechanisms. N. Engl. J. Med. 287:209-212, 1972.

Bellville, J.W., Swanson, G.D., and Aqleh, K.A. Respiratory effects of Δ-9-tetrahydrocannabinol. Clin. Pharmacol. Ther. 17:541-548, 1975.

Benowitz, N.L. and Jones, R.T. Cardiovascular effects of prolonged Δ-9-tetrahydrocannabinol ingestion. Clin. Pharmacol. Ther. 18:287-297, 1975.

Benowitz, N.L. and Jones, R.T. Effects of Δ-9-tetrahydrocannabinol on drug distribution and metabolism. Clin. Pharmacol. Ther. 22:259-268, 1977a.

Benowitz, N.L. and Jones, R.T. Prolonged Δ-9-tetrahydrocannabinol ingestion: Effects of sympathomimetic amines and autonomic blockades. Clin. Pharmacol. Ther. 21:336-342, 1977b.

Benowitz, N.L., Rosenberg, J., Rogers, W., et al. Cardiovascular effects of intravenous Δ-9-tetrahydrocannabinol: Autonomic nervous mechanisms. Clin. Pharmacol. Ther. 25:440-446, 1979.

Bernstein, J.G., Becker, D., Babor, T.F., and Mendelson, J.H. Physiological assessments: Cardiopulmonary function, pp. 147-160. In Mendelson, J.H., Rossi, A.M., and Meyers, R.E. (eds.) The Use of Marijuana: A Psychological and Physiological Inquiry. New York: Plenum Press, 1974.

Birmingham, M.K. and Bartova, A. Effects of cannabinol derivatives on blood pressure, body weight, pituitary-adrenal function, and mitochondrial respiration in the rat, pp. 425-438. In Nahas, G.G. (ed.) Marihuana: Chemistry, Biochemistry, and Cellular Effects. New York: Springer-Verlag, 1976.

Boulougouris, J.C., Panayiotopoulos, C.P., Antypas, E., et al. Effect of chronic hashish use on medical status in 44 users compared with 38 controls. Ann. N.Y. Acad. Sci. 282:168-172, 1976.

Bright, T.P., Kiplinger, G.F., Brown, D., et al. Effects of beta-adrenergic blockade on marihuana-induced tachycardia, pp. 1737-1744. In Report of the 33rd Annual Scientific Meeting of the Committee on Problems of Drug Dependence. Vol. 2. Washington, D.C.: National Academy of Sciences, 1971.

Burstein, S. and Raz, A. Inhibition of prostaglandin E_2 biosynthesis by Δ-1-tetrahydrocannabinol. Prostaglandins 2:369-374, 1972.

Busch, F.W., Seid, D.A., and Wei, E.T. Mutagenic activity of marihuana smoke condensates. Cancer Lett. 6:319-324, 1979.

Cavero, I., Buckley, J.P., and Jandhyala, B.S. Parasympatholytic activity of (-)-delta-9-transtetrahydrocannabinol in mongrel dogs. Eur. J. Pharmacol. 19:301-304, 1972.

Cavero, I., Solomon, T., Buckley, J.P., and Jandhyala, B.S. Studies on the bradycardia induced by (-)-Δ-9-transtetrahydrocannabinol in anesthetized dogs. Eur. J. Pharmacol. 22:263-269, 1973.

Dornbush, R.L. and Kokkevi, A. Acute effects of cannabis on cognitive, perceptual, and motor performance in chronic hashish users. Ann. N.Y. Acad. Sci. 282:313-322, 1976.

Drath, D.B., Shorey, J.M., Price, L., and Huber, G.L. Metabolic and functional characteristics of alveolar macrophages recovered from rats exposed to marijuana smoke. Infec. Immun. 25:26(-272, 1979.

Englert, L.F., Ho, B.T., and Taylor, D. The effects of (-)-Δ-9-tetrahydrocannabinol on reserpine induced hypothermia in rats. Br. J. Pharmacol. 49:243-252, 1973.

Fleischman, R.W., Baker, J.R., and Rosenkrantz, H. Pulmonary pathologic changes in rats exposed to marihuana smoke for 1 year. Toxicol. Appl. Pharmacol. 47:557-566, 1979.

Gash, A., Karliner, J.S., Janowsky, D., and Lake, C.R. Effects of smoking marihuana on left ventricular performance and plasma norepinephrine: Studies in normal men. Ann. Intern. Med. 89:448-452, 1978.

Gill, E.W. and Paton, W.D.M. Pharmacological experiments in vitro on the active principles of cannabis, pp. 165-173. In Joyce, C.R.B., Curry, S.H., London, J., and Churchill, A. The Botany and Chemistry of Cannabis, 1970.

Glatt, H., Ohlsson, A., Agurell, S., and Oesch, F. Δ-1-tetrahydrocannabinol and 1-alpha, 2-alpha-epoxyhexahydrocannabinol: Mutagenicity investigation in the Ames test. Mutat. Res. 66:329-335, 1979.

Graham, J.D.P. and Li, D.M.F. Cardiovascular and respiratory effects of cannabis in cat and rat. Br. J. Pharmacol. 49:1-10, 1973.

Hall, J.A.S. Testimony in Marihuana-Hashish Epidemic Hearing of the Committee of the Judiciary U.S. Senate. Washington, D.C.: U.S. Government Printing Office, 1975.

Hardman, H.F. and Hosko, M.J. An overview of the cardiovascular-autonomic action of cannabis, pp. 231-238. In Braude, M.C. and Szara, S. (eds.) Pharmacology of Marihuana. New York: Raven Press, 1976.

Henderson, R.L., Tennant, F.S., and Guerry, R. Respiratory manifestations of hashish smoking. Arch. Otolaryngol. 95:248-251, 1972.

Hernandez-Bolanos, J., Swenson, E.W., and Coggins, W.J. Preservation of pulmonary function in regular, heavy, long-term marijuana smokers. Am. Rev. Resp. Dis. 113 (Suppl.):100, 1976.

Ho, B.T., Taylor, D., and Englert, L.F. The effect of repeated administration of (-)-Δ-9-tetrahydrocannabinol on the biosynthesis of brain amines. Res. Commun. Chem. Pathol. Pharmacol. 5:851-854, 1973.

Ho, B.T. and Johnson, K.M. Sites of neurochemical action of Δ-9-tetrahydrocannabinol: Interaction with reserpine, pp. 367-382. In Nahas, G.G. (ed.) Marihuana: Chemistry, Biochemistry, and Cellular Effects. New York: Springer-Verlag, 1976.

Hoffmann, D., Brunnemann, K.D., Gori, G.B., and Wynder, E.L. On the carcinogenicity of marijuana smoke, pp. 63-81. In Runeckles, V.C. (ed.) Recent Advances in Phytochemistry New York: Plenum Publishing Corporation, 1975.

Howes, J. and Osgood, P. The effect of Δ-9-tetrahydrocannabinol on the uptake and release of ^{14}C-dopamine from crude striatal synaptosomal preparations. Neuropharmacology 13:1109-1114, 1974.

Howes, J.F. and Osgood, P.F. Cannabinoids and the inhibition of prostaglandin synthesis, pp. 415-424. In Nahas, G.G. (ed.) Marihuana: Chemistry, Biochemistry, and Cellular Effects. New York: Springer-Verlag, 1976.

Huber, G.L., Simmons, G.A., McCarthy, C.R., et al. Depressant effect of marihuana smoke on antibactericidal activity of pulmonary alveolar macrophages. Chest 68:769-773, 1975.

Huber, G.L., Pochay, V.E., Shea, J.W., et al. An experimental animal model for quantifying the biologic effects of marijuana on the defense system of the lung, pp. 301-328. In Nahas, G.G. and Paton, W.D.M. (eds.) Marihuana: Biological Effects. Analysis, Metabolism, Cellular Responses, Reproduction and Brain. Oxford: Pergamon Press, 1979a.

Huber, G.L., Shea, J.W., Hinds, W.E., et al. The gas phase of marijuana smoke and intrapulmonary bactericidal defenses. Bull. Eur. Physiopath. Resp. 15:491-503, 1979b.

Huber, G.L., Pochay, V.E., Pereira, W., et al. Marijuana, tetrahydrocannabinol, and pulmonary antibacterial defenses. Chest 77:403-410, 1980.

Huot, J. Cellular and biochemical alterations induced in vitro by delta-1-tetrahydrocannabinol: Effects on cell proliferation, nucleic acids, plasma cell membrane ATPase, and adenylate cyclase, pp. 313-327. In Nahas, G.G. (ed.) Marihuana: Chemistry, Biochemistry, and Cellular Effects. New York: Springer-Verlag, 1976.

Joachimoglu, G. Natural and smoked hashish, pp. 2-14. In Wolstenholme, G.E.W., Knight, J., London, J., and Churchill, A. Hashish: Its Chemistry and Pharmacology (CIBA Foundation Study Group 21), 1965.

Johnson, S. and Domino, E.F. Some cardiovascular effects of marihuana smoking in normal volunteers. Clin. Pharmacol. Ther. 12:762-768, 1971.

Kanakis, C.J., Pouget, J.M., and Rosen, K.M. The effects of Δ-9-tetrahydrocannabinol (cannabis) on cardiac performance with and without beta blockage. Circulation 53:703-707, 1976.

Kawasaki, H., Watanabe, S., Oishi, R., and Ueki, S. Effects of Δ-9-tetrahydrocannabinol on the cardiovascular system, and pressor and behavioral responses to brain stimulation in rats. Jpn. J. Pharmacol. 30:493-502, 1980.

Kochar, M.S. and Hosko, M.J. Electrocardiographic effects of marihuana. JAMA 225:25-27, 1973.

Leuchtenberger, C. and Leuchtenberger, R. Morphological and cytochemical effects of marijuana cigarette smoke on epithelioid cells of lung explants from mice. Nature 234:227-229, 1971.

Leuchtenberger, C., Leuchtenberger, R., and Schneider, A. Effects of marijuana and tobacco smoke on human lung physiology. Nature 241:137-139, 1973a.

Leuchtenberger, C., Leuchtengerger, R., Ritter, U., and Inui, N. Effects of marijuana and tobacco smoke on DNA and chromosomal complement in human lung explants. Nature 242:403-404, 1973b.

Leuchtenberger, C. and Leuchtenberger, R. Cytological and cytochemical studies of the effect of fresh marijuana cigarette smoke on growth and DNA metabolism of animal and human lung cultures, pp. 595-612. In Braude, M.C. and Szara, S. (eds.) Pharmacology of Marihuana. New York: Raven Press, 1976.

Loewe, S. Pharmacological study, pp. 149-220. In The Marihuana Problem in the City of New York: Sociological, Medical, Psychological and Pharmacological Studies. Lancaster, Pa.: Jacques Cattell Press, 1944.

Malit, L.A., Johnstone, R.E., Bourke, D.I., et al. Intravenous Δ-9-tetrahydrocannabinol: Effects on ventilatory control and cardiovascular dynamics. Anesthesiology 42:666-673, 1975.

Martz, R., Brown, D.J., Forney, R.B., et al. Propranolol antagonism of marihuana induced tachycardia. Life Sci. 11:999-1005, 1972.

Merritt, J.C., Crawford, W.J., Alexander, P.C., et al. Effect of marihuana on intraocular and blood pressure in glaucoma. Ophthalmology 87:222-228, 1980.

Nowlan, R. and Cohen, S. Tolerance to marijuana: Heart rate and subjective "high." Clin. Pharmacol. Ther. 22:550-556, 1977.

Perez-Reyes, M., Lipton, M.A., Timmons, M.C., et al. Pharmacology of orally administered Δ-9-tetrahydrocannabinol. Clin. Pharmacol. Ther. 14:48-55, 1973.

Rosenkrantz, H. and Braude, M.C. Acute, subacute and 23-day chronic marihuana inhalation toxicities in the rat. Toxicol. Appl. Pharmacol. 28:428-441, 1974.

Roy, P.E., Magnan-Lapointe, F., Huy, N.D., and Boutet, M. Chronic inhalation of marijuana and tobacco in dogs: Pulmonary pathology. Res. Commun. Chem. Pathol. Pharmacol. 14:305-317, 1976.

Rubin, V. and Comitas, L. Ganja in Jamaica: A Medical Anthropological Study of Chronic Marijuana Use. The Hague: Mouton and Co., 1975.

Seid, D.A. and Wei, E.T. Mutagenic activity of marihuana smoke condensates. Pharmacologist 21:204, 1979.

Shapiro, B.J., Tashkin, D.P., and Frank, I.M. Mechanism of increased specific airway conductance with marijuana smoking in healthy young men. Ann. Int. Med. 78:832-833, 1973.

Shapiro, B.J., Tashkin, D.P., and Frank, I.M. Effects of beta-adrenergic blockade and muscarinic stimulation upon cannabis bronchodilation, pp. 277-286. In Braude, M.C. and Szara, S. (eds.) Pharmacology of Marihuana. New York: Raven Press, 1976a.

Shapiro, B.J., Reiss, S., Sullivan, S.F., Tashkin, D.P., Simmons, M.S., Smith, R.T. Cardiopulmonary effects of marijuana smoking during exercise. Chest 70:441, 1976b.

Stefanis, C. Biological aspects of cannabis use, pp. 149-178. In Petersen, R.C. (ed.) The National Challenge of Drug Abuse. NIDA Research Monograph No. 19. HEW Publication No. (ADM)78-654. Washington, D.C.: U.S. Government Printing Office, 1978.

Sulkowski, A., Vachon, L., and Rich, E.S., Jr. Propranolol effects on acute marihuana intoxication in man. Psychopharmacology 52:47-53, 1977.

Tashkin, D.P., Shapiro, B.J., and Frank, I.M. Acute pulmonary physiologic effects of smoked marijuana and oral Δ-9-tetrahydrocannabinol in healthy young men. N. Engl. J. Med. 289:336-341, 1973.

Tashkin, D.P., Shapiro, B.J., and Frank, I.M. Acute effects of smoked marijuana and oral Δ-9-tetrahydrocannabinol on specific airway conductance in asthmatic subjects. Am. Rev. Respir. Dis. 109:420-428, 1974.

Tashkin, D.P., Shapiro, B.J., Lee, Y.E., and Harper, C.E. Effects of smoked marijuana in experimentally induced asthma. Am. Rev. Respir. Dis. 112:377-386, 1975.

Tashkin, D.P., Shapiro, B.J., Lee, E.Y., Harper, C.E. Subacute effects of heavy marijuana smoking pulmonary function in healthy young males. N. Engl. J. Med. 294:125-129, 1976.

Tashkin, D.P., Reiss, S., Shapiro, B.J., et al. Bronchial effects of aerosolized -9-tetrahydrocannabinol in healthy and asthmatic subjects. Am. Rev. Respir. Dis. 115:57-65, 1977a.

Tashkin, D.P., Levisman, J.A., and Abbasi, A.S. Short-term effects of smoked marihuana on left ventricular function in man. Chest 72:20-26, 1977b.

Tashkin, D.P., Soares, J.R., Hepler, R.S., Shapiro, B.J., and Rachelefsky, G.S. Cannabis, 1977. Ann. Int. Med. 89:539-549, 1978.

Tashkin, D.P., Calvarese, B.M., Simmons, M.S., and Shapiro, B.J. Respiratory status of seventy-four habitual marijuana smokers. Chest 78:699-706, 1980.

Tennant, F.S., Preble, M., Prendergast, T.J., and Ventry, P. Medical manifestations associated with hashish. JAMA 216:1965-1969, 1971.

Tennant, F.S., Guerry, R.L., and Henderson, R.L. Histopathologic and clinical abnormalities of the respiratory system in chronic hashish smokers. Substance and Alcohol Misuse 1:93-100, 1980.

Truitt, E.B. and Anderson, S.M. Biogenic amine alterations produced in the brain by tetrahydrocannabinols and their metabolites. Ann. N.Y. Acad. Sci. 191:68-73, 1971.

Vachon, L., FitzGerald, M.X., Solliday, N.H., et al. Single-dose effect of marihuana smoke: Bronchial dynamics and respiratory-center sensitivity in normal subjects. N. Engl. J. Med. 288:985-989, 1973.

van Went, G.F. Mutagenicity testing of 3 hallucinogens: LSD, psilocybin and Δ-9-THC, using the micronucleus test. Experientia 34:324-325, 1978.

Vollmer, R.R., Cavero, I., Ertel, R.J., et al. Role of the central automatic nervous system in the hypotension and bradycardia induced by (-)-Δ-9-trans-tetrahydrocannabinol. J. Pharm. Pharmacol. 26:186-192, 1974.

Wehner, F.C., Van Rensburg, S.J., and Thiel, P.G. Mutagenicity of marijuana and transkei tobacco smoke condensates in the salmonella/microsome assay. Mutat. Res. 77:135-142, 1980.

Weil, A.T., Zinberg, N.E., and Nelsen, J.M. Clinical and psychological effects of marihuana in man. Science 162:1234-1242, 1968.

Weiss, J.L., Watanabe, A.M., Lemberger, L., et al. Cardiovascular effects of Δ-9-tetrahydrocannabinol in man. Clin. Pharmacol. Ther. 13:671-684, 1972.

Zwillich, C.W., Doekel, R., Hammill, S., and Weil, J.V. The effects of smoked marijuana on metabolism and respiratory control. Am. Rev. Respir. Dis. 118:885-891, 1978.

4

EFFECTS OF MARIJUANA ON THE BRAIN

The most clearly established effects of cannabis are upon behavior. These effects, described in Chapter 6, indicate that major actions of cannabinoids are upon the brain. The ways in which marijuana alters the brain to produce its behavioral effects are not known.

Efforts to discover the causes of the behavioral effects have included studies on brain morphology, physiology, and chemistry to be reviewed in this chapter. Effects of marijuana on brain electrical activity and on brain chemistry have been measured, but their significance for brain function is not known because of our limited knowledge of brain-behavior relations. Marijuana causes temporary intoxication and results in changes in brain physiology and chemistry similar to those caused by other intoxicating drugs. Although these kinds of studies may ultimately shed light on the way marijuana produces its behavioral changes, they do not provide answers to important clinical questions. Does marijuana cause long-term changes in the brain that lead to chronic psychiatric or neurological disorders? So far, the studies reviewed below provide no convincing evidence for long-term changes because of use of marijuana.

BRAIN MORPHOLOGY

There is substantial controversy about whether marijuana causes changes in brain structure or in brain cells. Two studies have reported that marijuana produces changes in brain morphology. Both suffer sufficiently from methodologic and interpretational defects that their conclusions cannot be accepted. Furthermore, other studies have not found changes in morphology.

Gross Morphology

Data suggesting that use of marijuana causes brain atrophy were obtained by pneumoencephalography (injection of air into spaces in and surrounding the brain) on 10 users of marijuana who had sought medical attention because of neurologic complaints (Campbell et al., 1971). The size of the largest brain cavities (ventricles) was measured to determine whether loss of brain tissue had occurred. The authors interpreted their data as showing that atrophy was present.

One of the first critics of this report questioned the interpretation of the radiologic techniques used (Bull, 1971). The results also have been seriously criticized because of the marijuana users studied. They had neurological symptoms or signs sufficient to justify an invasive and painful diagnostic test, but there is no evidence that such neurological complaints occur with greater frequency in users of marijuana than in the general population. Further, Campbell's patients did not only use marijuana, but also used such behavior-altering drugs, as lysergic acid diethylamide (LSD) and amphetamines.

More recent evidence has been provided by computed tomography (CT) scans of the brain. This technique, which is noninvasive, painless, and yields more precise and quantifiable measures of brain atrophy, has replaced pneumoencephalography as a diagnostic test. Using CT methods, two studies failed to find evidence of cerebral atrophy in healthy chronic marijuana users (Co et al., 1977; Keuhnle et al., 1977). These latter results suggest that the earlier findings were attributable to the imprecision of conventional pneumoencephalography, or to the fact that a group with neurologic complaints was studied, or to the use of multiple psychoactive drugs by these individuals. This last possibility is reinforced by CT scans of animals who received a variety of psychoactive drugs. Marijuana alone produced no evidence of brain atrophy, whereas other drugs, such as amphetamines, did produce changes (Rumbaugh et al., 1980).

Microscopic Morphology

Three post mortem studies on monkeys in the same laboratory have reported changes in the microscopic morphology of the brain at the ultrastructural level (Harper et al., 1977; Meyers and Heath, 1979; Heath et al., 1980). No similar studies on human beings have been reported. The monkeys received either chronic exposure to marijuana smoke or chronic injections of Δ-9-THC. Changes reported to have occurred in the brains included alteration in synaptic* cleft width, increased density of synaptic cleft material, a decrease in volume of rough endoplasmic reticulum, presence of clumping of synaptic vesicles in axon terminals (where impulses travel away from the cell body), and an increase in intranuclear inclusions. These changes appear dramatic, but they must be interpreted with caution. The three studies are based principally upon examination of two limited brain areas only in three treated monkeys, two receiving marijuana smoke

---

*A synapse is the region of communication between nerve cells, forming the place where a nervous impulse is transmitted from one nerve cell to another.

and one intravenous Δ-9-THC; a fourth treated animal was added to the last study and more brain areas were analyzed in it (Heath et al., 1980). Further, although the material was evaluated "doubleblind" after electron micrographs had been made, it would appear that fixation, tissue preparation, and photography were carried out before these safeguards against bias were applied. It is possible that unknown but systematic differences occurred between experimental (treated) and control animals in fixation and preparation of tissue or in selection of samples for micrography. In addition, it should be noted that at least one of the changes noted, clumping of synaptic vesicles (Harper et al., 1977), is a normal variant in the synaptic morphology of axon terminals in mammalian brain (Sipe and Moore, 1977) and does not represent a pathological change. Also, these studies have not been replicated and, because the basis for interpretation is such a limited sample, it is concluded that no definitive interpretation can be made at this time. However, the possibility that marijuana may produce chronic, ultrastructural changes in brain has not been ruled out and should be investigated.

NEUROPHYSIOLOGY

One source of information on the mechanisms of action of a drug, such as marijuana, is the study of its physiological effects. Effects of marijuana on the electrical activity of the brain have been demonstrated by means of the electroencephalogram (EEG). The standard, or clinical, EEG measures tiny variations at the scalp of voltages produced by the electrical activity of the brain. Voltage differences between two points on the scalp, or between the scalp and an inactive reference site, are recorded on moving paper, producing a graph of voltage over time. The waves observed are classified according to frequencies as delta, theta, alpha, and beta. While the changes in EEG described below are of interest, their biological significance is unknown.

Acute (Short-Term) Effects in Waking EEG

Ingested marijuana or Δ-9-THC produces rather slight effects on the EEG of an awake subject. Relatively high doses (210 mg Δ-9-THC or its equivalent/day) have failed to produce measurable changes even though marked behavioral effects were observed. The EEG effect most frequently reported in recent studies has been an increased abundance of alpha waves associated with a slight slowing (about 0.25 Hz) of the alpha frequency (Rodin et al., 1970; Volavka et al., 1971; Fink, 1976). However, reduced alpha abundance and increased fast frequency activity (beta) have also been reported (Wikler and Lloyd, 1945; Jones and Stone, 1970). Most studies which report EEG changes have noted that tolerance develops with repeated drug administration. No significance with respect to hazard can be inferred from the effects of cannabis on the waking EEG. For a further review of this literature, see Fried (1977).

Persistent Effects in Waking EEG

The occurrence of persistent (long-lasting) changes in EEG with use of marijuana would cause concern even if their significance for brain function was unknown. However, in attempting to investigate the question of whether such changes occur, there inevitably arise crucial issues of subject selection. If one selects only chronic marijuana users who are in good health, one may be eliminating systematically those who have been adversely affected by use of the drug and who might have shown EEG changes. On the other hand, if one includes in such studies marijuana users who suffer from various illnesses or behavioral disturbances, one might find abnormalities of the EEG that result from these conditions rather than from the marijuana.

Long-term use of marijuana, either in the modest doses customarily used in this country or the heavy doses of hashish and ganga used by certain studied populations abroad, has not been shown to produce changes in the EEG. No abnormalities were found in the EEG of 10 healthy students who had smoked marijuana regularly for 1 year (Rodin et al., 1970). Another study compared clinical EEG records of 40 hashish users and 40 matched controls in Greece (Fink, 1976). Each record was evaluated independently by four qualified neurologist-electroencephalographers. No differences were observed in the incidence of abnormal records in the users and controls, a result consistent with the absence of significant differences between the two groups in various tests of neurological function.

Essentially, the same negative results were obtained in studies of ganga users in Jamaica (Rubin and Comitas, 1975) and marijuana users in Costa Rica (Karacan et al., 1976). In these later studies subjects were carefully selected to include only those in good health who were functioning adequately in the community. As mentioned above, this method of selection runs the risk of eliminating subjects whose health or behavior were adversely affected by marijuana and who might have shown EEG changes. This methodological difficulty cannot be eliminated in any small sample investigation of marijuana users.

Acute Effects in Event-Related Potentials

One can employ computer averaging to retrieve from the EEG certain information that is not detectable by visual inspection. In this way, the electrical events that follow a stimulus may be studied in subjects who are at rest, asleep, or carrying out certain tasks. These computer-averaged potentials provide clues to the sequential processing of information by the brain.

Although the literature is inconsistent, it is clear that cannabis can produce effects on event-related potentials (EPs) (Herning et al., 1979). Effects on amplitude are more often reported than effects on latency of the event-related waves. Several studies with inconsistent results have appeared; these inconsistencies result from differences in task, dose, or duration of administration. Thus, EPs in response to sensory stimuli are unaffected or even increased by cannabis if the subject is passive, but are decreased in amplitude if the subject is performing a task. One study found the first negative wave, a component of the auditory EP, was reduced at a dose of 180-210 mg per day, but not at a dose of 70-90 mg per day during acute (1 to 3 days) administration (Herning et al., 1979). After 2 weeks at the higher dosage, this effect was observed only for the more difficult tasks. This study demonstrates differences in marijuana effects on EPs according to dose, duration of administration, and task complexity.

Acute Effects in Sleep EEG

Drugs often produce marked effects on the EEG during sleep, but producing little or no change in the waking EEG. This is the case with marijuana and Δ-9-THC.

In relatively high doses (70-210 mg/day), Δ-9-THC and marijuana extract produced marked effects on sleep EEG (Feinberg et al., 1975, 1976). On initial administration, the time spent in REM sleep* (stage REM duration) was reduced below baseline levels (placebo) by 18 percent and the number of eye movements by 49 percent. Some tolerance (return toward baseline levels) was apparent during the period (12-16 days) of drug administration. On withdrawal, REM duration was increased above baseline by 49 percent and rapid eye movements were increased by 67 percent. While these effects are quite large, their clinical significance is unknown. They were not accompanied by such unusual behavioral changes as hallucinations or disorientation, although there was evidence of withdrawal--irritability, increased reflexes, and mild agitation. With much smaller doses of Δ-9-THC, either a small reduction in REM sleep (Pivik et al., 1972; Freemon, 1974) or no change has been reported (Barratt et al., 1974; Hosko et al., 1973; Pranikoff et al., 1973).

Persistent Effects in Sleep EEG

We are not aware of any investigation of sleep in abstinent long-term marijuana users. However, 32 male chronic marijuana users and matched controls were studied in Costa Rica (Karacan et al., 1976). The users habitually smoked 2.5 to 23.3 cigarettes per day (mean = 9.2) and had used the drug for 10 to 27 years; they continued their usual intake during the study. (Costa Rican cigarettes contain about 200 mg

---

*A stage in sleep during which Rapid Eye Movements may be detected and vivid dreaming usually occurs.

of marijuana). The subjects selected for this study had normal medical, neurologic, and laboratory evaluations.

Sleep was recorded for 8 consecutive nights. Prior to each night's recording, the users described their marijuana intake during the previous 24 hours. This intake was not directly monitored or controlled by the experimenters, because the goal was to observe sleep patterns under "naturalistic" conditions. The subjects were forbidden to use marijuana during the 2-3 hours prior to sleep recording. (For further details of this extensive study, see Karacan et al., 1976.)

All of the major variables derived from visual sleep stage classification were examined. The only statistically significant differences between marijuana users and their matched controls were in one of the sleep latency measures and in REM percentage of total sleep and average REM period length. The differences were quite small and may have been due to the subjects experiencing early withdrawal at the time their sleep was recorded. This is a likely explanation for these findings according to studies described previously (Feinberg et al., 1975, 1976).

The Costa Rican study concluded there was a lack of evidence of major disturbances of EEG sleep patterns in user subjects studied _in situ_ (Karacan et al., 1976). Thus, long-term marijuana use has not been demonstrated to cause marked and consistent abnormalities of sleep EEG that can be demonstrated in studies with small samples.

Electrophysiological Studies in Animals

Sleep Studies

The findings of several animal studies carried out to investigate the effects of marijuana on EEG differ in some respects to those in human beings. Species differences are thought to be responsible for some of the variations found from species to species. For example, 5 and 10 mg/kg Δ-9-THC administered acutely to rats suppressed REM, reduced slow-wave sleep, and increased wakefulness (Moreton and Davis, 1973). Chronic administration caused an initial suppression of REM, which returned to baseline after 4 days and remained at baseline levels for a further 16 days. In contrast to the human studies, there was no withdrawal increase in REM above baseline during a 10-day withdrawal period. Similar results were obtained in a short-term study that employed intravenous doses of Δ-9-THC (0.5 and 1.0 mg/kg) to rabbits (Fujuimori and Himwich, 1973).

Appreciable qualitative differences in sleep EEG response to Δ-9-THC have also been detected in primates when compared with human studies. When 1.2 mg/kg Δ-9-THC is administered to squirrel monkeys in a single oral dose, daily for 60 days, no significant effects on REM sleep duration occurred; instead, a decrease in EEG stages 3 and 4 was noted (Adams and Barratt, 1975).

EEG Studies in Subcortical Structures

Electrode implantation is rarely possible in man, but is a routine and essential technique for the study of brain electrophysiology in animals. Animal experiments also permit use of higher doses and more prolonged administration than is possible with human subjects. For these reasons, animal experiments can yield important data that cannot be obtained in human studies. In general, EEG recordings after short-term administration of marijuana are similar from surface (cortex) or from deep brain (subcortex) regions. However, after chronic administration of high doses of Δ-9-THC, abnormal recordings have been observed in subcortical regions of some animals, readings not seen in the cortex. Although these findings have not been replicated, they are of particular concern, because they raise the possibility that chronic exposure to high doses of marijuana produces long-lasting effects on brain physiology.

After intravenous administration of a range of Δ-9-THC doses (from 0.05 to 12.8 mg/kg) to rhesus monkeys, a general increase in EEG synchrony was observed; and at higher dose ranges, there were specific EEG changes in the limbic system, frontal cortex, thalamus and fastigial nuclei (Martinez et al., 1972). In this study, the increase in high-voltage activity showed a good dose-response relationship. In a second study, oral dosing of three rhesus monkeys with a crude marijuana extract containing 25 percent Δ-9-THC produced dose-related EEG changes, including slow waves in the hippocampus, amygdala, and septum (Stadnicki et al., 1974). Tolerance to the behavioral and EEG changes occurred with daily treatment, which was stopped after 51 days. Behavioral withdrawal effects were noted, but EEG changes during withdrawal were minimal and there was no evidence of EEG changes persisting beyond the period of Δ-9-THC ingestion.

Two studies that monitored EEG recording from deep brain sites after chronic administration of high doses of marijuana found changes in EEGs from deep brain sites that were not observed in surface areas after drug withdrawal (Fehr et al., 1976; Heath, 1976; Heath et al., 1979). Studies of two rats with electrodes implanted in the anterior neocortex, dorsal hippocampus, and mesencephalic reticular formation 1 year after exposure to 20 mg/kg for 6 months (Fehr et al., 1976) yielded hippocampal recordings with "epileptiform" abnormalities, in contrast to one control and two alcohol-treated animals.

The second study was carried out on thirteen feral-raised rhesus monkeys (Heath 1976; Heath et al., 1979). Ten monkeys had electrodes implanted in deep sites and in brain cortex. Four monkeys were made to smoke marijuana three times a day, 5 days per week for 6 months; two other monkeys with implants were given 0.6 mg/kg Δ-9-THC each day, 5 days per week for 6 months; still other monkeys were used as controls or received smaller doses of marijuana. In three high-dose monkeys, two smoking and one ingesting Δ-9-THC, changes in EEG could be detected in recordings from deep brain sites; the changes continued 7 months after cessation of marijuana exposure. No EEG abnormalities were present in recordings from the brain surface.

One of the major criticisms of both these studies is their use of small numbers of animals. Furthermore, there have been no attempts at replication by other workers. Nevertheless, because these findings provide some of the only evidence for a possible irreversible effect of chronic high doses of marijuana, they are mentioned here with a strong urging for additional studies in an effort to replicate these findings.

EPILEPSY

Because of the effects of marijuana on brain electrical activity, questions have been raised about its association with epilepsy. Two questions are raised in the literature. First, does marijuana produce seizures? Second, does marijuana or a derivative prevent seizures? The first question will be discussed here. The second is reviewed in Chapter 7, which is concerned with the potential therapeutic uses of cannabis.

There are anecdotal reports in the literature that suggest seizures may be induced by marijuana in some persons with a known seizure disorder. A rigorous study, using adequate numbers of patients with documented seizure patterns, has not been done. Reports of experimental animal studies are conflicting and varied (Feeney et al., 1973, 1979; Lemberger, 1980). There are some circumstances in which cannabis administration does not alter certain types of seizures such as the photosensitive seizures in the baboon (Meldrum et al., 1974), and others in which it seems that seizures are induced. A single rabbit that responded to Δ-9-THC administration with seizures was bred to establish a colony of rabbits with similar response (Consroe and Fish, 1981). It will be of considerable interest to determine mechanisms of seizure induction and pharmacologic response patterns in this unusual animal model. However, as described further in Chapter 7, the bulk of the animal literature and some data from human studies suggest that the more prominent effect of marijuana derivatives, especially cannabinol and cannabidiol, is to decrease rather than increase seizure susceptibility (see Karler and Turkanis, 1981, for review).

NEUROCHEMISTRY

Our knowledge of the effects of marijuana on brain chemistry has come largely from studies in animals. Cannabis and some of its derivatives have been shown to cause chemical effects in the brain, as demonstrated by effects on neurotransmitters and on nucleic acids. The evidence is reviewed below.

Neurotransmitters

The brain is composed of many information-processing networks of nerve cells. Within each of these networks the transfer of information from one nerve cell to another is dependent upon chemicals called neurotransmitters. These substances are produced by nerve cells, released when the cells are stimulated and act to alter the excitability of neighboring nerve cells. Neurotransmitters play an essential role in the transmission and processing of information, and it is not surprising that many drugs that alter behavior do so by their actions on neurotransmitters. The understanding of the effects of marijuana on the brain must include knowledge of its effects on neurotransmitter systems.

Several different classes of chemicals act as neurotransmitters. The first chemical to be demonstrated to have this function was acetylcholine, and it is now established that acetylcholine is the neurotransmitter for several nerve cell networks in the brain. A number of studies in animals have examined the effect of marijuana on brain acetylcholine (see Domino, 1981, for a brief review of the extensive literature). The most clear-cut effects have been on acetylcholine turnover, a measure of the level of activity of neurons producing the chemical. Small doses of Δ-9-THC cause a reduction in acetylcholine turnover in the hippocampus (Domino et al., 1978; Revuelta et al., 1978; Domino, 1981) and this results from reduced activity of the acetylcholine neurons. It is noteworthy that the effect is produced by small doses and only by cannabinoids. Administration of physostigmine, a drug that enhances acetylcholine action by partially blocking its breakdown, to five healthy human volunteers (2 hours after ingestion of 20 to 40 mg of Δ-9-THC) produced enhancement of the lethargy and somnolence occurring late in the course of the Δ-9-THC intoxication (Freemon et al., 1975). The results of this study, and others in man and animals (El-Yousef et al., 1973; Low et al., 1973; Drew and Miller, 1974; Freemon et al., 1975), have led to the conclusion that Δ-9-THC acts to inhibit acetylcholine nerve cell networks. The exact nature of this action is not known, but it may be related to the memory deficits produced (Domino, 1981).

There have been studies of cannabinoids on several other neurotransmitters in brain, including catecholamines, serotonin, and gamma aminobutyric acid (Banerjee et al., 1975; Bracs et al., 1975). Although some effects have been reported, they either are produced by a very high dose or are so fragmentary that their implications are unclear. The effects of cannabinoids on neurotransmitters that have been studied to date, other than acetylcholine, are not striking. In particular, there is no evidence for any significant, long-term toxic effect of cannabinoids on any of the nerve cell networks that produce identified neurotransmitters.

Proteins, Enzymes, Nucleic Acids

A very few studies have examined the effects of marijuana on neurochemical variabless other than neurotransmitters (Luthra and Rosenkrantz, 1974; Luthra et al., 1975, 1976). After chronic administration to rats either of Δ-9-THC or marijuana smoke (for periods from 28 to 180 days), these investigators examined brain lipid, protein, and ribonucleic acid (RNA) content. With very high doses of Δ-9-THC (up to 500 mg/kg/day), some decrease in brain protein and RNA was noted; no decrease was noted in lipid content. However, with smaller doses, or administration of marijuana smoke, no consistent or marked changes were noted. The significance of these effects is unknown. Whether additional effects might be observed with more sophisticated and sensitive methods directed to more restricted analytical problems cannot be answered at present.

SUMMARY

There is no persuasive evidence that marijuana causes morphological changes in the brain. Computer tomography studies on users of marijuana reveal no gross changes in brain structure. Electron micrographic studies of monkey brains indicating morphologic changes are methodologically flawed and cannot be used as evidence for an effect of marijuana on brain cell morphology. Clear effects on brain electrical activity in human beings and in animals have been found after drug exposure. These effects have not been demonstrated to persist in human beings after the drug has been discontinued. Studies of EEG from deep brain structures in chronically treated animals have shown changes after the withdrawl of the drug. These limited findings need to be confirmed by further studies. Studies in human beings and animals indicate that, despite the neurophysiologic effects demonstrated in EEG studies, marijuana does not appear to increase epileptic seizure susceptibility. Current evidence has shown marijuana causes some chemical changes in brain. Cannabinoids affect several neurotransmitter systems, especially the cholinergic system. At high doses marijuana also has been shown to affect nucleoprotein synthesis. The significance of these findings for brain function as demonstrated by human behavior or their clinical relevance is unknown.

RECOMMENDATIONS FOR RESEARCH

In view of the widespread use of cannabis, it would be worthwhile to carry out further and more systematic studies of the effects of cannabis on brain structure, chemistry, and electrophysiology. Such studies should be closely correlated with behavior, e.g., learning, psychomotor coordination (see Chapter 6). One useful approach might be to investigate the effects of medium and high doses of cannabis (defined in terms of the patterns of human consumption) on juvenile and adult monkeys during and after long-term exposure. Juvenile monkeys should be included because the immature nervous system may be more sensitive to harmful drug effects; this issue is of great clinical concern, because marijuana use by human beings now begins quite early in life (see Chapter 2). Observations also should be made during long-term abstinence after previous long-term exposure to determine whether any persistent abnormalities have been produced. A systematic approach to these questions using modern methods of measurement and analysis could extend our present knowledge substantially.

REFERENCES

Adams, P.M. and Barratt, E.S. Effect of chronic marijuana administration on stages of primate sleepwakefulness. Biol. Psychiatry 10:315-322, 1975.

Banerjee, S.P., Snyder, S.H., and Mechoulam, R. Cannabinoids: Influence on neurotransmitter uptake in rat brain synaptosomes. J. Pharmacol. Exp. Ther. 194:74-81, 1975.

Barratt, E.S., Beaver, W., and White, R. The effects of marijuana on human sleep patterns. Biol. Psychiatry 8:47-54, 1974.

Bracs, P., Jackson, D.M., and Chester, G.B. The effect of Δ-9-tetrahydrocannabinol on brain amine concentration and turnover in whole rat brain and in various regions of the brain. J. Pharm. Pharmacol. 27:713-715, 1975.

Bull, J. Cerebral atrophy in young cannabis smokers. Lancet 2:1420, 1971.

Campbell, A.M.G., Evans, M., Thomson, J.L.G., and Williams, M.J. Cerebral atrophy in young cannabis smokers. Lancet 2:1219-1225, 1971.

Co, B.T., Goodwin, D.N., Gado, M., et al. Absence of cerebral atrophy in chronic cannabis users. JAMA 237:1229-1230, 1977.

Consroe, P. and Fish, B.S. Behavioral pharmacology of tetrahydrocannabinol convulsions in rabbits. Comm. Psychopharmacol. Comm. Pharmacol. 4:287-291, 1981.

Domino, E.F., Donelson, A.C., and Tuttle, T. Effects of Δ-9-tetrahydrocannabinol on regional brain acetylcholine, pp. 673-678. In Jenden, D.J. (ed.) Cholinergic Mechanisms and Psychopharmacology. New York: Plenum Press, 1978.

Domino, E.F. Cannabinoids and the cholinergic system. J. Clin. Pharmacol. 21(Suppl.):249S-255S, 1981.

Drew, W.G. and Miller, L.L. Cannabis: Neural mechanisms and behavior--A theoretical review. Pharmacology 11:12-32, 1974.

El-Yousef, M.K., Janowsky, D.S., Davis, J.M., and Rosenblatt, J.E. Induction of severe depression by physostigmine in marijuana intoxicated individuals. Br. J. Addict. 68:321-325, 1973.

Fehr, K.A., Kalant, H., Leblanc, A.E., and Knox, G.V. Permanent learning impairment after chronic heavy exposure to cannabis or ethanol in the rat, pp. 495-505. In Nahas, G.G. (ed.) Marihuana: Chemistry, Biochemistry, and Cellular Effects. New York: Springer-Verlag, 1976.

Feeney, D.M., Wagner, H.R., McNamara, M.C., and Weiss, G. Effects of tetrahydrocannabinol on hippocampal evoked afterdischarges in cats. Exp. Neurol. 41:357-365, 1973.

Feeney, D.M. Marihuana and epilepsy: Paradoxical anticonvulsant and convulsant effects, pp. 643-657. In Nahas, G.G. and Paton, W.D.M. (eds.) Marihuana: Biological Effects. Analysis, Metabolism, Cellular Responses, Reproduction and Brain. Oxford: Pergamon Press, 1979.

Feinberg, I., Jones, R., Walker, J.M., et al. Effects of high dosage delta-9-tetrahydrocannabinol on sleep patterns in man. Clin. Pharmacol. Ther. 17:458-466, 1975.

Feinberg, I., Jones, R., Walker, J.M., et al. Effects of marijuana tetrahydrocannabinol on electroencephalographic sleep patterns. Clin. Pharmacol. Ther. 19:782-794, 1976.

Fink, M. Effects of acute and chronic inhalation of hashish, marijuana, and delta-9-tetrahydrocannabinol on brain electrical activity in man: Evidence for tissue tolerance. Ann. N.Y. Acad. Sci. 282:387-398, 1976.

Freemon, F.R. The effect of delta-9-tetrahydrocannabinol on sleep. Psychopharmacologia 35:39-44, 1974.

Freemon, F.R., Rosenblatt, J.E., and El-Yousef, M.K. Interaction of physostigmine and delta-9-tetrahydrocannabinol in man. Clin. Pharmacol. Ther. 17:121-126, 1975.

Fried, P.A. Behavioral and electroencephalographic correlates of the chronic use of marijuana--A review. Behav. Biol. 21:163-196, 1977.

Fujimori, M. and Himwich, H.E. Δ-9-Tetrahydrocannabinol and the sleep-wakefulness cycle in rabbits. Physiol. Behav. 11:291-295, 1973.

Harper, J.W., Heath, R.G., and Myers, W.A. Effects of cannabis sativa on ultrastructure of the synapse in monkey brain. J. Neurosci. Res. 3:87-93, 1977.

Heath, R.G. Marihuana and Δ-9-tetrahydrocannabinol: Acute and chronic effects on brain function of monkeys, pp. 345-356. In Braude, M.C. and Szara, S. (eds.) Pharmacology of Marihuana. New York: Raven Press, 1976.

Heath, R.G., Fitzjarrell, A.T., Garey, R.E., and Myers, W.A. Chronic marihuana smoking: Its effect on function and structure of the primate brain, pp. 713-730. In Nahas, G.G. and Paton, W.D.M. (eds.) Marihuana: Biological Effects. Analysis, Metabolism, Cellular Responses, Reproduction and Brain. Oxford: Pergamon Press, 1979.

Heath, R.G., Fitzjarrell, A.T., Fontana, C.J., and Garey, R.E. Cannabis sativa: Effects on brain function and ultrastructure in Rhesus monkeys. Biol. Psychiatry 15:657-690, 1980.

Herning, R.I., Jones, R.T., and Peltzman, D.J. Changes in human event related potentials with prolonged delta-9-tetrahydrocannabinol (THC) use. Electroencephalogr. Clin. Neurophysiol. 47:556-570, 1979.

Hosko, M.J., Kochar, M.S., and Wang, R.I.H. Effects of orally administered delta-9-tetrahydrocannabiol in man. Clin. Pharmacol. Ther. 14:344-352, 1973.

Jones, R.T. and Stone, G.C. Psychological studies of marijuana and alcohol in man. Psychopharmacologia 18:108-117, 1970.

Karacan, I., Fernandez-Salas, A., Coggins, W.J., et al. Sleep electroencephalographic-electrooculographic characteristics of chronic marijuana users: Part I. Ann. N.Y. Acad. Sci. 282:348-374, 1976.

Karler, R. and Turkanis, S.A. The cannabinoids as potential antiepileptics. J. Clin. Pharmacol. 21(Suppl.):4375-4485, 1981.

Kuehnle, J., Mendelson, J.H., Davis, K.R., and New, P.F.J. Computed tomographic examination of heavy marijuana smokers. JAMA 237:1231-1232, 1977.

Lemberger, L. Potential therapeutic usefulness of marijuana. Ann. Rev. Pharmacol. Toxicol. 20:151-172, 1980.

Low, M.D., Klonoff, H., and Marcus, A. The neurophysiological basis of the marijuana experience. Can. Med. Assoc. J. 108:157-164, 1973.

Luthra, Y.K. and Rosenkrantz, H. Cannabinoids: Neurochemical aspects after oral chronic administration to rats. Toxicol. Appl. Pharmacol. 27:158-168, 1974.

Luthra, Y.K., Rosenkrantz, H., Heyman, I.A., and Braude, M.C. Differential neurochemistry and temporal pattern in rats treated orally with Δ-9-tetrahydrocannabinol for periods up to six months. Toxicol. Appl. Pharmacol. 32:418-431, 1975.

Luthra, Y.K., Rosenkrantz, H., and Braude, M.C. Cerebral and cerebellar neurochemical changes and behavioral manifestations in rats chronically exposed to marijuana smoke. Toxicol. Appl. Pharmacol. 35:455-465, 1976.

Martinez, J.L., Stadnicki, S.W., and Schaeppi, U.N. Delta-9-tetrahydrocannabinol: Effects on EEG and behavior of Rhesus monkeys. Life Sci. 11:643-651, 1972.

Meldrum, B.S., Fariello, R.G., Puil, E.A., et al. Delta-9-tetrahydrocannabinol and epilepsy in the photosensitive baboon, Papio papio. Epilepsia 15:255-264, 1974.

Moreton, J.E. and Davis, W.M. Electroencephalographic study of the effects of tetrahydrocannabinols on sleep in the rat. Neuropharmacology 12:897-907, 1973.

Myers, W.A. and Heath, R.G. Cannabis sativa: Ultrastructural changes in organelles of neurons in brain septal region of monkeys. J. Neurosci. Res. 4:9-17, 1979.

Pivik, R.T., Zarcone, V., Dement, W.C., and Hollister, L.E. Delta-9-tetrahydrocannabinol and synhexl: Effects on human sleep patterns. Clin. Pharmacol. Ther. 13:426-435, 1972.

Pranikoff, K., Karacan, I., Larson, E.A., et al. Effects of marijuana smoking on the sleep EEG: Preliminary studies. J. Fla. Med. Assoc. 60:28-31, 1973.

Revuelta, A.V., Moroni, F., Cheney, D.L., and Costa, E. Effect of cannabinoids on the turnover rate of acetylcholine in rat hippocampus, striatum, and cortex. Arch. Pharmacol. 304:107-110, 1978.

Rodin, E.A., Domino, E.F., and Porzak, J.P. The marihuana-induced "social high." Neurological and electroencephalographic concomitants. JAMA 213:1300-1302, 1970.

Rubin, V. and Comitas, L. Ganja in Jamaica: A Medical Anthropological Study of Chronic Marijuana Use. The Hague: Mouton and Co., 1975.

Rumbaugh, C.L., Fang, H.C.H., Wilson, G.H., et al. Cerebral CT findings in drug abuse: Clinical and experimental observations. J. Comput. Assisted Tomography 4:330-334, 1980.

Sipe, J.C. and Moore, R.Y. The lateral hypothalamic area: An ultrastructural analysis. Cell Tiss. Res. 179:177-196, 1977.

Stadnicki, S.W., Schaeppi, U., Rosenkrantz, H., and Braude, M.C. Crude marihuana extract: EEG and behavioral effects of chronic oral administration in rhesus monkeys. Psychopharmacologia 37:225-233, 1974.

Volavka, J., Dornbush, R., Feldstein, S., et al. Marijuana, EEG and behavior. Ann. N.Y. Acad. Sci. 191:206-215, 1971.

Wikler, A. and Lloyd, B. Effect of smoking marijuana cigarettes on cortical electrical activity. Fed. Proc. 4:141, 1945.

5

EFFECTS OF MARIJUANA ON OTHER BIOLOGICAL SYSTEMS

This chapter covers what little is known about the effects of cannabis on male and female reproduction and endocrine systems, birth defects and teratogenic effects, genetics, the immune system, and body temperature.

MALE REPRODUCTIVE FUNCTION

A variety of studies indicate that marijuana and some of its derivatives have reversible, suppressive effects upon testicular function in animals and men. These have been measured in terms of diminished weights of the prostate gland, seminal vesicles, or testes, and in decreased levels of testosterone (the male hormone) in blood plasma or suppression of spermatogenesis following chronic or acute administration of cannabis or Δ-9-THC. Appropriate observations have indicated that the effects of cannabinoids on the male reproductive tract and on testicular function were completely reversed 1 month after drug withdrawal.

There is no general agreement as to the cause or magnitude of these effects. The major reasons for this lack of agreement relate to major differences in study design, including species studied (man, monkey, or rodent), route of drug administration, and purity of the drug used.

Human Studies

In 1974, a group of 20 men were studied who had used marijuana at least 4 days a week for a minimum of 6 months without the use of other drugs (Kolodny et al., 1974). Plasma testosterone levels in subjects smoking five to nine marijuana cigarettes per week were significantly lower than controls (however, only 2 had levels out of the normal range, i.e., below 400 ng/dl); all but 1 of the men smoking more than 10 marijuana cigarettes per week had testosterone levels below 400 ng/dl. These results suggest that there was a dose-dependent effect of marijuana on testosterone levels. Plasma levels of lutenizing hormone (LH) and follicle-stimulating hormone

(FSH), gonadotropins that control the growth of the ovaries or testes and their hormonal activities, were in the normal range; however, in men smoking more than 10 marijuana cigarettes per week, the FSH level was significantly lower than for those who smoked 5 to 10 marijuana cigarettes per week. Because only random samples of blood were obtained for gonadotropic measurements, small but significant changes could have been missed. Levels of prolactin, the female hormone involved in lactation and also present in small quantities in men, were all in the low normal range. In addition, the men who smoked more than 10 marijuana cigarettes per week had significantly lower sperm counts than those who smoked the lesser quantity (26 versus 68 million/ml). These individuals obtained marijuana from a variety of sources, and there was no way to determine whether they were taking other drugs that could lower plasma testosterone.

Later in 1974, another study reported that plasma testosterone levels were not suppressed in 27 men studied in a research ward (Mendelson et al., 1974) These individuals smoked marijuana cigarettes supplied by the federal government. For unexplained reasons, the mean testosterone levels in these individuals were greater than 1,000 ng/dl (higher than the normal mean) before and during the smoking periods. This is in marked contrast to the mean value of 742 ng/dl for nonsmokers in the study of Kolodny et al. mentioned above. There was no report of gonadotropic values or semen analysis in the Mendelson Study.

A study of 16 patients on a metabolic ward who smoked NIDA cigarettes (Hembree et al., 1979) showed that 5 to 6 weeks of high-dose (2 percent) marijuana administration (8-20 cigarettes/day) was associated with a decline in sperm count during the fifth and sixth weeks after initiation of drug exposure. This was preceded by a decrease in sperm motility and an increase in abnormal forms of sperm. Once a week during the study five blood samples were obtained at 15-minute intervals for measurement of testosterone, LH, and FSH. No change in these hormone levels was noted throughout the study (although no values were reported). The relationship in time of these samples to the last previous cigarette was not mentioned, therefore the test would not have excluded a transient decline in hormonal levels after each cigarette. However, because hormonal suppression of spermatogenesis takes longer than 4 weeks and usually is not associated with an increase in the number of abnormal forms and a decrease in motility, the authors concluded that the effect upon the seminiferous tubular epithelium was direct rather than by suppression of gonadotropins. This is the only reported study in man that measured the hour-to-hour fluctuations in gonadotropic levels.

Another study (Coggins et al., 1976) evaluated the health status of 84 marijuana smokers who had used the agent three or more times per week for a minimum of 10 years. Testosterone levels were measured in 38 users and 38 nonusers. The mean levels and ranges were virtually identical. This heterogeneous group of men patients studied in Costa Rica was not recruited for the purpose of studying the pituitary-gonadal axis. No gonadotropic levels or semen samples were studied.

Endocrine function studies are briefly mentioned in a paper by Cohen (1976). Subjects were recruited on the basis of heavy marijuana use and were studied in a metabolic ward. They smoked an average of five marijuana cigarettes per day, which was believed to be the equivalent of 103 mg of Δ-9-THC. During acute administration, mean levels of plasma testosterone declined from 754 to 533 ng/dl over a 3-hour period. After 9 weeks of smoking, plasma testosterone levels had declined from 740 to 509 ng. Plasma LH levels were reported to have fallen after the fourth week; however, no absolute values were given. In addition, no standard errors are given for any of the means presented in this paper. Therefore, it is impossible to evaluate the significance of the reported findings.

In Greece, a population of 47 chronic hashish users was studied. Electron microscope studies of the acrosome, the head of the sperm, showed abnormality in some patients (Issidorides, 1979). It is difficult to evaluate the study because no quantitative data were presented.

Animal Studies

All of the studies mentioned below are substantially different from those of human beings because, with one exception, the active agent (usually Δ-9-THC) was administered intraperitoneally at a dose of 2.5 to 25 mg/kg. Based on calculations given by Cohen (1976), 3 to 6 mg/kg/day would be considered a large dose in human beings.* Also, human beings self-administer the drug over many hours rather than as a single dose.

In castrated rhesus monkeys, plasma LH and FSH fell acutely following acute administration of Δ-9-THC (Smith et al., 1980). During this suppression period, both gonadotropins could be stimulated by lutenizing hormone-releasing factor (LHRF), which causes the release of LH. The effect of Δ-9-THC was to suppress prolactin release, which, in turn, could be stimulated by thyrotropin-releasing hormone (TRH). Studies in other species have tended to confirm these observations in monkeys.

The results are compatible with the hypothesis that the effect of marijuana and its derivatives is on gonadotropic secretion (Farclerode et al., 1979). Testicular cytochrome P-450 (an enzyme) decreased in the rat following 2 to 9 weeks of treatment. The concentrations of this enzyme, plus a variety of other testicular markers, were restored with FSH and LH therapy. The effect of various cannabinoids has been studied on sperm morphology in the mouse (Zimmerman et al., 1979).

*Rosenkrantz (1981) considers 0.6-3.0 mg/kg by inhalation and 1.8-9.0 mg/kg orally to be large doses in human beings. For the monkey, 1.8-9.0 mg/kg by inhalation and 5-27 mg/kg orally would be considered a high dose. (These concentrations are equivalent to six cigarettes/day.)

Mice were given five daily intraperitoneal injections of Δ-9-THC, cannabidiol, or cannabinol at doses approaching or exceeding the LD_{50} (the dose necessary to kill 50 percent of the animals). Thirty-five days after the last treatment, animals were killed and sperm were evaluated by scanning electron microscopy. Control animals had 1.5 percent abnormal forms. Animals that received LD_{50} doses of the various derivatives had 2.4 to 5.0 percent abnormal forms.

Only a few studies have examined the effects of cannabis on spermatogenesis (Huang et al., 1979). Marijuana was administered to rats in a smoke machine. After 30 days of exposure, marijuana smoke lowered the sperm counts in animals significantly, as did cannabinoid-free smoke. By 75 days, however, only the marijuana smoke group maintained a low sperm count. In the marijuana-treated group, there was an increased number of abnormal forms, particularly with an increase in dissociation of sperm heads and tails. In the discussion of this paper, the authors reported elevated serum FSH levels following marijuana exposure, but did not present data. They concluded that marijuana has a direct effect on the testis. A variety of in vitro studies support this suggestion (Jakubovic et al., 1977, 1979).

Marijuana and its derivatives also have been shown to be antiandrogenic (antagonistic to male hormones) (Purohit et al., 1980). Several constituents, including Δ-9-THC, can bind to the receptor for androgen. Marijuana also has been demonstrated to be estrogenic (like female sex hormones) in vivo, and recent studies suggest that these effects may be mediated via the estrogen receptor. These observations have been disputed by others (reviewed by Purohit et al., 1980). The ability to inhibit or mimic the action of sex steroids provides one mechanism by which these agents can produce their effects. There obviously are many others.

FEMALE REPRODUCTIVE FUNCTION

The effect of cannabis on female reproduction has been studied in rats, mice, rabbits, and monkeys. The work in rhesus monkeys is of particular importance, because of the similarity in the menstrual cycle among primate species, including human beings.

Human Studies

There is only one study reported on the effects of marijuana on reproductive function in women. The work has appeared in print as a report of the proceedings of a 1978 symposium held in Mexico City (Bauman et al., 1979) and as part of the congressional record subsequent to testimony before a Senate committee hearing (Bauman, 1980). These publications do not provide details on methodology or on individual hormone values. Differences between the control and experimental groups, recognized by the investigators, could be of importance; alcohol use, for example, was more frequent in the marijuana-using group. The study attempted to establish the endocrine (hormonal) profile and menstrual patterns of women who used marijuana on a chronic and frequent basis. Twenty-six women who used it at least three times a week for 6 months were compared with 17 women who had never used the substance. The number of cycles studied for each variable investigated is not clear from the publications. This difficulty notwithstanding, the report reveals no difference in plasma levels of LH and FSH between the two groups and no change in peaks and basal values of the female hormones estradiol or progesterone, the critical hormone levels controlling the process of ovulation. It would be expected that no major difference was found in the incidence of anovulatory cycles between the two groups. By combining anovulation and shortened luteal phase, however, the authors report a statistically significant difference in the marijuana-using group, which could be clinically important in causing subfertility. This evidence is, at best, only suggestive. The observation that testosterone levels in marijuana-using women are elevated is difficult to interpret in terms of clinical significance; apparently, the subjects did not report episodes of acne, abnormal hairiness, or other testosterone-dependent side-effects. According to the authors, serum prolactin levels are lower in marijuana users than in controls. The implications of this observation for fertility, lactation, or the development of breast cancer are not clear.

The absence of other studies on users of marijuana makes it difficult to draw conclusions on the implications of the data cited above. Several of the effects noted are different from the more extensive and experimentally controlled observations in rhesus monkeys and other laboratory animals. This situation calls attention to the urgent need for more comprehensive endocrine and gynecologic investigations of women who use marijuana.

Animal Studies

Administration of crude marijuana extract to rats or mice resulted generally in suppression of ovarian function and in various aspects of estrogen activity, such as uterine metabolism, weight, glycogen content, and levels of RNA and sialic acid (Chakravarty et al., 1975; Dixit et al., 1975).

The administration of crude marijuana extract for 30 days to rats and mice abolished the estrus cycle and caused a significant reduction in the size of the ovaries and in some primordial ova (Dixit et al., 1975). Intraperitoneal administration of Δ-9-THC to rats, appropriately timed, has also been reported to block ovulation (Nir et al., 1973). This effect of Δ-9-THC was exerted by suppressing the characteristic preovulatory surge of plasma LH. Other investigators have reported suppression also of plasma FSH and prolactin when Δ-9-THC is given just before ovulation (Ayalon et al., 1977). The substance was found to depress plasma concentration of LH in ovariectomized rats (Marks, 1973; Tyrey, 1978, 1980) and rhesus monkeys (Besch et al., 1977). Asch et al. (1979) also showed in the rabbit, a reflex ovulator, that a precoital single dose of Δ-9-THC blocks the postcoital LH surge and ovulation.

Administration of LHRF was able to bring about the release of LH in Δ-9-THC treated rats and rhesus monkeys (Smith et al., 1979). These results indicate a direct effect of cannabinoids at the level of the hypothalamus, part of brain important in reproductive hormone regulation. The ovulation-blocking effect of the cannabinoids was further investigated by Cordova et al. (1980). Natural and chemically modified cannabinoids blocked ovulation in rats.

Administration of Δ-9-THC to rhesus monkeys during the follicular phase resulted in prolonged periods of amennorhea (absence or abnormal stoppage of the menstrual flow), absence of midcycle LH surge, and progesterone levels characteristic of anovulation (Asch et al., 1981).

BIRTH DEFECTS AND TERATOGENICITY

Because Δ-9-THC crosses the placenta it is a potential teratogen, an agent that causes defects in the developing embryo. This effect could occur in either of two ways: (1) exposure to cannabis prior to conception could harm the sex cells (the ova and sperm), or (2) the fetus could be harmed directly during organogenesis. In addition, Δ-9-THC can be secreted in breast milk and, therefore, can be toxic postnatally.

Human Studies

The evidence for teratogenicity in human beings is very difficult to interpret. Although there is widespread use of marijuana in young women of reproductive age, there is no evidence yet of any teratogenic effects of high frequency or consistent association with the drug. There are isolated reports of congenital anomalies in the offspring of marijuana users, but there is no evidence that they occurred more often in users than in nonusers and in those cases there was coincident use of other drugs. Subtle development effects in offspring, such as nervous system abnormalities, and reductions in birth weight and height may indeed exist (Finnegan, 1980; Fried, 1980; Hingson et al., in press). Additional carefully designed, prospective studies should provide valuable information in this area.

Animal Studies

Crude marijuana extract and Δ-9-THC are teratogenic at certain doses in animals.*

*Bibliography available upon request from the Institute of Medicine, National Academy of Sciences.

One study reported that subcutaneous injection of pregnant hamsters and rabbits with various doses of crude marijuana extract caused malformations of the brain, spinal cord, forelimb, and liver, as well as edema of the head and spinal region in developing embryos (Gerber and Schramm, 1969). In hamsters, significant embryocidal and growth retardation effects also were noted. It was concluded that doses greater than 200 mg/kg in hamsters and 250 mg/kg in rabbits were teratogenic. Caution in interpreting these findings must be xercised because the teratogenic effects may be caused by any combination of constituents of the cannabis extract.

In a study of mice, the teratological effects of Δ-9-THC were evaluated for doses ranging from 3.0 to 400 mg/kg by various routes of administration—intravenous, subcutaneous, and intragastric (Joneja, 1976). Significant fetal growth retardation was induced at higher dose levels and by some routes of administration. For example, a high dose of 400 mg/kg was significantly teratogenic by the intragastric route; 12.1 percent of the live fetuses were malformed.

In a study of female monkeys given an oral dose of 2.4 mg/kg Δ-9-THC for 1 to 4 years, a nonspecific pattern of reproductive difficulties was observed characteristic of "high-risk" pregnancies, including a high rate of offspring loss during pregnancy or in the early postnatal period (Sassenrath et al., 1979).

GENETIC EFFECTS

The potential genetic effects of marijuana are of major concern because of its prevalent use by young people in their reproductive years (see Chapter 2). Although there is a growing amount of evidence that drugs can induce mutations, and an improving ability to use toxicological methods to evaluate agents for their mutagenic potential (such as the Ames test, which detects changes or damages in the genetic material), the available information on the genetic hazards or even on the potential genetic hazards of the use of marijuana is extremely limited.

Mutagenicity

Elsewhere in this report (Chapter 3) the scientific evidence that marijuana smoke and tar are mutagenic has been discussed. Lung explants of mice and human fibroblast cultures exposed to fresh smoke showed abnormalities of cell division, as well as changes in chromosome structure and in DNA synthesis (Leuchtenberger and Leuchtenberger, 1971; Leuchtenberger, et al., 1973a,b). Moreover, extracts and smoke condensates of marijuana are mutagenic when evaluated by the Ames test (Busch et al., 1979; Seid and Wei, 1979; Wehner et al., 1980). Animal studies on rodents painted with marijuana tar, three times weekly for 1 year, resulted in skin papillomas, carcinomas, and fibrosarcomas (Hoffmann et al., 1975).

However, extensive testing with Δ-9-THC using three established tests for mutagenesis failed to detect any mutagenic effect, or any effect as an inhibitor of DNA repair (Legator et al., 1976; Glatt et al., 1979; Zimmerman et al., 1978).

Cytogenetic Effects

The numbers and kinds of chromosomes (structures in a cell nucleus that contain and transmit genetic information carried in DNA) are highly characteristic for a given species. Structural variation and changes in numbers of chromosomes may be evidence for genetic damage produced by drugs and other chemical agents. Unfortunately, the literature on the effects of marijuana on chromosomes is limited and conflicting. Studies suggesting that marijuana probably does not break chromosomes are fairly conclusive. There is less evidence that marijuana may produce aneuploidy (abnormal numbers of chromosomes) in some daughter cells during cell division.

Does marijuana cause chromosome breaks? The weight of the evidence from in vitro cultures of human cells and from in vivo animal and human studies is that neither marijuana nor Δ-9-THC causes chromosome breaks.

In Vitro and Animal Studies

Cultures of human leukocytes, exposed to different concentrations of Δ-9-THC, showed no increase in the incidence of chromosome breaks or gaps when compared to controls (Stenchever and Allen, 1972). Studies of golden hamsters given subcutaneous injections for 10 days of marijuana extract distillate containing 17.1 percent Δ-9-THC (Nicholson et al., 1973), and of beagle dogs trained to smoke high doses of marijuana (3 g/day/week for 30 months), showed no significant differences in chromosome gaps or breaks when compared with control groups (Genest et al., 1976).

Human Studies

Cytogenetic analysis of chromosomes from peripheral blood leukocytes and cultures of subjects exposed to marijuana smoking, marijuana extract, or synthetic Δ-9-THC revealed no increase in chromosome breakage attributable to these compounds (Nichols et al., 1974; Matsuyama, 1976; Morishima et al., 1979). Doses ranged from 20 mg Δ-9-THC per day to 12-16 marijuana cigarettes per day. Studies that have reported chromosome breaks or gaps in cell cultures of users of marijuana have largely been carried out on multiple drug users, and the breaks and gaps may be due to other factors associated with a life of heavy drug use (Gilmour et al., 1971; Herha and Obe, 1974). However, in a retrospective study on college students, chromosome breaks were found in blood cultures of 49 light (one or less exposure per week) and heavy (more than two exposures per week) users of marijuana (Stenchever et al., 1974). One problem in this study is the poor dose characterization. Furthermore, the increase in the numbers of breaks in both light and heavy users of marijuana was not dose-related; the same frequency of breaks was observed in both groups. Although the evidence is inconclusive, it suggests that marijuana does not cause chromosome breaks.

Does marijuana interfere with cell division and chromosome segregation, thereby resulting in abnormal numbers of chromosomes? There is conflicting evidence in the literature. On the one hand, no significant effects of marijuana smoke or Δ-9-THC on chromosome complement have been reported using the micronuclei test in mice or in cytogenetic studies in dogs (Genest et al., 1976; Legator et al., 1976). On the other hand, more extensive studies have demonstrated aneuploidy resulting from in vitro exposure of cells to marijuana as well as in vivo studies of animals and human beings.

In Vitro and Animal Studies

Exposure of mouse lung and adult human lung tissue culture to marijuana smoke in vitro resulted in abnormal cell proliferation and abnormalities in DNA content (Leuchtenberger and Leuchtenberger, 1971; Leuchtenberger, et al., 1973b). Addition of Δ-9-THC and olivetol, a compound with a ring structure similar to cannabinoids, to normal human leukocyte cultures induced hypodiploidy (defined as metaphase nuclei with a chromosome complement of less than 30 chromosomes—a normal human cell contains 46 chromosomes) (Morishima et al., 1976). Hybrid mice treated for 5 consecutive days with Δ-9-THC, cannabinol, and cannabidiol at a dose of 10 mg/kg had a three- to fivefold increase of micronuclei over controls. The number of micronuclei increased with increasing Δ-9-THC dosage. Examination of bone marrow mitosis in these same mice showed a five- to sevenfold increase in chromosome number aberrations during metaphase (Zimmerman and Raj, 1980).

Human Studies

Studies of lymphocytes cultured from human marijuana smokers defined either as "moderate" users (at least one marijuana cigarette per week, range 1-10 for a minimum of two years) or "heavy" users (more than three times per week) all of whom consumed between 12.9 and 15.3 marijuana cigarettes per day during the experiment, turned up a significantly larger number of cells with less than 30 chromosomes than would be found in normal control cultures (Morishima et al., 1979). These positive findings suggest that marijuana may affect chromosome segregation during cell division and result in cells with fewer than the normal number of chromosomes. What these findings mean in terms of risk for abnormalities in offspring or possible disease is not known. Findings in lymphocyte cultures may not be relevant to what is happening in the germ cells (sex cells).

THE IMMUNE SYSTEM

The immune system functions in protecting the body against viruses, bacteria, and other infections. It also plays a major role in preventing the growth and dissemination of cancerous cells.

There have been reports that cannabis is immunogenic, capable of activating components in the immune system. These components include such cells as lymphocytes, some of which produce antibodies in response to invasion by a foreign agent, and macrophages, which can be stimulated by inflammation to ingest invaders.

Human Studies

There have been reports that cannabis interferes with components in the immune system in man. Antibodies will develop in response to marijuana in some people, along with an allergic response, while others develop antibodies without apparent allergic reaction (Liskow et al., 1971; Shapiro et al., 1974, 1976; Lewis and Slavin, 1975). However, the studies reporting these effects were not designed to determine which components of the marijuana are immunogenic and which are allergenic.

Studies of various aspects of the immune system in persons who were chronic users of marijuana have indicated mild decreases in activity of one or another component of the system; however, other investigators have noted no changes outside of the normal range (Gupta et al., 1974; Petersen et al., 1975, 1976; White et al., 1975; Lau et al., 1976; Rachelefsky et al., 1976; Silverstein and Lessin, 1976; Cushman and Khurana, 1977; McDonough et al., 1980). These apparent inconsistencies may stem from the variability in the amount of marijuana consumed among users in different studies and the differences in the immune system assays. Hashish, as distinct from marijuana, was shown to have a slight temporary stimulatory effect on the immune system (Kaklamani et al., 1978; Kalofoutis et al., 1978).

Animal Studies

A number of studies have shown that Δ-9-THC and other cannabinoids induce immunological defects in rodents (Petersen and Lemberger, 1976; Lefkowitz and Klager, 1978, Lefkowitz et al., 1978; Preuss and Lefkowitz, 1978). The doses varied from 5 to 25 mg/kg (intraperitoneally) to 100 mg/kg (orally). At the higher doses there was a diminution of immune response, as measured by standard immunological assays. Delta-9-THC had the same effects on cells grown _in vitro_. Other cannabinoids also have been tested for their effects. Cannabinol, Δ-8-THC, and 1-methyl-Δ-8-THC had the same immunosuppressive effects as Δ-9-THC, but cannabidiol had no immunosuppressive effect. Immunizing rabbits with Δ-9-THC resulted in the production of antibodies (Chiarotti et al., 1980).

BODY TEMPERATURE

Regulation of body temperature is a complex process that can be influenced by drugs. In several species of animals, Δ-9-THC produces a lowering of body temperature (hypothermia). The effect is seen when animals are housed at normal room temperatures, and it is greater with colder ambient temperatures (Pertwee and Travendale, 1979). Marijuana apparently causes a decrease in heat production for reasons that are unclear.

In experiments with human subjects, marijuana has produced little or no change in body temperature when given in a cool environment (Beaconsfield et al., 1972; Hanna et al., 1976). In a hot environment (40°C) marijuana caused inhibition of sweating and a consistent rise in body temperature (Jones et al., 1980). Thus, there is evidence that marijuana does interfere with temperature regulation, although there is no currently known clinical significance to this finding.

Cannabis appears to interfere with temperature regulation, but the clinical significance is unknown.

SUMMARY

Male Reproductive Function

In animals, marijuana and its derivatives can acutely lower gonadotropic secretion when administered intraperitoneally. There is also some evidence in animals to suggest that these agents can directly affect the seminiferous tubule. In man, sperm number and motility are decreased during chronic marijuana use. From the available studies, it appears this was due to a direct effect of the cannabinoids either on the seminiferous tubular epithelium or the epididymal sperm. Due to conflicting and incomplete evidence, it is not possible to conclude at the present time whether marijuana smoking has a significant effect upon gonadotropic and testosterone concentrations in humans. Whether the decrease in sperm number or motility has any effect on fertility is not known.

Female Reproductive Function

There is only one study of human beings that attempts to establish the endocrine profile and menstrual patterns of women who used marijuana on a chronic and frequent basis. By combining categories of anovulation and shortened luteal phase, a statistically significant difference was noticed in the marijuana using group. It is not known if this leads to problems with fertility or lactation, or if it leads to cancer of the reproductive organs.

Animal studies have shown that Δ-9-THC lowers the serum gonadotropic levels. It is unknown if there is a direct effect on the reproductive tissues, particularly under prolonged use of cannabis products.

Birth Defects and Teratogencity

Cannabis is teratogenic at high doses in animals. There is no evidence of obvious teratogenicity or structural defects in the offspring of human users. But the data are not adequate to reveal a long-range functional impairment or a very low level of teratogenicity if one is present. It may be impossible to identify a distinct role for cannabis in the production of subtle effects in offspring, because of the confounding influences of malnutrition, smoking, and alcohol.

Genetic Effects

Marijuana and Δ-9-THC do not appear to break chromosomes, although there is some conflicting evidence on this point. Multiple drug use seems to be correlated with an increase in the numbers of gaps and breaks in the genetic material. Furthermore, marijuana may affect chromosome segregation during cell division, resulting in abnormal numbers of chromosomes in daughter cells. While these conflicting results are worrisome, their clinical significance is not known. Further investigations, especially controlled prospective studies, of human beings are needed.

The Immune System

The data from animal studies suggest that Δ-9-THC and some of its analogues have a mild, transient, immunosuppressant effect in both _in vitro_ and _in vivo_ systems; the effects are mild compared with known immunosuppressant drugs. The studies in human beings are contradictory; some demonstrated mild, immunosuppressive effects, but others, using the same or similar methods, did not find any differences in the immune system between normals and chronic marijuana smokers. At the present time, there have been no human or animal studies that have determined if marijuana smokers are more prone to infections or other diseases. Because of the widespread use of marijuana, even weak immunosuppressive effects are a concern. Since further research may not demonstrate definitive findings, immunologic effects should be studied along with other variables in a larger investigation. If marijuana is to be used on immunosuppressed patients (for example, for antiemetic purposes during cancer chemotherapy), even minor additional suppression might be dangerous.

RECOMMENDATIONS FOR RESEARCH

The committee recommends the following types of studies.

• Further observations should be made regarding the relation of marijuana use to reproductive defects in human beings, especially on young users whose reproductive biology is undergoing rapid change. The principal need is for assessment of endocrine profiles and semen analysis in male users versus nonusers, with adequate control of confounding variables--for example, diet, alcohol, other drug use. In women, the principal need is for more data on endocrine and menstrual patterns in users versus nonusers, with particular attention to the length of cycles, the presence or absence of ovulation, and the existence or absence of subfertility. More studies are needed to detect subtle, low-frequency, or cumulative effects on reproductive function in long-term, heavy users.

- Although routine testing of teratogenicity in human beings is not recommended at this time, the collection of precise epidemiologic information on the outcome of human pregnancy in marijuana users is of great importance and must be carefully controlled.
- There are no good animal models for studying the effects of smoking marijuana, but cytogenetic studies in animals after exposure to Δ-9-THC by other routes than smoking would be of some value. The most relevant studies still would be <u>in vivo</u> human studies.
- Marijuana has been found to have mild immunological effects in a variety of test systems, but studies of its influence on the body's immune defense against microorganisms are lacking and need to be conducted.
- Critical experiments are needed to test the hypothesis that Δ-9-THC causes disruption of thermoregulatory effector responses rather than an alteration of the level of thermoregulation.
- Inherited variation in the way some drugs are metabolized is widely recognized. This type of variation must be evaluated in respect to susceptibility to marijuana.

REFERENCES

Asch, R.H., Fernandez, E.O., Smith, C.G., and Pauerstein, C.J. Precoital single doses of Δ-9-tetrahydrocannabinol block ovulation in the rabbit. <u>Fertil. Steril.</u> 31:331-334, 1979.

Asch, R.H., Smith, C.G., Siler-Khodr, T.M., and Pauerstein, C.J. Effects of Δ-9-tetrahydrocannabinol during the follicular phase of the Rhesus monkey (<u>Macaca mulatta</u>). <u>J. Clin. Endocrin. Metab.</u> 52:50-55, 1981.

Ayalon, D., Nir, I., Cordova, T., Bauminger, S., et al. Acute effect of Δ-1-tetrahydrocannabinol on the hypothalamo-pituitary-ovarian axis in the rat. <u>Neuroendocrinology</u> 23:31-42, 1977.

Bauman, J. Marijuana and the female reproductive system, pp. 85-88. Testimony before the Subcommittee on Criminal Justice of the Committee on the Judiciary, U.S. Senate, "Health Consequences of Marihuana Use," January 16-17, 1980. Washington, DC: U.S. Government Printing Office, 1980.

Bauman, J.E., Kolodny, R.C., Dornbusch, R.L., and Webster, S.K. Efectos endocrinos del uso cronico de la mariguana en mujeres, pp. 85-97. In Simposio Internacional Sobre Actualizacion en Mariquana, Volume 10. Tlalpan, Mexico, July 1979.

Beaconsfield, P., Ginsburg, J., and Rainsbury, R. Marihuana smoking: Cardiovascular effects in man and possible mechanisms. N. Engl. J. Med. 287:209-212, 1972.

Besch, N.F., Smith, C.G., Besch, P.K., and Kaufman, R.H. The effect of marihuana (delta-9-tetrahydrocannabinol) on the secretion of lutenizing hormone in ovariectomized Rhesus monkey. Am. J. Obstet. Gynecol. 128:635-642, 1977.

Busch, F.W., Seid, D.A., and Wei, E.T. Mutagenic activity of marihuana smoke condensates. Cancer Lett. 6:319-324, 1979.

Chakravarty, I., Sengupta, D., Bhattacharyya, P., and Ghosh, J.J. Effect of treatment with cannabis extract on the water and glycogen contents of the uterus in normal and estradiol-treated prepubertal rats. Toxicol. Appl. Pharmacol. 34:513-516, 1975.

Chiarotti, M., Giusti, G.V., and Vigevani, F. In vivo and in vitro properties of anti-delta-9-tetrahydrocannabinol antibody. Drug Alcohol Dependence 5:231-233, 1980.

Coggins, W.J., Swenson, E.W., Dawson, W.W., et al. Health status of chronic heavy cannabis users. Ann. N.Y. Acad. Sci. 282:148-161, 1976.

Cohen, S. The 94-day cannabis study. Ann. N.Y. Acad. Sci. 282:211-220, 1976.

Cordova, T., Ayalon, D., Lander, N., et al. The ovulation blocking effect of cannabinoids: Structure-activity relationships. Psychoneuroendocrinology 5:53-62, 1980.

Cottrell, J.C., Sohn, S.S., and Vogel, W.H. Toxic effects of marihuana tar on mouse skin. Arch. Environ. Health 26:277-278, 1973.

Cushman, P. and Khurana, R. A controlled cycle of tetrahydrocannabinol smoking: T and B cell rosette formation. Life Sci. 20:971-979, 1977.

Dixit, V.P., Arya, M., and Lohiya, N.K. The effect of chronically administered cannabis extract on the female genital tract of mice and rats. Endokrinologie 66:365-368, 1975.

Finnegan, L.P. Pulmonary problems encountered by the infant of the drug-dependent mother. Clin. Chest Med. 1:311-325, 1980.

Fried, P.A. Marihuana use by pregnant women: Neurobehavioral effects in neonates. Drug Alcohol Dependence 6:415-424, 1980.

Genest, P., Huy, N.D., and Roy, P.D. Toxicity study of marijuana in dogs: Effects on the mitotic index and chromosomes. Res. Commun. Psychol. Psychiatr. Behav. 1:83-290, 1976.

Gerber, W.F. and Schramm, L.C. Effect of marihuana extract on fetal hamsters and rabbits. Toxicol. Appl. Pharmacol. 14:276-282, 1969.

Gilmour, D.G., Bloom, A.D., Lele, K.P., et al. Chromosomal aberrations in users of psychoactive drugs. Arch. Gen. Psychiatry 24:268-272, 1971.

Glatt, H., Ohlsson, A., Agurell, S., and Oesch, F. Delta-1-tetrahydrocannabinol and 1-alpha, 2-alpha-epoxyhexahydrocannabinol: Mutagonicity investigation in the Ames test. Mutat. Res. 66:329-335, 1979.

Gupta, S., Grieco, M.H., and Cushman, P. Impairment of rosette-forming T-lymphocytes in chronic marihuana smokers. N. Engl. J. Med. 291:874-877, 1974.

Hanna, J.M., Strauss, R.H., Itagaki, B., et al. Marijuana smoking and cold tolerance in man. Aviation, Space, and Environmental Medicine 47:634-639, 1976.

Harclerode, J., Nyquist, S.E., Nazar, B., and Lowe, D. Effects of cannabis on sex hormones and testicular enzymes of the rodent, pp. 395-405. In Nahas, G.G. and Paton, W.D.M. (eds.) Marihuana: Biological Effects. Analysis, Metabolism, Cellular Responses, Reproduction and Brain. Oxford: Pergamon Press, 1979.

Hembree, W.C., Nahas, G.G., Zeidenberg, P., and Huang, H.F.S. Changes in human spermatozoa associated with high dose marihuana smoking, pp. 429-439. In Nahas, G.G. and Paton, W.D.M. (eds.) Marihuana: Biological Effects. Analysis, Metabolism, Cellular Responses, Reproduction and Brain. Oxford: Pergamon Press, 1979.

Herha, J. and Obe, G. Chromosomal damage in chronical users of cannabis in vivo investigation with two-day leukocyte cultures. Pharmakopsychiat. 7:328-337, 1974.

Hingson, R., Alpert, J.J., Day, N. et al. Effects of maternal drinking and marijuana use on fetal growth and development. J. Pediatr. (in press).

Hoffmann, D., Brunnemann, K.D., Gori, G.B., and Wynder, E.L. On the carcinogenicity of marijuana smoke, pp. 63-81. In Runeckles, V.C. (ed.) Recent Advances in Phytochemistry. New York: Plenum Publishing Corporation, 1975.

Huang, H.F.S., Nahas, G.G., and Hembree, W.C. Effects of marihuana inhalation on spermatogenesis of the rat, pp. 419-427. In Nahas, G.G. and Paton, W.D.M. (eds.) Marihuana: Biological Effects. Analysis, Metabolism, Cellular Responses, Reproduction and Brain. Oxford: Pergamon Press, 1979.

Issidorides, M.R. Observations in chronic hashish users: Nuclear aberrations in blood and sperm and abnormal acrosomes in spermatozoa, pp. 377-388. In Nahas, G.G. and Paton, W.D.M. (eds.) Marihuana: Biological Effects. Analysis, Metabolism, Cellular Responses, Reproduction and Brain. Oxford: Pergamon Press, 1979.

Jakubovic, A. and McGeer, P.L. Biochemical changes in rat testicular cells in vitro produced by cannabinoids and alcohol: Metabolism and incorporation of labeled glucose, amino acids, and nucleic acid precursors. Toxicol. Appl. Pharmacol. 41:473-486, 1977.

Jakubovic, A., McGeer, E.G., and McGeer, P.L. Effects of cannabinoids on testosterone and protein synthesis in rat testis Leydig cells in vitro. Molec. Cell. Endocrinol. 15:41-50, 1979.

Joneja, M.G. A study of teratological effects of intravenous, subcutaneous, and intragastric administration of Δ-9-tetrahydrocannabinol in mice. Toxicol. Appl. Pharmacol. 36:151-162, 1976.

Jones, E.P., Manno, J.E., Brown, R.D., et al. Tachycardia in rats following intracerebroventricular (ICV) administration of Δ-9-tetrahydrocannabinol (THC). Fed. Proc. Fed. Am. Soc. Exp. Biol. 39:848, 1980.

Kaklamani, E., Trichopoulos, D., Koutselinis, A., et al. Hashish smoking and T-lymphocytes. Arch. Toxicol. 40:97-101, 1978.
Kalofoutis, A., Koutselinis, A., Dionyssiou-Asteriou, A., and Miras, C. The significance of lymphocyte lipid changes after smoking hashish. Acta Pharmacol. Toxicol. 43:81-85, 1978.
Kolodny, R.C., Masters, W.H., Kolodner, R.M., and Toro, G. Depression of plasma testosterone levels after chronic intensive marijuana use. N. Engl. J. Med. 290:872-874, 1974.
Lau, R.J., Tubergen, D.G., Barr, M., and Domino, E.F. Phytohemagglutinin-induced lymphocyte transformation in humans receiving delta-9-tetrahydrocannabinol. Science 192:805-807, 1976.
Lefkowitz, S.S. and Klager, K. Effect of delta-9-tetrahydrocannabinol on in vitro sensitization of mouse splenic lymphocytes. Immunol. Commun. 7:557-566, 1978.
Lefkowitz, S.S., Klager, K., Nemeth, D., and Pruess, M. Immunosuppression of mice by delta-9-tetrahydrocannabinol. Res. Commun. Chem. Pathol. Pharmacol. 19:101-107, 1978.
Legator, M.S., Weber, E., Connor, T., and Stoeckel, M. Failure to detect mutagenic effects of Δ-9-tetrahydrocannabinol in the dominant lethal test, host-mediated assay, blood-urine studies, and cytogenetic evaluation with mice, pp. 699-709. In Braude, M.C. and Szara, S. (eds.) Pharmacology of Marihuana. New York: Raven Press, 1976.
Leuchtenberger, C. and Leuchtenberger, R. Morphological and cytochemical effects of marijuana cigarette smoke on epithelioid cells of lung explants from mice. Nature 234:227-229, 1971.
Leuchtenberger, C., Leuchtenberger, R., and Schneider, A. Effects of marijuana and tobacco smoke on human lung physiology. Nature 241:137-139, 1973a.
Leuchtenberger, C., Leuchtengerger, R., Ritter, U., and Inui, N. Effects of marijuana and tobacco smoke on DNA and chromosomal complement in human lung explants. Nature 242:403-404, 1973b.
Lewis, C.R. and Slavin, R.G. Allergy to marijuana: A clinical and skin-testing study. J. Allergy Clin. Immunol. 55:131-132, 1975.
Liskow, B., Liss, J.L., and Parker, C.W. Allergy to marihuana. Ann. Intern. Med. 75:571-573, 1971.
Marks, B.H. Δ-1-tetrahydrocannabinol and luteinizing hormone secretion. Prog. Brain Res. 39:331-338, 1973.
Matsuyama, S.S., Jarvik, L.F., Fu, T., and Yen, F. Chromosome studies before and after supervised marijuana smoking, pp. 723-729. In Braude, M.C. and Szara, S. (eds.) Pharmacology of Marihuana. New York: Raven Press, 1976.
McDonough, R.J., Madden, J.J., Falek, A., et al. Alteration of T and null lymphocyte frequencies in the peripheral blood of human opiate addicts: In vivo evidence for opiate receptor sites on T lymphocytes. J. Immunol. 125:2539-2543, 1980.
Mendelson, J.H., Kuehnle, J., Ellingboe, J., and Babor, T.F. Plasma testosterone levels before, during and after chronic marihuana smoking. N. Engl. J. Med. 291:1051-1055, 1974.

Morishima, A., Milstein, M., Henrich, R.T., and Nahas, G.G. Effects of marihuana smoking, cannabinoids, and olivetol on replication of human lymphocytes: Formation of micronuclei, pp. 711-722. In Braude, M.C. and Szara, S. (eds.) Pharmacology of Marihuana. New York: Raven Press, 1976.

Morishima, A., Henrich, R.T., Jayaraman, J., and Nahas, G.G. Hypoploid metaphases in cultured lymphocytes of marihuana smokers, pp. 371-376. In Nahas, G.G. and Paton, W.D.M. (eds.) Marihuana: Biological Effects. Analysis, Metabolism, Cellular Responses, Reproduction and Brain. Oxford: Pergamon Press, 1979.

Nichols, W.W., Miller, R.C., Heneen, W. et al. Cytogenetic studies on human subjects receiving marihuana and Δ-9-tetrahydrocannabinol. Mutat. Res. 26:413-417, 1974.

Nicholson, M.T., Pace, H.B., and Davis, W.M. Effects of marihuana and lysergic acid diethylamide on leukocyte chromosomes of the golden hamster. Res. Commun. Chem. Pathol. Pharmacol. 6:427-434, 1973.

Nir, I., Ayalon, D., Tsafriri, A. et al. Suppression of the cyclic surge of luteinizing hormone secretion and of ovulation in the rat by Δ-1-tetrahydrocannabinol. Nature 243:470-471, 1973.

Pertwee, R.G. and Tavendale, R. Effects of Δ-9-tetrahydrocannabinol, 2.4-dinitrophenol and pentolinium tartrate on behavioral thermoregulation in mice. Br. J. Pharmacol. 66:39-50, 1979.

Petersen, B.H., Lemberger, L., Graham, J., and Dalton, B. Alterations in the cellular-mediated immune responsiveness of chronic marihuana smokers. Psychopharmacol. Commun. 1:67-74, 1975.

Petersen, B.H., Graham, J., and Lemberger, L. Marihuana, tetrahydrocannabinol and T-cell function. Life Sci. 19:395-400, 1976.

Petersen, B.H. and Lemberger, L. Effect of delta-9-tetrahydrocannabinol administration of antibody production in mice. Fed. Proc. 35:333, 1976.

Pruess, M.M. and Lefkowitz, S.S. Influence of maturity on immunosuppression by delta-9-tetrahydrocannabinol. Proc. Soc. Exp. Biol. Med. 158:350-353, 1978.

Purohit, V., Ahluwahlia, B.S., and Vigersky, R.A. Marihuana inhibits dihydrotestosterone binding to the androgen receptor. Endocrinology 107:848-850, 1980.

Rachelefsky, G.S., Opelz, G., Mickey, M.R., et al. Intact humoral and cell-mediated immunity in chronic marijuana smoking. J. Allergy Clin. Immunol. 58:483-490, 1976.

Rosenkrantz, H. In Report of an Addiction Research Foundation/World Health Organization (ARF/WHO) Scientific Meeting on Adverse Health of Behavioral Consequences of Marijuana Use. ARF/WHO, Toronto, 1981.

Sassenrath, E.N., Banovitz, C.A., and Chapman, L.F. Tolerance and reproductive deficit in primates chronically drugged with Δ-9-THC. Pharmacologist 21:201, 1979.

Seid, D.A. and Wei, E.T. Mutagenic activity of marihuana smoke condensates. Pharmacologist 21:204, 1979.

Shapiro, C.M., Orlina, A.R., Unger, P., and Billings, A.A. Antibody response to cannabis. JAMA 230:81-82, 1974.

Shapiro, C.M., Orlina, A.R., Unger, P.J., et al. Marihuana-induced antibody response. J. Lab. Clin. Med. 88:194-201, 1976.

Silverstein, M.J. and Lessin P. 2,4-dinitrochlorobenzene skin testing in chronic marihuana users, pp. 199-203. In Braude, M.C. and Szara, S. (eds.) Pharmacology of Marihuana New York: Raven Press, 1976.

Smith, C.G., Besch, N.F., Smith, R.G., and Besch, P.K. Effect of tetrahydrocannabinol on the hypothalamic-pituitary axis in the ovariectomized Rhesus monkey. Fertil. Steril. 31:335-339, 1979.

Smith, C.G., Besch, N.F., and Asch, R.H. Effects of marihuana on the reproductive system, pp. 273-294. In Thomas, J.A. and Singhal, R.L. (eds.) Advances in Sex Hormone Research Baltimore: Urban and Schwarzenberg, 1980.

Stenchever, M.A. and Allen, M. The effect of delta-9-tetrahydrocannabinol on the chromosomes of human lymphocytes in vitro. Am. J. Obstet. Gynecol. 114:819-821, 1972.

Stenchever, M.A., Kunysz, T.J., and Allen, M.A. Chromosome breakage in users of marihuana. Am. J. Obstet. Gynecol. 118:106-113, 1974.

Tyrey, L. Δ-9-Tetrahydrocannabinol suppression of episodic luteinizing hormone secretion in the ovariectomized rat. Endocrinology 102:1808-1814, 1978.

Tyre, L. Δ-9-Tetrahydrocannabinol: A potent inhibitor of episodic luteinizing hormone secretion. J. Pharmacol. Exp. Ther. 213:306-308, 1980.

Wehner, F.C., Van Rensburg, S.J., and Thiel, P.G. Mutagenicity of marijuana and transkei tobacco smoke condensates in the salmonella/microsome assay. Mutat. Res. 77:135-142, 1980.

White, S.C., Brin, S.C., and Janicki, B.W. Mitogen-induced blastogenic responses of lymphocytes from marihuana smokers. Science 188:71-72, 1975.

Zimmerman, A.M. and Raj, A.Y. Influence of cannabinoids on somatic cells in vivo. Pharmacology 21:277-287, 1980.

Zimmerman, A.M., Stich, H., and San, R. Nonmutagenic action of cannabinoids in vitro. Pharmacology 16:333-343, 1978.

Zimmerman, A.M., Bruce, W.R., and Zimmerman, S. Effects of cannabinoids on sperm morphology. Pharmacology 18:143-148, 1979.

6

BEHAVIORAL AND PSYCHOSOCIAL EFFECTS OF MARIJUANA USE

The mind-altering effects of marijuana underlie its widespread and increasing popularity. Marijuana users who experience effects on mood, perception, and motivation report that they seek the "high" and the "mellowing-out." However, under some circumstances many of these same effects can be considered adverse. Perceptual distortions that are sought by users pose risks for driving cars or using other machines. There is reason to be concerned about effects on learning by students using marijuana in school. Older adults receiving Δ-9-THC as therapy may be highly intolerant of altered consciousness and perceived loss of control. Thus, it has become a matter of practical as well as scientific interest to learn more about the effects of marijuana on the brain and behavior.

Many psychological and neuropsychological studies have been conducted to investigate specific effects of marijuana on behavior. These include studies of intellectual functions, such as memory, attention, sequential information processing, and decision-making, as well as perceptual and psychomotor functions. There is a methodological challenge in trying to design experiments that will discriminate reliably among these functions and determine precisely which is being affected when a drug produces a particular behavioral outcome. For example, one's ability to process and respond to environmental stimuli represents a chain of events. The sequence begins with a sensation or perception. Drugs can influence the manner, speed, and accuracy with which this input is received. The information must then be stored in memory, even if only very briefly, and then retrieved from memory to be integrated with recalled prior experiences and other sensory inputs. The response from the subject is the result of the integration of new and old information. A drug acting at any point in this chain of events can alter behavioral performance.

Studies of the effects of marijuana on complex behavior must be carefully interpreted, because there are numerous variables that can influence the results. First, there is the drug itself. The dose, type of preparation, route of administration, and speed of administration must be specified. Next, the user--his personality, level of innate ability, motivation to perform, and especially his previous experience with marijuana, are powerful influences on test results. Finally, there is the type of behavioral test and the setting in which it is performed. Simpler and well-practiced skills are less susceptible to disruption by drug effects than are novel or complex tasks. The studies in the literature vary in their attention to these factors.

Most of these studies have been carried out on male college students who volunteer for marijuana research. Although this age-group (19-25) represents a period of peak use of marijuana, it cannot be assumed that findings from a college population will generalize to other sectors of the youth population. The differing motives of student volunteers seriously confound the interpretation of results in intellectual areas, where it has been established that motivation plays a significant role in determining performance. Some dedicated users want to do well and demonstrate that marijuana has no harmful effect. Others are simply interested in obtaining the drug and enjoying its effects with little interest in the experiment. Additional methodological issues that recur in this body of research include: (a) reliance on self-reports by subjects regarding personal history of frequency and intensity of drug use, (b) occasional reliance on self-reports of drug dose and level of intoxication at the time of the experiment, (c) lack of standardized dosages and methods of administration of Δ-9-THC even when the drug is administered by the investigator, and (d) lack of attention to motives and beliefs of users and nonusers with whom they interact.

A representative sample of studies will be reviewed here, and a summary table of 88 reports of the relationship between marijuana use and behavioral and psychosocial functioning is available from the Institute of Medicine by request.

PERCEPTUAL AND PSYCHOMOTOR FUNCTIONS

Acute Effects

The studies reported here cover the range of commonly used doses* from very low up to 0.250 mg/kg of Δ-9-THC in marijuana cigarettes at a single sitting. These are acute effects--changes that can be seen after a single dose. The effects begin to be seen at about the same dose level at which a "high" is perceived (0.050-0.150 mg/kg Δ-9-THC). Generally the effects are dose-related. In other words, low doses have small effects; higher doses tend to have greater effects.

*Doses are reported in milligrams per kilogram (mg/kg) where provided by the authors or as total doses in milligrams with the route of administration.

Coordination

Marijuana has been found to impair motor coordination at doses commonly used in social settings by both naive and chronic users. The functions studied include: hand steadiness (Mayor's Committee on Marihuana, 1944; Clark et al., 1970; Milstein et al., 1975), body sway (Mayor's Committee on Marihuana, 1944; Kiplinger et al., 1971; Evans et al., 1973), and accuracy of execution movements (Rafaelsen et al., 1973; Milstein et al., 1975; Kvalseth, 1977). Studies have also showed a dose-related increase in impairment of postural stability as measured by increased body sway (Kiplinger et al., 1971).

Reaction Time

Reaction time is defined as the time lag between a signal and the response a subject makes to that signal. Most studies examine the time that it takes a subject to respond to a visual or auditory signal. The effects of marijuana on either speed of initial detection of the signal or speed of response have been inconsistent at doses commonly used in social settings ("low to moderate"). The same subjects are impaired at some times, but not at other times (Mayor's Committee on Marihuana, 1944; Clark et al., 1970; Dornbush et al., 1971; Moskowitz et al., 1972, 1974; Borg et al., 1975; Schaefer et al., 1977; Peeke et al., 1976; Stillman et al., 1977). The meaning of this inconsistency is uncertain, but it probably involves an effect on attention mechanisms. When a subject is intoxicated with marijuana, he is probably less likely to attend to the reaction time task. Perhaps it is when he does pay attention to the task that function on this test is not impaired.

Tracking

Tracking is the term used to describe the act of following a moving stimulus. It is an important component of driving and flying skills. Tracking behavior is highly sensitive to the effects of marijuana. Impairment of tracking occurs even at very low doses (4.5 mg by smoking) in naive subjects (Weil et al., 1968). Studies of experienced users have also demonstrated consistent impairment. The tracking impairment has been found to persist for 4 to 8 hours, well beyond the feeling of intoxication ("high") by one laboratory (Moskowitz and Sharma, 1979; Moskowitz et al., 1981). No other studies have measured the effects of marijuana beyond 2 hours. This finding on the long-lasting effects has very important implications, as will be discussed later when the effects of marijuana on driving are reviewed, and, therefore, such studies should be repeated by other investigators.

While reaction time studies (as noted above) showed inconsistent results, tracking behavior is regularly and significantly diminished by marijuana at doses usually used in social settings. Tracking tasks differ from reaction time studies, because the subject must continuously pay attention to the task. Since reaction time tests are intermittent, continuous attention is not required, and this may explain why reaction time studies fail to show consistent marijuana effects.

Sensory and Perceptual Functions

Tests that measure a subject's ability to detect a brief flash of light show significant impairment by low to moderate doses (2-3 mg are examples) of smoked marijuana (Sharma and Moskowitz, 1972, 1973, 1974; Moskowitz et al., 1972, 1974; Casswell and Marks, 1973; Jones and Stone, 1970). Sustained attention is required in signal detection tasks, and the relation between this sustained attention requirement and motivation effects has not been explored. Signal detection tasks are prototypes of perceptual demands found in man-machine interactions. The large reductions in signal detection that occur under the influence of marijuana may suggest a substantial risk for users who are operating machines. Other visual functions, such as visual search, that depend on eye movements are not impaired.

Intellectual and Cognitive Functions

The effects of marijuana on such intellectual and cognitive functions as verbal fluency, short-term memory, learning ability, calculation skills, ability to follow complex directions, and time sense have been investigated and are reported below. However, this area of study has been hampered by the lack of standard measures of functioning in the intellectual and cognitive areas tested. Overall, the investigation of marijuana effects on intellectual and cognitive functioning has not followed a logical progression.

Learning and Memory When studying the effects of drugs on learning, it is difficult to control all of the factors that might influence the results; for example, as noted above, how hard a subject tries to perform can make a big difference even in the presence of a sedating drug. Thus, it is not surprising that early studies of marijuana's effects gave inconsistent results.

More recently, several studies have demonstrated that a single moderate dose of marijuana impairs short-term memory. This effect is especially noticeable in the phases of short-term memory that are heavily dependent on attention, such as information acquisition and storage (Abel, 1970, 1971; Dornbush et al., 1971; Dittrich et al., 1973; Melges et al., 1974; Belmore and Miller, 1980). Examples of the types of impaired tasks would be remembering a sequence of numbers or syllables or memorising and following a sequence of directions.

Physiological changes have been monitored in some of the same studies in which intellectual impairment has been reported. Miller and Cornett (1978) found that increases in heart rate are produced by marijuana to about the same degree as impairment on intellectual tasks. This linking of a physiological marker with studies of behavioral effects is a useful model for research in this field.

<u>Time Sense</u> Another intellectual function influenced by marijuana is time sense. Under the influence of moderate doses of the drug, most investigators report that subjects consistently overestimate the amount of time that has elapsed. Thus, under the influence of marijuana, a given event is reported to last longer than it actually does last (Clark et al., 1970; Vachon et al., 1974; Tinklenberg et al., 1976a).

<u>State-Dependent Learning</u> State-dependent learning refers to a situation in which material that is learned while under the influence of a drug is remembered best in the state of drug intoxication in which it was originally learned. A series of studies were conducted with oral doses of 20 mg (in a subsequent study this dose was calibrated to 0.3 mg/kg) of Δ-9-THC to investigate the extent to which learning and memory are linked to the state of intoxication (Darley et al., 1973a,b, 1974, 1977). This modest dose of marijuana caused learning to take place more slowly than when the subject was drug-free. Once learned, recall of the learning that occurred during intoxication was best when the subject was again under the influence of marijuana. Although state-dependent learning occurs with marijuana, the quality of learning and recall is impaired because the information or problem-solving skills learned in the marijuana-intoxicated state will be reduced or impaired. These investigators believe that the major deficit is in the attention-storage phase of learning.

Oral Communication

Marijuana use in low to moderate doses impairs oral communication, especially clarity of sequential dialogue with other persons (Dornbush et al., 1971; Paul and Carson, 1973; Zeidenberg et al., 1973; Crockett et al., 1976; Miller et al., 1977a-d, 1978a,b, 1979; Pfefferbaum et al., 1977; Miller and Cornett, 1978; Natale et al., 1979; Belmore and Miller, 1980). Marijuana at moderate doses disrupts continuity of speech by impairing short-term memory (6-18 seconds duration) (Belmore and Miller, 1980). Communication while intoxicated is also impaired by the intrusion of irrelevant words and ideas into the stream of communication. When a list of words is learned and then the subjects are asked to recall those words without regard to sequence, words that were never in the original list are inserted during recall more often by subjects given Δ-9-THC than by those who were drug-free (Pfefferbaum et al., 1977; Miller and Cornett, 1978; Miller et al., 1978a,b). Zeidenberg et al. (1973) administered 5 mg Δ-9-THC orally and found that, in a social context, phrases became shorter, speech became slower, and there was greater lag time between the cue to talk and the actual onset of talking. These subjects were also less able to recognize three-letter nonsense syllables to which they had previously been exposed. Further, when experimental subjects were all given the same dose of Δ-9-THC, they reported different subjective levels of intoxication. Those who reported more intoxication showed greater disruption of two-person communication (Paul and Carson, 1973).

Experimental subjects who were asked to tell stories about ambiguous pictures (the Thematic Apperception Test) demonstrated drug impaired organization and integration of stories. The authors reported "a timeless, nonnarrative quality, with greater discontinuity in thought sequence and more frequent inclusion of contradictory ideas" (Roth et al., 1975). When asked to talk for five minutes on any topic, subjects under Δ-9-THC demonstrated decreased variability of language and an increase in personal references, as well as less detailing of items mentioned in the monologue and less critical evaluation of those items (Natale et al., 1979).

Auto Accidents

Simulator Studies

A driving simulator is a laboratory instrument that requires the subject to perform a sample of the behavior required in automobile driving situations. Simulators differ from most of the laboratory studies described above in that complex behavior is required. Although simulators are representative of the multitask character of driving, no one simulator is capable of presenting all aspects of driving simultaneously. The behavior sampled varies across simulators; however, in comparison to car driving situations, the simulator has the advantage of presenting a standard stimulus to all subjects.

Most simulator studies reveal impairment of driving skills following moderately intoxicating doses of marijuana such as 10-15 mg (Crancer et al., 1969; Dott, 1972; Ellingstad et al., 1973; Rafaelsen et al., 1973; Moskowitz et al., 1976; Smiley et al., 1981). These impairments have been reported in simulators that test the perceptual functions as well as those that test motor skills of car control.*

*Another type of simulator study examined marijuana's effect on performance in a flying simulator (Janowsky et al., 1976). Subjects smoked marijuana cigarettes with 0.09 mg/kg Δ-9-THC, a dose of Δ-9-THC commonly used in social settings. Significant impairment of short-term memory was noted. Subjects were unable to recall where they were in the execution of a task. On the simulator they tended to forget where they were in a given flight sequence.

Test Courses

Experimental studies of the effects of marijuana on closed course automobile driving performance show that this skill is impaired by marijuana. Car handling skills were reduced, as shown by objective measures (Klonoff, 1974; Hansteen et al., 1976; Attwood, in press). It should be noted that these studies, involving subjects under the influence of marijuana, examined performance in less complex situations than are actually met in real-life driving situations. However, a closed course has the advantages of standard conditions and safety factors. In real-life driving situations, the perceptual and cognitive demands are considerably more complex. The Klonoff (1974) study of driving performance on city streets indicates that smoked marijuana (5-10 mg Δ-9-THC) impairs judgment and concentration in addition to impairing car handling skills.

Accident Surveys

Experimental evidence of impairments caused by marijuana on psychomotor functions, judgment, and motor skills involved in driving has led to research on the relationship of the use of marijuana and automobile accidents. A strongly positive relationship between use of alcohol and increased driving risk has long been established. The techniques used to establish the relationship of alcohol to accidents might appear to offer an excellent paradigm for comparable marijuana-accident research. However, there have been practical reasons why the roadside survey model of using breath samples obtained from accident drivers and comparing those to breath samples of randomly selected drivers who are passing the accident site in the same direction, the same time of day, and same day of the week has not worked for marijuana studies. Whereas there has been 97 percent cooperation for alcohol breath analysis, marijuana determination requires a blood sample, and only a minority of drivers willingly cooperate. Further, marijuana has a quite different body distribution pattern due to its high fat solubility. Delta-9-THC is not only technically quite difficult to detect in samples of body fluid, but it may be active in the nervous system long after it is not detectable in blood. The detrimental effects on driving skills (Moskowitz and Sharma, 1979; Moskowitz et al., 1981) may even persist 4 to 8 hours beyond the time when the user has had subjective feelings of euphoria or sleepiness.

Several reports of accident surveys have recently been published (Teale et al., 1977; Cimbura et al., 1980; McBay and Owens, 1981), but all suffer from the problems discussed above and particularly from the lack of a reasonable comparison group. For example, one study reported that 16 percent of Boston drivers had Δ-9-THC in their blood (Sterling-Smith, 1975). There was no description of the group who declined to give a blood sample but provided breath or urine samples instead. Also, there is no information as to the frequency of finding Δ-9-THC in the blood of those drivers who have not had an accident or otherwise come to police attention. In addition, many users of marijuana also use other drugs so that data are available on only a few subjects who only used marijuana.

In an effort to obtain some reference point for the association of marijuana with accidents as compared with other drugs, Warren et al. (in press) reanalyzed the Cimbura et al. (1980) data. Twelve percent of the fatally injured drivers and pedestrians in that study had been found to have Δ-9-THC in their blood. The presence of other drugs was also determined and a culpability index was developed. A culpability index compares the frequency that a drug is found in drivers assigned responsibility for causing a collision with the frequency in individuals from the same sample who had not caused an accident.

Aspirin was found to have a culpability index of 1.0. That is, it was no more frequent in individuals assigned responsibility for a collision than on those who were not. This is of some significance because it serves as an internal check on the technique, agreeing with the a priori assumption that it would be unlikely for aspirin users to be overrepresented among those responsible for accidents. In contrast, subjects with cannabinoids present in the urine were found to have a culpability index of 1.7, the same culpability level found for the presence of alcohol. This indicates an excess of Δ-9-THC-positive drivers in the category responsible for accidents. The presence of antihistamines produced a culpability index of 1.5, and tranquilizers/antidepressants, 1.8.

Given the difficulties in executing epidemiologic studies where it is so difficult to obtain adequate control groups, it would appear that only tentative conclusions about marijuana's role in accidents can be reached. Supportive evidence that marijuana is a contributing cause of accidents comes from surveys of marijuana users who report they receive a higher-than-average number of tickets for driving violations and are involved in a higher-than-average number of accidents (Johnston, 1980). Nevertheless, the problems described above are yet to be solved. But the culpability index model presents a methodology that may be refined and utilized in future studies.

Alcohol-Marijuana Interactions

Surveys show that marijuana and alcohol are frequently consumed together (Fishburne et al., 1980; Johnston et al., 1980). Thus, it is important to determine what interactions, if any, occur between these two drugs. As both drugs have sedative properties, an additive effect would be expected and has been found in the few systematic investigations of the effects of this combination. One study reported that 0.05 percent blood alcohol level concentration (BAC) increased the impairment produced by 5 mg of smoked Δ-9-THC on tracking behavior (Manno et al., 1971). In a study using two doses of alcohol and two doses of marijuana, even the low dose of alcohol (0.07 percent BAC) and the low dose of Δ-9-THC (1.4 mg) impaired complex tracking in an additive fashion (Hansteen et al., 1976).

Higher doses produced more pronounced decrements. A combination of Δ-9-THC (0.320 mg/kg) and ethanol (a dose that produces a peak blood level of less than 0.08 percent BAC) has also produced an additive effect on the ability to perform on a psychomotor test (Belgrave et al., 1979). This additive effect would be of concern to those operating a motor vehicle.

The issue of alcohol-marijuana interactions is an important one, but currently few data are available. Clearly, more studies of marijuana's interaction with alcohol and other commonly used drugs are needed.

Chronic Effects

Animal Studies

Studies of chronic effects are necessary to determine whether a drug produces changes that persist after administration has stopped. In view of the theoretical possibility of cumulative or persistent marijuana effects, it is surprising that only a few laboratories have conducted experiments involving repeated dosing and testing for residual effects. Mice injected with 10 mg/kg Δ-9-THC for 20-40 days were found to be persistently impaired in new learning 100 days after the injections stopped (Radouco-Thomas et al., 1976). Similarly, rats given 20 mg/kg of Δ-9-THC orally for 180 days had learning still impaired 2 months after the Δ-9-THC treatment stopped (Fehr et al., 1976). This was confirmed by the same group in two subsequent studies (Fehr et al., 1979; Stiglick and Kalant, in press). Another group of investigators, however, could find no residual learning effects in monkeys 20 days after stopping comparable doses of Δ-9-THC (Ferraro and Grilly, 1974).

Human Studies

Clinical reports of memory impairment, lack of concentration, lethargy, etc., in nonintoxicated chronic users of marijuana have led to studies in which psychological testing was administered to users of marijuana and controls. The results of these studies are inconclusive. Several studies show impaired performance in users as compared to controls (Agarwal et al., 1975; Soueif, 1976; Wig and Varma, 1977; Mendhiratta et al., 1978); others found no significant residual effects in the marijuana users (Bowman and Pihl, 1973; Rubin and Comitas, 1975; Satz et al., 1976; Ray et al., 1978; Schaeffer et al., 1981). All of these studies can be criticized on methodological grounds, and the results have been disputed. This is not surprising, because it is technically very difficult to obtain a sample of chronic marijuana users, get them into a truly drug-free condition, test them, and similarly test an appropriate group of controls.

Several groups of investigators (Dornbush et al., 1972; Frank et al., 1976; Harshman et al., 1976; Rossi et al., 1977) examined chronic marijuana users before and after 21-94 days of chronic intoxication in a research hospital setting. None of the investigators found any psychological changes during postdrug testing. However, 2 months of use is a relatively short period of time for a change to be detected, and the subjects had already been using marijuana for at least a year prior to entering each study (Fehr et al., 1976).

The available studies of chronic behavioral effects lead to no clear conclusions. Although some animal studies demonstrated a learning deficit that persisted for months after daily marijuana exposure was discontinued, the human studies have such methodological weaknesses that they cannot be interpreted. A prospective concurrent cohort study and a retrospective case-control study of possible outcomes of and risk factors for use of marijuana could add useful information. (See research recommendations at the end of this chapter.)

CLINICAL SYNDROMES

In this section we will discuss both acute and chronic behavioral changes that have been reported in the clinical literature to be associated with the use of marijuana. An association based on case reports does not imply causality. Studies of appropriate control groups are necessary. In general, acute or immediate clinical effects of drugs can be determined scientifically much more readily than chronic or delayed effects. This is as true for marijuana as it is for alcohol and other drugs. Thus, the acute effects of marijuana are based on more solid evidence than are the reported chronic effects.

Acute Effects

The acute clinical effects of marijuana seem to occur on a continuum from mild dysphoria to acute brain syndrome. In the literature, three different syndromes have been described, although there is blurring of the boundaries in this classification and no general agreement as to diagnostic criteria.

Anxiety/Panic Reaction

A major portion of the evidence for this effect comes from reports by marijuana users themselves. Marijuana's popularity notwithstanding, a surprisingly high proportion of users report reactions that they regard as unpleasant or undesirable. For example, 33 percent of regular users reported that while intoxicated they occasionally experienced such symptoms as acute panic, paranoid reaction, hallucinations, and unpleasant distortions in body image (Tart, 1970; Negrete and Kwan, 1972). Another study reported that 16 percent of regular users reported anxiety, fearfulness, confusion, dependency, or aggressive urges as a "usual occurrence" (Halikas et al., 1971). Similar findings in groups of stable, well-adjusted, moderate users have been found by other investigators (Annis and Smart, 1973; Marcus et al., 1974). First-time users are more likely than are experienced users to report adverse reactions. The frequency of such reactions appears to be higher when the setting for use is not a favorable one; for example, when the user sees the environment as threatening.

These adverse psychological reactions also have been observed in subjects of laboratory experiments with marijuana. Such controlled observations of persons whose immediate prior mental status and whose dosage were known give a basis for concluding that acute adverse psychological reactions can occur under single moderate doses of marijuana. These effects are more likely at higher doses. They usually last no longer than 2 to 4 hours. Acute paranoid reactions under these controlled conditions have been reported (Mendelson and Meyer, 1972; Tassinari et al., 1973; Frank et al., 1976; Melges, 1976). Ingestion, in which titration of dose (dose adjustment as occurs during smoking) is difficult, may be more likely to produce adverse effects than administration by smoking marijuana. However, chronic use and interaction with other psychoactive substances are not required.

As frequently as these adverse reactions are observed and self-reported, medical treatment is rarely sought. For example, a college student health clinic reported only six students per year sought medical treatment for an adverse reaction to marijuana out of a student population of 20,000 (Pillard, 1970). In the general population, a diagnosis of acute cannabis reaction was found in only 10 cases out of 700,000 hospital admissions in the United States (Lundberg et al., 1971). In the U.S. Army, only 18 such cases were treated over a several-year period from a military population of 33,000 (Tennant and Groesbeck, 1972). There are no recent figures showing requests for medical treatment now that the use of marijuana is more intense, widespread, and reaching younger age-groups. However, a unique monitoring of drug causality behavior documenting emergency room encounters conducted by the Drug Enforcement Administration and the National Institute on Drug Abuse (U.S. Department of Health and Human Services, 1979) may in the future provide additional information about the frequency of adverse reactions to use of marijuana.

Dysphoric Reaction

Therapeutic trials have been carried out testing Δ-9-THC as a possible treatment for mood disorders (see Chapter 7). Severe dysphoric reactions characterized by disorientation, catatonialike immobility, acute panic, and heavy sedation have occurred in several patients. The dysphoric symptoms appeared at moderate doses comparable to those used in social settings. They lasted only a few hours and responded to discontinuation of the drug and reassurance of the patients (Kotin et al., 1973; Ablon and Goodwin, 1974).

Similar dysphoric reactions have been reported in cancer patients who were on a therapeutic trial of Δ-9-THC to control the nausea associated with chemotherapy. The symptoms, course, and response to ceasing use of the drug were identical to those described above. Investigators have suggested that the dysphoric response is more likely to occur in older patients not accustomed to drug use for whom the mood-altering effects are unanticipated and unwelcome (Shiling and Stillman, 1980).

Acute Brain Syndrome

Diagnostic criteria for the syndrome now called delirium and previously called acute brain syndrome appear in Diagnostic and Statistical Manual of Mental Disorders, Third Edition, 1980 (DSM III). These include: (a) a clouding of consciousness as manifested by impairment of ability to sustain attention to environmental stimuli, or impairment of ability to sustain goal-directed thinking or goal-directed behavior; (b) a disorder of memory or orientation; (c) perceptual disturbances; and (d) a change in sleep pattern and/or a change in psychomotor activity. The symptoms develop over a short period of time and fluctuate rapidly.

Both the symptom pattern and the course of the acute brain syndrome fit the descriptions of one type of behavior disorder associated with use of marijuana. It has been reported to develop in persons who have a history of prolonged, regular, heavy use of marijuana. It is defined as an "acute" brain syndrome because it comes on during the period of drug use and it gradually disappears after the drug is stopped. The majority of case reports have come from Eastern countries where the cannabis products customarily used have high potency (Spencer, 1970; Chopra and Smith, 1974; Meyer, 1975). It has also been reported in U.S. Army personnel stationed in Viet Nam (Talbott and Teague, 1969) and in Europe (Tennant, 1972), where soldiers had access to very high Δ-9-THC concentrations in cannabis substances. In contrast to the Indian public mental hospital patients who were hospitalized for many weeks, U.S. soldiers recovered in 3 to 11 days and returned to duty. This difference in duration may reflect sociocultural differences in length of in-patient treatment more than a difference in the disorder.

Withdrawal Syndrome

Studies of animals and human subjects given moderate to high doses of marijuana orally or by inhalation several times per day have demonstrated tolerance to many of the effects of marijuana (see Chapter 1). When such use of marijuana is stopped after several days, a withdrawal syndrome occurs. In human subjects, this resembles the typical mild withdrawal symptoms seen after prolonged sedative use (Jones and Benowitz, 1976). Subjects show irritability, agitation, insomnia, and EEG changes (see Chapter 4). These symptoms are self-limiting; they peak at 30 hours and disappear by 90 hours.

There is no clinical evidence that physical dependence plays an important role in persistent use of marijuana. Withdrawal symptoms would not be expected in intermittent users; however, daily round-the-clock users of high-dose marijuana may be expected to show some symptoms of withdrawal soon after stopping regular use.

Chronic Effects

Cannabis Psychosis

Cannabis psychosis refers to a chronic psychotic condition (out of contact with reality) reportedly seen in heavy marijuana users, but extending beyond the period of acute intoxication. Some authors have described a schizophrenialike picture with delusions and hallucinations, and others have stressed the existence of organic mental confusion. Most of the reports have come from observation of hospitalized patients in Asian and African countries (Asuni, 1964; Chopra and Smith, 1974; Thacore and Shukla, 1976). There are no reports in the North American literature. At this time, there is insufficient evidence to say that cannabis psychosis exists as a separate clinical entity (Murphy, 1963; Edwards, 1976).

"Amotivational Syndrome"

Clinicians coined the term "amotivational syndrome" to describe a characteristic set of personality changes seen in some daily users of marijuana (McGlothlin and West, 1968; Smith, 1968). The changes include apathy, loss of ambition, loss of effectiveness, diminished ability to carry out long-term plans, difficulty in concentrating, and a decline in school or work performance. As usually described, these changes are seen in frequent or daily users, and thus they may be considered a form of chronic intoxication. The term "amotivational syndrome" is not an official diagnosis, but there is agreement among many clinicians who treat young people that this constellation of symptoms is common. It may also be seen in nonmarijuana users, and daily use of marijuana is not always associated with loss of motivation.

The evidence presented for the linking of this syndrome with marijuana consists of case reports. For example, Baker and Lucas (1969) described the case of a man whom friends described as previously conscientious, capable, and effective; but after smoking hashish daily for 3 years, he changed into a person for whom use of drugs was a way of life and in whom a serious deterioration of social function was observed. Other reports consist of groups of cases with similar histories (Thurlow, 1971). The symptoms mentioned, in addition to loss of motivation, include falling grades, difficulties in concentration, intermittent confusion, and impaired memory. Some authors report improvement when use of marijuana is stopped (Kolansky and Moore, 1971, 1972).

A variety of other data support such a condition. In a large survey, daily marijuana users were asked about the drug's adverse effects (Johnston et al., 1980). The most common response was "loss of energy" (42 percent). Nearly a third (32 percent) of the daily users thought that marijuana caused them to be less interested in other activities than they had been before, and a third (34 percent) thought that it hurt their school and/or job performance. Another type of evidence comes from comparisons of college students who use marijuana with others who do not. Several such studies (Shean and Fechtmann, 1971; Linn, 1972; Simon, 1974; Finnell and Jones, 1975) found marijuana users had increased levels of psychological disturbance, lower academic performance, and lower performance on scales measuring attitudes toward achievement and purpose in life. But some studies in both the United States and foreign countries have failed to show significant differences between marijuana users and abstainers (Brill and Christie, 1974; Rubin and Comitas, 1975).

Interpretation of the evidence linking marijuana to "amotivational syndrome" is difficult. Such symptoms have been known to occur in the absence of marijuana. Even if there is an association between this syndrome and use of marijuana, that does not prove that marijuana causes the syndrome. Many troubled individuals seek an "escape" into use of drugs; thus, frequent use of marijuana may become one more in a series of counterproductive behaviors for these unhappy people.

The available evidence does not allow a sorting of the various possibilities in the relationship between use of marijuana and the complex of symptoms in the "amotivational syndrome." It appears likely that both self-selection and authentic drug effects contribute to the "motivational" problems seen in some chronic marijuana users (see Chapter 2). Persons who are experiencing loss of motivation, apathy, and the other aforementioned symptoms probably will worsen the situation by taking any sedating drug. They should be warned to avoid frequent use of marijuana, alcohol, and other nonprescribed drugs.

"Flashbacks"

In 1968, Keeler et al. reported four cases of the brief spontaneous recurrence of a mental state similar to that experienced during marijuana intoxication 1 to 21 days after the last drug use. Three of the four subjects complained of hallucinations comparable to flashbacks usually associated with LSD (Horowitz, 1969). Three separate reports of marijuana flashbacks followed (Smith, 1968; Favazza and Domino, 1969; Weil, 1970) and all of these latter subjects had used LSD prior to marijuana. In a survey of 720 servicemen, not a single case of flashback in any subject for whom hashish was the only drug consumed was documented (Tennant and Groesbeck, 1972). But in the same sample, 15 subjects were identified who had LSD flashbacks precipitated by use of marijuana. A larger sample of 2,001 army personnel (Stanton et al., 1976) revealed that use of marijuana had the highest and only statistically significant association with the precipitation of LSD flashbacks among five classes of abused drugs. Clinical studies also have provided evidence that marijuana precipitates a recurrence of the LSD flashbacks experience (Holsten, 1976; Abraham, 1981).

The existence of flashbacks following use of either LSD or marijuana is entirely based on self-reports, because there are no distinctive physical signs or tests, such as EEG changes, to identify this condition. There is no current pharmacological explanation of the phenomenon, and data regarding dose and time parameters do not exist. Still, the reports by users are reasonably consistent. Thus, there is clinical evidence that use of marijuana by those who have previously used LSD increases the likelihood of recurrence of the LSD experience.

Effects on Preexisting Mental Illness

The only evidence available regarding this issue consists of case reports of patients who had recovered and apparently were doing well until they used marijuana. There is no information on the number of mentally ill patients who have used marijuana without complications.

The available data, therefore, do not prove that marijuana worsens mental illness. Still, there are sufficient numbers of uncontrolled clinical reports showing a temporal association between use of marijuana and return of mental symptoms, so that patients should be warned of this possibility.

Patients with a history of schizophrenia may be particularly sensitive to marijuana's effects. Four schizophrenic patients who were otherwise well controlled with medication suffered serious relapse of their schizophrenic symptoms following use of marijuana (Treffert, 1978). Other cases have been reported (Smith and Mehl, 1970; Weil, 1970; Bernhardson and Gunne, 1972). These all were cases in which marijuana was purchased on the street, so the dose and purity were unknown.

Patients with mood disorders have also been reported to show worsening of mental symptoms after use of marijuana. For example, four cases are known in which marijuana apparently precipitated a relapse of psychotic (hypomanic) behavior (Harding and Knight, 1973). Furthermore, depressed patients treated with Δ-9-THC have been observed to show a high incidence of dysphoric reactions (Ablon and Goodwin, 1974).

Effects Sometimes Reported By Users

Mood Changes

There is a general belief that use of marijuana alters mood. This property is one of the desired effects sought by many users. Investigators have described a number of variables that enter into the mood response to marijuana (Jones, 1971). These include dosage, past experience, attitude, expectations, and setting. For example, individuals who used marijuana in isolation tended to be relaxed and slightly drowsy; in contrast, when the user was in a group situation, marijuana was associated with euphoria and lack of sedative effect (Jones, 1971). Further evidence that mood changes are not attributable solely to the pharmacological action of marijuana comes from a study that found that elevation in mood occurred immediately before use of marijuana and immediately after, but that mood was not correlated with other indicatic of the subjective level of intoxication (Rossi et al., 1978). Instead, mood was correlated significantly with the moods of others, whether or not the other persons were intoxicated.

It appears that preexisting mood can influence the decision to use marijuana. High school students who exhibit symptoms of depression are more likely than are others to begin using marijuana as well as other illicit drugs (Paton et al., 1977). There is some evidence that students use the drug as a self-prescribed remedy for their own mood problems, often reporting that they use marijuana as a means of psychological coping (Johnston et al., 1980; Kaplan, 1980).

A belief that marijuana can be used to alleviate clinical depression is not supported by other studies, including one in which Δ-9-THC was carefully tested as an antidepressant. It was given to depressed patients as an experimental treatment without success (Ablon and Goodwin, 1974) (see Chapter 7).

Interpersonal Behavior

Adolescents and young adults often report that they use marijuana to facilitate interaction in new social situations (Mirin and McKenna, 1975). In a survey of 704 midwestern undergraduate students, most reported that marijuana was a meaningful "tool of social bonding" (Linn, 1971). There seems to be a widespread belief that marijuana smoking has several facilitative effects, including enhanced social effectiveness, closer social bonding, heightened interpersonal sensitivity and empathy, and enhanced sexual pleasure. The subcultural lore on one of these measures of interpersonal behavior--sexual effects--has not been studied systematically either in surveys or in experimental studies. The effects on sex hormones are controversial (see Chapter 5). Studies in experimental situations have failed to show any enhancement of social interaction and, in fact, some decrements were noted (Galanter et al., 1974; Clopton et al., 1979; Janowsky et al., 1979). Data from natural settings rather than experimental settings are not available.

Effects on Aggression

Because marijuana users have been involved in delinquent behavior, a number of investigators have questioned whether use of marijuana enhances aggressiveness in human beings. There are specific concerns about potential links of use of marijuana to aggression. Both retrospective and experimental studies in human beings have failed to yield evidence that marijuana use leads to increased aggression. Most of these studies suggest quite the contrary effect. Marijuana appears to have a sedative effect, and it may reduce somewhat the intensity of angry feelings and the probability of interpersonal aggressive behavior (McGuire and Megaree, 1974; Tinklenberg, 1974; Salzman et al., 1976; Taylor et al., 1976; Tinklenberg et al., 1976b; Hemphill and Fisher, 1980).

SUMMARY

There is experimental evidence that marijuana seriously impairs psychomotor performance. Strong evidence for impairment has been found in:

- coordination as examined by hand steadiness, body sway, and accuracy of execution of movement;
- tracking performance;
- perceptual tasks;
- vigilance;
- performance on automobile driving and flying simulators; and
- operating automobiles on test roadways.

Less reliable evidence of impairment or reliable evidence of a small degree of impairment was found in reaction time, simple sensory functions, and control of eye movements. Although the effects that marijuana produces on psychomotor functions used in driving are clear, studies linking marijuana to auto accidents are inconclusive. The research is impaired by methodological problems related to the pharmacology of marijuana. One recent study reported that marijuana and alcohol had a similar degree of association with fatal accidents, but more investigation is needed.

Studies also have shown acute effects of marijuana on short-term memory. State-dependent learning also has been shown, in that information or problem-solving skills learned in the intoxicated state will be reduced or impaired in the drug-free state. One laboratory has shown tracking impairment to persist for 4 to 8 hours beyond the feeling of intoxication. Some animal studies demonstrate a learning deficit that persists for months after marijuana exposure has been discontinued, but human studies do not permit secure conclusions.

The acute clinical effects of marijuana are fairly well established, although there is no general agreement as to how to classify them. Anxiety and panic reactions have been reported by users and observed in experimental situations. They are not uncommon, but they rarely require medical attention. When marijuana is used to treat nausea and other conditions, mental effects can occur, which some patients, especially older persons, may regard as unpleasant. These mental effects may require cessation of the treatment.

Marijuana also has been found to produce an acute brain syndrome. This is a more severe mental problem consisting of confusion and loss of contact with reality. It lasts from several hours to several days and appears to be more likely to occur with higher doses.

Chronic effects of any drug are more difficult to assess than are immediate effects. The evidence that marijuana produces a chronic psychosis is not convincing. The possible role of marijuana in causing an amotivational syndrome is a matter of great concern. Apathy, poor school work or work performance, and lack of goals characterize a number of long-term marijuana users. But it has not been possible to determine how much is caused by use of marijuana and how much was antecedent; it seems likely that both factors (drug effect and self-selection) contribute to the motivational problems seen in chronic users of marijuana. Existing studies have produced conflicting results. None of the investigators has looked at effects on the very young daily marijuana user, who is regarded as potentially at high risk for damaging effects because of physiological and psychological immaturity.

There is clinical evidence that marijuana use by former LSD users may precipitate a recurrence of LSD-type hallucinations known as a "flashback." Other clinical evidence raises the possibility that marijuana use can worsen preexisting mental illness.

RECOMMENDATIONS FOR RESEARCH

The committee recommends the following types of studies.

- Systematic research on acute behavioral and psychosocial effects of marijuana should be extended to other age groups. There are virtually no data on prepubertal children, young adolescents, older adults, and aging persons.
- Studies of effects of daily use of marijuana on school children are greatly needed. These effects should include the learning of new material, physical, psychological, and social development, acquisition of coping skills, and tools of daily living.
- Systematic studies of long-term effects of marijuana are increasingly possible now that longitudinal studies have identified representative panels of persons known to be chronic heavy users. These studies should cover interactive effects of marijuana and other drugs on behavioral and psychosocial responses, especially interactions of alcohol and marijuana because of their frequency of associated use.
- Dosage effects should be restudied, taking into account the higher potency cannabis that is in current use. Further study is needed of the timing and depth of inhalation of cigarettes with standard doses of marijuana. More animal studies at varying doses are needed. In view of the long-term retention of marijuana in body tissues, further study is needed to see whether or not chronic users may have impairments of function even in the absence of an acute dose

of marijuana. The factors that influence the persistence of effects following an acute dose are not understood.

- The correlation of changes in a physiological marker, such as increased heart rate, with observations of behavioral effects should be encouraged.
- Many of these recommendations, along with those of other chapters, could be consolidated and carried out as part of a study that is both a prospective cohort study and a retrospective case-control study of possible outcomes and risk factors with marijuana use.
- A cohort of drug-naive junior high school students could be assembled and followed over time to see which students become marijuana users and which remain nonusers. Students would be subjected to physical and psychosocial testing at predetermined time intervals. The two groups would be evaluated in terms of the incidence of specific outcomes and the relative risks associated with these outcomes after appropriate follow-up periods.

In order to identify risk factors for marijuana use, individuals who become marijuana users would be compared to individuals who remain nonusers using a case-control methodology. By combining these two epidemiologic research strategies, the etiology and effects of marijuana use may be studied.

REFERENCES

Abel, E.L. Marijuana and memory. Nature 227:1151-1152, 1970.

Abel, E.L. Effects of marihuana on the solution of anagrams, memory, and appetite. Nature 231:260-261, 1971.

Ablon, S.L. and Goodwin, F.K. High frequency of dysphoric reactions to tetrahydrocannabinol among depressed patients. Am. J. Psychiatry 131:448-453, 1974.

Abraham, H.D. Visual disturbances in population of LSD users, Paper presented at the 134th Annual Meeting of the American Psychiatric Association, New Orleans, May 14, 1981.

Agarwal, A.K., Sethi, B.B., and Gupta, S.C. Physical and cognitive effects of chronic bhang (cannabis) intake. Indian J. Psychiatry 17:1-7, 1975.

Annis, H.M. and Smart, R.G. Adverse reactions and recurrences for marijuana use. Br. J. Addict. 68:315-319, 1973.

Asuni, T. Socio-psychiatric problems of cannabis in Nigeria. Bull. Narcotics 16:17-28, 1964.

Attwood, D.A. Cannabis, alcohol and driving: Effects on selected closed-course tasks. In Proceedings of the 8th International Conference on Alcohol, Drugs and Traffic Safety, June 15-19, 1980, Stockholm, Sweden (in press).

Baker, A.A. and Lucas, E.G. Some hospital admissions associated with cannabis. Lancet 1:148, 1969.

Belgrave, B.E., Bird, K.D., Chesher, G.B., et al. The effects of (-)trans-Δ-9-tetrahydrocannabinol, alone and in combination with ethanol, on human performance. Psychopharmacology 62:53-60, 1979.

Belmore, S.M. and Miller, L.L. Levels of processing and acute effects of marijuana on memory. Pharmacol. Biochem. Behav. 13:199-203, 1980.

Bernhardson, G. and Gunne, L.M. Forty-six cases of psychosis in cannabis abusers. Int. J. Addict. 7:9-16, 1972.

Borg, J., Gershon, S., and Alpert, M. Dose effects of smoked marihuana on human cognitive and motor functions. Psychopharmacologia 42:211-218, 1975.

Bowman, M. and Pihl, R.O. Cannabis: Psychological effects of chronic heavy use. A controlled study of intellectual functioning in chronic users of high potency cannabis. Psychopharmacologia 29:159-170, 1973.

Brill, N.Q. and Christie, R.L. Marihuana use and psychosocial adaptation. Arch. Gen. Psychiatry 31:713-719, 1974.

Casswell, S. and Marks, D. Cannabis induced impairment of performance of a divided attention task. Nature 241:60-61, 1973.

Chopra, G.S. and Smith, J.W. Psychotic reactions following cannabis use in East Indians. Arch. Gen. Psychiatry 30:24-27, 1974.

Cimbura, G., Warren, R.A., Bennett, R.C., et al. Drugs Detected in Fatally Injured Drivers and Pedestrians in the Province of Ontario Ottawa, Ontario: Traffic Injury Research Foundation of Canada, 1980.

Clark, L.D., Hughes, R., and Nakashima, E.N. Behavioral effects of marijuana: Experimental studies. Arch. Gen. Psychiatry 23:193-198, 1970.

Clopton, P.L., Janowsky, D.S., Clopton, J.M., et al. Marijuana and the perception of affect. Psychopharmacology 61:203-206, 1979.

Crancer, A., Dille, J.M., Delay, J.C., et al. Comparison of the effects of marihuana and alcohol on simulated driving performance. Science 164:851-854, 1969.

Crockett, D., Klonoff, H., and Clark, C. The effects of marijuana on verbalization and thought processes. J. Pers. Assess. 40:582-587, 1976.

Darley, C.F., Tinklenberg, J.R., Hollister, L.E., and Atkinson, R.C. Marihuana and retrieval from short-term memory. Psychopharmacologia 29:231-238, 1973a.

Darley, C.F., Tinklenberg, J.R., Roth, W.T., et al. Influence of marihuana on storage and retrieval processes in memory. Mem. Cognit. 1:196-200, 1973b.

Darley, C.F., Tinklenberg, J.R., Roth, W.T., and Atkinson, R.C. The nature of storage deficits and state-dependent retrieval under marihuana. Psychopharmacologia 37:139-149, 1974.

Darley, C.F., Tinklenberg, J.R., Roth, W.T., et al. Marijuana effects on long-term memory assessment and retrieval. Psychopharmacology 52:239-241, 1977.

Diagnostic and Statistical Manual of Mental Disorder, Third Edition (DSM III). Washington, D.C.: American Psychiatric Association, 1980.

Dott, A.B. Effect of Marijuana on Risk Acceptance in a Simulated Passing Task. DHEW Publication No. (HSM)72-10010. Washington, D.C.: U.S. Government Printing Office, 1972.

Dittrich, A., Battig, K., and Zeppelin, I.V. Effects of (-)-Δ^9-tetrahydrocannabinol (Δ^9-THC) on memory, attention and subjective state. Psychopharmacologia 33:369-376, 1973.

Dornbush, R.L., Fink, M., and Freedman, A.M. Marijuana, memory, and perception. Am. J. Psychiatry 128:194-197, 1971.

Dornbush, R.L., Clare, G., Zaks, G., et al. 21-Day administration of marijuana in male volunteers, pp. 115-128. In Lewis, M.F. (ed.) Current Research in Marijuana. New York: Academic Press, 1972.

Edwards, G. Cannabis and the psychiatric position, pp. 321-340. In Graham, J.D.P. (ed.) Cannabis and Health. New York: Academic Press, 1976.

Ellingstad, V.S., McFarling, L.H., and Struckman, D.L. Alcohol, Marijuana and Risk Taking. Contract No. DOT-HS-191-2-301. University of South Dakota, Vermillion, 1973.

Evans, M.A., Martz, R., Brown, D.J., et al. Impairment of performance with low doses of marihuana. Clin. Pharmacol. Ther. 14:936-940, 1973.

Favazza, A.R. and Domino, E.F. Recurrent LSD experience (flashbacks) triggered by marihuana. Univ. Mich. Med. Cent. J. 35:214-216, 1969.

Fehr, K.A., Kalant, H., Leblanc, A.E., and Knox, G.V. Permanent learning impairment after chronic heavy exposure to cannabis or ethanol in the rat, pp. 495-505. In Nahas, G.G. (ed.) Marihuana: Chemistry, Biochemistry, and Cellular Effects. New York: Springer-Verlag, 1976.

Fehr, K.O., Kalant, H., and Knox, G.V. Residual effects of high-dose cannabis treatment on learning muricidal behavior and neurophysiological correlates in rats, pp. 681-691. In Nahas, G.G. and Paton, W.D.M. (eds.) Marihuana: Biological Effects. Analysis, Metabolism, Cellular Responses Reproduction and Brain. Oxford: Pergamon Press, 1979.

Ferraro, D.P. and Grilly, D.M. Effects of chronic exposure to Δ-9-tetrahydrocannabinol on delayed matching-to-sample in chimpanzees. Psychopharmacologia 37:127-138, 1974.

Finnell, W.S. and Jones, J.D. Marijuana, alcohol and academic performance. J. Drug Educ. 5:13-21, 1975.

Fishburne, P.M., Abelson, H.I., and Cisin, I. National Survey on Drug Abuse: Main Findings: 1979. DHHS Publication No. (ADM)80-976. Washington, D.C.: U.S. Government Printing Office, 1980.

Frank, I.M., Lessin, P.J., Tyrrell, E.D., et al. Acute and cumulative effects of marihuana smoking in hospitalized subjects: A 36-day study, pp. 673-679. In Braude, M.C. and Szara, S. (eds.) Pharmacology of Marihuana. New York: Raven Press, 1976.

Galanter, M., Stillman, R., Wyatt, R.J., et al. Marihuana and social behavior. A controlled study. Arch. Gen. Psychiatry 30:518-521, 1974.

Halikas, J.A., Goodwin, D.W., and Guze, S.B. Marijuana effects: A survey of regular users. JAMA 217:692-694, 1971.

Hansteen, R.W., Miller, R.D., Lonero, L., et al. Effects of cannabis and alcohol on automobile driving and psychomotor tracking. Ann. N.Y. Acad. Sci. 282:240-256, 1976.

Harding, T. and Knight, F. Marihuana-modified mania. Arch. Gen. Psychiatry 29:635-637, 1973.

Harshman, R.A., Crawford, H.J., and Hecht, E. Marihuana, cognitive style, and lateralized hemispheric functions, pp. 205-254. In Cohen, S. and Stillman, R.C. (eds.) The Therapeutic Potential of Marihuana. New York: Plenum Medical Book, 1976.

Hemphill, R.E. and Fisher, W. Drugs, alcohol and violence in 604 male offenders referred for inpatient psychiatric assessment. S. Afr. Med. J. 57:243-247, 1980.

Holsten, F. Flashbacks: A personal follow-up. Arch. Psychiat. Nervenkr. 222:293-304, 1976.

Horowitz, M.J. Flashbacks: Recurrent intrusive images after the use of LSD. Am. J. Psychiatry 126:565-569, 1969.

Janowsky, D.S., Meachom, M.P., Blaine, J.D., et al. Marijuana effects on simulated flying ability. Am. J. Psychiatry 133:384-388, 1976.

Janowsky, D.S., Clopton, P.L., Leichner, P.O., et al. Interpersonal effects of marijuana. Arch. Gen. Psychiatry 36:781-785, 1979.

Johnston, L.D. The daily marijuana user. Paper presented at the meeting of the National Alcohol and Drug Coalition, Washington, D.C., September 18, 1980.

Johnston, L.D., Bachman, J.G., and O'Malley, P.M. Highlights from Student Drug Use in America, 1975-1980. DHHS Publication No. (ADM) 81-1066. Washington, D.C.: U.S. Government Printing Office, 1980.

Jones, R.T. Marihuana-induced "high": Influence of expectation, setting and previous drug experience. Pharmacol. Rev. 23:359-369, 1971.

Jones, R.T. and Benowitz, N. The 30-day trip--Clinical studies of cannabis tolerance and dependence, pp. 627-642. In Braude, M.C. and Szara, S. (eds.) Pharmacology of Marihuana. New York: Raven Press, 1976.

Jones, R.T. and Stone, G.C. Psychological studies of marijuana and alcohol in man. Psychopharmacologia 18:108-117, 1970.

Kaplan, H.B. Deviant Behavior in Defense of Self. New York: Academic Press, 1980.

Keeler, M.H., Reifler, C.B., and Liptzin, M.B. Spontaneous recurrence of marihuana effect. Amer. J. Psychiatry 125:384-386, 1968.

Kiplinger, G.F., Manno, J.E., Rodda, B.E., and Forney, R.D. Dose-response analysis of the effects of tetrahydrocannabinol in man. Clin. Pharmacol. Ther. 12:650-657, 1971.

Klonoff, H. Effects of marijuana on driving in a restricted area and on city streets: Driving performance and physiological changes, pp. 359-379. In Miller, L.L. (ed.) Marijuana: Effects on Human Behavior. New York: Academic Press, 1974.

Kolansky, H. and Moore, W.T. Effects of markhuana on adolescents and young adults. JAMA 216:486-492, 1971.

Kolansky, H. and Moore, W.T. Toxic effects of chronic marihuana use. JAMA 222:35-41, 1972.

Kotin, J., Post, R.M., and Goodwin, F.K. Delta-9-tetrahydrocannabinol in depressed patients. Arch. Gen. Psychiatry 28:345-348, 1973.

Kvalseth, T.O. Effects of marijuana on human reaction time and motor control. Percept. Mot. Skills 45:935-939, 1977.

Linn, L.S. Social identification and the use of marijuana. Int. J. Addict. 6:79-107, 1971.

Linn, L.S. Psychopathology and experience with marijuana. Br. J. Addict. 67:55-64, 1972.

Lundberg, G.D., Adelson, J., and Prosnitz, E.H. Marijuana-induced hospitalization. JAMA 215:121, 1971.

McBay, A.J. and Owens, S.M. Marihuana and driving, pp. 257-263. In Harris, L.S. (ed.) Problems of Drug Dependence, 1980. NIDA Research Monograph No.34. DHHS Publication No. (ADM) 81-1058. Washington, D.C.: U.S. Government Printing Office, 1981.

McGlothlin, W.H. and West, L.J. The marijuana problem: An overview. Am. J. Psychiatry 125:370-378, 1968.

McGuire, J.S. and Megaree, E.I. Personality correlates of marijuana use among youthful offenders. J. Consult. Clin. Psychol. 42:124-133, 1974.

Manno, J.E., Kiplinger, G.F., Scholz, N., et al. The influence of alcohol and marihuana on motor and mental performance. Clin. Pharmacol. Ther. 12:202-211, 1971.

Marcus, A.M., Klonoff, H., and Low, M. Psychiatric status of the marihuana user. Can. Psychiatr. Assoc. J. 19:31-39, 1974.

Mayor's Committee on Marihuana. The Marihuana Problem in the City of New York. Sociological, Medical, Psychological and Pharmacological Studies. Lancaster, Pa.: Jaques Cattell Press, 1944.

Melges, F.T., Tinklenberg, J.R., Deardorff, C.M., et al. Temporal disorganization and delusional-like ideation. Arch. Gen. Psychiatry 30:855-861, 1974.

Melges, F.T. Tracking difficulties and paranoid ideation during hashish and alcohol intoxication. Am. J. Psychiatry 133:1024-1028, 1976.

Mendelson, J. and Meyer, R. Behavioral and biological concomitants of chronic marihuana smoking by heavy and casual users. Technical Papers of the First Report of the National Committee on Marihuana and Drug Abuse, pp. 68-246. Washington, D.C.: U.S. Government Printing Office, 1972.

Mendhiratta, S.S., Wig, N.N., and Varma, S.K. Some psychological correlates of long-term heavy cannabis users. Br. J. Psychiatry 132:482-486, 1978.

Meyer, R.E. Psychiatric consequences of marijuana use: The state of the evidence, pp. 133-152. In Tinklenberg, J.R. (ed.) Marijuana and Health Hazards: Methodological Issues in Current Research. New York: Academic Press, Inc., 1975.

Miller, L.L., Cornett, T.L., Brightwell, D.R., et al. Marijuana: Effects on storage and retrieval of prose material. Psychopharmacology 51:311-316, 1977a.

Miller, L., Cornett, T., Drew, W., et al. Marijuana: Dose-response effects on pulse rate, subjective estimates of potency, pleasantness, and recognition memory. Pharmacology 15:268-275, 1977b.

Miller, L.L., McFarland, D.J., Cornett, T.L., et al. Marijuana: Effects on free recall and subjective organization of pictures and words. Psychopharmacology 55:257-262, 1977c.

Miller, L.L., McFarland, D., Cornett, T.L., and Brightwell, D. Marijuana and memory impairment: Effect on free recall and recognition memory. Pharmacol. Biochem. Behav. 7:99-103, 1977d.

Miller, L.L. and Cornett, T.L. Marijuana: Dose effects on pulse rate, subjective estimates of intoxication, free recall and recognition memory. Pharmacol. Biochem. Behav. 9:573-577, 1978.

Miller, L., Cornett, T.L., and McFarland, D. Marijuana: An analysis of storage and retrieval deficits in memory with the technique of restricted reminding. Pharmacol. Biochem. Behav. 8:327-332, 1978a.

Miller, L., Cornett, T.L., and Nallan, G. Marijuana: Effect on nonverbal free recall as a function of field dependence. Psychopharmacology 58:297-301, 1978b.

Miller, L.L., Cornett, T.L., and Wikler, A. Marijuana: Effects on pulse rate, subjective estimates of intoxication and multiple measures of memory. Life Sci. 25:1325-1330, 1979.

Milstein, S.L., MacCannell, K., Karr, G., and Clark, S. Marijuana-produced impairments in coordination. J. Nerv. Ment. Dis. 161:26-31, 1975.

Mirin, S.M. and McKenna, G.J. Combat zone adjustment: The role of marihuana use. Milit. Med. 140:482-485, 1975.

Moskowitz, H., Sharma, S., and McGlothlin, W. Effect of marihuana upon peripheral vision as a function of the information processing demands in central vision. Percept. Mot. Skills 35:875-882, 1972.

Moskowitz, H., Shea, R., and Burns, M. Effect of marihuana on the psychological refractory period. Percept. Mot. Skills 38:959-962, 1974.

Moskowitz, H., Ziedman, K., and Sharma, S. Visual search behavior while viewing driving scenes under the influence of alcohol and marihuana. Hum. Factors 18:417-432, 1976.

Moskowitz, H. and Sharma, S. The effects of marihuana on skills performance. Report to the National Institute on Drug Abuse, Contract No. 271-76-3316, Southern California Research Institute, Los Angeles, Calif., 1979.

Moskowitz, H., Sharma, S., and Ziedman, K. Duration of skills performance impairment under marijuana. American Association for Automotive Medicine Proceedings, October 1-3, 1981, pp. 87-96. San Francisco, Calif..

Murphy, H.B.M. The cannabis habit: A review of recent psychiatric literature. Bull. Narc. 15:15-23, 1963.

Natale, M., Zeidenberg, P., and Jaffe, J. Delta-9-tetrahydrocannibinol: Acute effects on defensive and primary-process language. Int. J. Addict. 14:877-889, 1979.

Negrete, J.C. and Kwan, M.W. Relative value of various etiological factors in short lasting, adverse psychological reactions to cannabis smoking. Int. Pharmacopsychiat. 7:249-259, 1972.

Paton, S., Kessler, R., and Kandel, D. Depressive mood and adolescent illicit drug use: A longitudinal analysis. J. Genet. Psychol. 131:267-289, 1977.

Paul, M.I. and Carson, I.M. Marihuana and communication. Lancet 2:270-271, 1973.

Peeke, S.C., Jones, R.T., and Stone, G.C. Effects of practice on marijuana-induced changes in reaction time. Psychopharmacology 48:159-163, 1976.

Pfefferbaum, A., Darley, C.F., Tinklenberg, J.R., et al. Marijuana and memory intrusions. J. Nerv. Ment. Dis. 165:381-386, 1977.

Pillard, R.C. Marijuana. N. Engl. J. Med. 283:294-303, 1970.

Radouco-Thomas, S., Magnan, F., Grove, R.N., et al. Effect of chronic administration of Δ^1-tetrahydrocannabinol on learning and memory in develping mice, pp. 487-498. In Braude, M.C. and Szara, S. (eds.) Pharmacology of Marihuana. New York: Raven Press, 1976.

Rafaelsen, L., Christrup, H., Bech, P., and Rafaelsen, O.J. Effects of cannabis and alcohol on psychological tests. Nature 242:117-118, 1973.

Ray, R., Prabhu, G.G., Mohan, D., et al. The association between chronic cannabis use and cognitive functions. Drug Alcohol Dependence 3:365-368, 1978.

Rossi, A.M., Kuehnle, J.C., and Mendelson, J.H. Effects of marihuana on reaction time and short-term memory in human volunteers. Pharmacol. Biochem. Behav. 6:73-77, 1977.

Rossi, A.M., Kuehnle, J.C., and Mendelson, J.H. Marihuana and mood in human volunteers. Pharmacol. Biochem. Behav. 8:447-453, 1978.

Roth, W.T., Rosenbloom, M.J., Darley, C.F., et al. Marihuana effects on TAT form and content. Psychopharmacologia 43:261-266, 1975.

Rubin, V. and Comitas, L. Ganja in Jamaica: A Medical Anthropological Study of Chronic Marijuana Use. The Hague: Mouton and Co., 1975.

Salzman, C., Van Der Kolk, B.A., and Shader, R.I. Marijuana and hostility in a small-group setting. Am. J. Psychiatry 133:1029-1033, 1976.

Satz, P., Fletcher, J.M., and Sutker, L.S. Neuropsychologic, intellectual, and personality correlates of chronic marijuana use in native Costa Ricans. Ann. N.Y. Acad. Sci. 282:266-306, 1976.

Schaefer, C.F., Gunn, C.G., and Dubowski, K.M. Dose-related heart-rate, perceptual, and decisional changes in man following marihuana smoking. Percept. Mot. Skills 44:3-16, 1977.

Schaeffer, J., Andrysiak, T., and Ungerleides, J.T. Cogention and long-term use of gauja (cannabis). Science 213:465-466, 1981.

Sharma, S. and Moskowitz, H. Effect of marihuana on the visual autokinetic phenomenon. Percept. Mot. Skills 35:891-894, 1972.

Sharma, S. and Moskowitz, H. Marihuana Dose Study of Vigilance Performance, Proceedings, 81st Annual Conference, American Psychological Association, pp. 1035-1036, 1973.

Sharma, S. and Moskowitz, H. Effects of two levels of attention demand on vigilance performance under marihuana. Percept. Mot. Skills 38:967-970, 1974.

Shean, G.D. and Fechtmann, F. Purpose in life scores of student marihuana users. J. Clin. Psychol. 27:112-113, 1971.

Shiling, D.J. and Stillman, R.C. (moderators). Psychological effects of THC in cancer. Paper session at the 133rd American Psychiatric Association annual meeting, San Francisco, California, May 6, 1980.

Simon, W.E. Psychological needs, academic achievement and marijuana consumption. J. Clin. Psychol. 30:496-498, 1974.

Smiley, A., Ziedman, K., and Moskowitz, H. Pharmacokinetics of drug effects on driving performance: driving simulator tests of marihuana alone and in combination with alcohol. Report to the National Institute on Drug Abuse, Contract No. 271-76-3316, 1981.

Smith, D.E. The acute and chronic toxicity of marijuana. J. Psychadelic Drugs 2:37-47, 1968.

Smith, D.E. and Mehl, C. An analysis of marijuana toxicity. Clin. Toxicol. 3:101-115, 1970.

Soueif, M.I. Some determinants of psychological deficits associated with chronic cannabis consumption. Bull. Narc. 28:25-42, 1976.

Spencer, D.J. Cannabis-induced psychosis. Br. J. Addict. 65:369-372, 1970.

Stanton, M.D., Mintz, J., and Franklin, R.M. Drug flashbacks. II. Some additional findings. Int. J. Addict. 11:53-69, 1976.

Sterling-Smith, R.S. Alcohol, marihuana and other drug patterns among operators involved in fatal motor vehicle accidents, pp. 93-105. In: Israelstam, S. and Lambert, S., eds. Alcohol, Drugs and Traffic Safety. Toronto: Addictive Research Foundation of Ontario, 1975.

Stiglick, A. and Kalant, H. Learning impairment in the radial-arm maze following prolonged cannabis treatment in rats. Psychopharmacology (in press).

Stillman, R.C., Wolkowitz, O., Weingartner, H., et al. Marijuana: Differential effects on right and left hemisphere functions in man. Life Sci. 21:1793-1800, 1977.

Talbott, J.A. and Teague, J.W. Marihuana psychosis: Acute toxic psychosis associated with the use of cannabis derivatives. JAMA 210:299-302, 1969.

Tart, C.T. Marijuana intoxication: Common experiences. Nature 226:701-704, 1970.

Tassinari, C.A., Ambrosetto, G., and Gastaut, H. Effects of marijuana and delta-9-THC at high doses in man. Electroencephalogr. Clin. Neurophysiol. 34:760, 1973.

Taylor, S.P., Vardaris, R.M., Rawtich, A.B., et al. The effects of alcohol and delta-9-tetrahydrocannabinol on human physical aggression. Aggressive Behav. 2:153-161, 1976.

Teale, J.D., Clough, J.M., King, L.J., et al. The incidence of cannabinoids in fatally injured drivers: An investigation by radioimmunoassay and high pressure liquid chromatography. *J. Forens. Sci. Soc.* 17:177-183, 1977.

Tennant, F.S. Drug abuse in the U.S. Army, Europe. *JAMA* 221:1146-1149, 1972.

Tennant, F.S. and Groesbeck, C.J. Psychiatric effects of hashish. *Arch. Gen. Psychiatry* 27:133-136, 1972.

Thacore, V.R. and Shukla, S.R.P. Cannabis psychosis and paranoid schizophrenia. *Arch. Gen. Psychiatry* 33:383-386, 1976.

Thurlow, H.J. On drive state and cannabis: A clinical observation. *Can. Psychiatr. Assoc. J.* 16:181-182, 1971.

Tinklenberg, J.R. Marijuana and human aggression, pp. 339-357. In Miller, L.L. (ed.) *Marijuana: Effects on Human Behavior*. New York: Academic Press, 1974.

Tinklenberg, J.R., Roth, W.T., and Kopell, B.S. Marijuana and ethanol: Differential efects on time perception, heart rate, and subjective response. *Psychopharmacology* 49:275-279, 1976a.

Tinklenberg, J.R., Roth, W.T., Kopell, B.S., and Murphy, P. Cannabis and alcohol effects on assaultiveness in adolescent delinquents. *Ann. N.Y. Acad. Sci.* 282:85-94, 1976b.

Treffert, D.A. Marijuana use in schizophrenia: A clear hazard. *Am. J. Psychiatry* 135:1213-1215, 1978.

U.S. Department of Health and Human Services, National Institute on Drug Abuse. *Project DAWN. Annual Report--1979.* Washington, D.C.: U.S. Government Printing Office, 1979.

Vachon, L., Sulkowski, A., and Rich, E. Marihuana effects on learning, attention and time estimation. *Psychopharmacologia* 39:1-11, 1974.

Warren, R., Simpson, H., Cimbura, G., et al. Drug Involvement in traffic fatalities in the province of Ontario. *Proceedings of the 24th Conference of the American Association for Automotive Medicine* (in press).

Weil, A.T., Zinberg, N.E., and Nelsen, J.M. Clinical and psychological effects of marihuana in man. *Science* 162:1234-1242, 1968.

Weil, A.T. Adverse reactions to marihuana, classification and suggested treatment. *N. Engl. J. Med.* 282:997-1000, 1970.

Wig, N.N. and Varma, V.K. Patterns of long-term heavy cannabis use in North India and its effects on cognitive functions: A preliminary report. *Drug and Alcohol Dependence* 2:211-219, 1977.

Zeidenberg, P., Clark, W.C., Jaffe, J., et al. Effect of oral administration of delta-9-tetrahydrocannabinol on memory, speech, and perception of thermal stimulation: Results with four normal human volunteer subjects. Preliminary report. *Compr. Psychiatry* 14:549-556, 1973.

7

THERAPEUTIC POTENTIAL AND MEDICAL USES OF MARIJUANA

There has been growing interest in the possibility that cannabis and its derivatives will be valuable for the treatment of several medical and psychiatric conditions. The 97th Congress, for example, introduced a bill (H.R. 4498) "to provide for the therapeutic use of marijuana in situations involving life-threatening or sense-threatening illness and to provide adequate supplies of marijuana for such use."

Most of the putative therapeutic effects of cannabis are believed to be mediated by the central nervous system. These include effects on appetite, nausea and vomiting, epilepsy, muscle spasticity, anxiety, depression, pain, and on glaucoma, asthma, and the symptoms of withdrawal from alcohol and narcotics. The literature on these and other therapeutic actions believed mediated by the central nervous system will be reviewed in this chapter.

In general, the committee finds that cannabis shows promise in some of these areas, although the dose necessary to produce the desired therapeutic effect is often close to one that produces an unacceptable frequency of toxic (undesirable) side-effects. What is perhaps more encouraging than the therapeutic effects observed thus far is that cannabis seems to exert its beneficial effects through mechanisms that differ from those of other available drugs. This raises the possibility that some patients who would not be helped by conventional therapies could be treated effectively with cannabis. A second possibility is that cannabis could be combined with other drugs to achieve a therapeutic goal, but with each drug being used at a lower dose than would be required if either were used alone. As a result, fewer side-effects would be expected to occur. It may be possible to reduce side-effects by synthesizing related molecules that could have a more favorable ratio of desired to undesired actions; this line of investigation should have high priority, because such synthetic derivatives may ultimately have widespread therapeutic use.

GLAUCOMA

Glaucoma is the leading cause of blindness in the United States. The term is used to describe a group of ocular diseases characterized by an increase in intraocular pressure, which damages the optic nerve and leads eventually to loss of vision. The disease affects over two million Americans of age 35 or older. Although there is increasing risk of glaucoma with increasing age, there are forms that develop in infancy. The National Society to Prevent Blindness (1980) also estimates that 300,000 new cases are diagnosed each year.

Treatment of glaucoma depends on the type and cause. It may be pharmacological or surgical. Surgery is useful treatment in relatively few cases; there is a high incidence of failure and serious complications may occur. Available antiglaucoma drugs are effective in regulating intraocular pressure in many patients, and are the mainstay of treatment in the most common form of glaucoma, but there are some adverse side-effects. Some patients are refractory to present forms of treatment and become blind as the disease progresses; for them, there is a particularly urgent need to find effective drugs.

Cannabis (the crude drug), Δ-9-THC (the pure compound), and some other cannabinoid derivatives lower intraocular pressure when administered by various routes, such as inhalation, oral, or intravenous. However, adverse side-effects of cannabis and Δ-9-THC also have been reported. Most patients with glaucoma are elderly, and have a reduced tolerance for many of these side-effects. Even without the adverse side effects, smoking, oral, and intravenous routes of administration are not suitable for the long term. For example, to give adequate control for intraocular pressure, four marijuana cigarettes per day of 2 percent Δ-9-THC would be necessary; this amount is considered heavy usage and could pose a serious health problem in long-term use. Therefore, topical application would be the most salutary route of administration for the patient who needs continuous treatment.

Human Studies

Interest in using cannabis for the treatment of glaucoma was first stimulated by the observation of Hepler et al. (1971, 1972) that intraocular pressure decreased when healthy human subjects smoked cannabis (0.9 percent and 1.5 percent Δ-9-THC content) using an ice-cooled water pipe. (See Green, 1979, for an extensive literature review.)

A study of the acute ocular effects of cannabis in 429 subjects showed there was a dose-related and statistically significant reduction of intraocular pressure following the smoking or ingestion of cannabis containing 1, 2, or 4 percent Δ-9-THC (Hepler et al., 1976a). The amount of pressure decrease was in the range of 30 percent for the cannabis that contained 2 percent Δ-9-THC. Nineteen hospitalized subjects who smoked cannabis of 1 or 2 percent

Δ-9-THC content were observed for 35 days and another 29 subjects were observed as in-patients for a total of 94 days. There was a consistent drop in intraocular pressure in those smoking the 2 percent cannabis and the reduction appeared to last 4 to 5 hours (Hepler et al., 1976a). The authors noted that there did not seem to be much of a cumulative effect on size of pupils or upon intraocular pressure response. Studies by other investigators have confirmed this effect of cannabis and Δ-9-THC in causing reduction of intraocular pressure in humans (Shapiro, 1974; Purnell and Gregg, 1975).

Perez-Reyes et al. in 1976 investigated the effect of intravenous infusion of six cannabinoids in healthy volunteers. Delta-8-THC, Δ-9-THC, 11-hydroxy-Δ-9-THC, cannabinol, cannabidiol, and 8-β-hydroxy-Δ-9-THC were tested on healthy subjects with normal intraocular pressure; Δ-8-THC, Δ-9-THC, and 11-hydroxy-THC caused the greatest reduction in pressure. Of these Δ-8-THC caused the largest decrease in intraocular pressure, with the least number of psychological side-effects.

In a preliminary study of 11 human glaucoma patients who smoked marijuana (1, 2, and 4 percent) or ingested Δ-9-THC (15 mg), intraocular pressure was lowered an average of 30 percent in 7 out of 11 patients (Hepler et al., 1976a). Another study showed that most patients had a decrease in intraocular pressure after ingestion of 15, 20, or 30 mg of Δ-9-THC and after smoking cannabis containing 1, 2, and 4 percent Δ-9-THC (Hepler et al., 1976b).

Ideally, the synthesis of a preparation that could be applied topically to the eye would be most desirable for humans, because this would allow for self-administration. However, initial studies in humans with a topical preparation of Δ-9-THC have not shown a consistent effect on intraocular pressure (Merritt et al., 1981). More work needs to be done on this possibility.

Animal Studies

While animal studies have supported the observation that Δ-9-THC lowers intraocular pressure after oral and topical administration in rabbits (Green et al., 1977a,b; 1978), and after intravenous administration in the cat (Innemee et al., 1979), the reduction in intraocular pressure is not completely understood. It may result in part from a central nervous system effect, and in part through action on the adrenergic system in the eye, probably mediated by the neurotransmitter norepinephrine.

Side-Effects

Marijuana and Δ-9-THC given orally, intravenously, or in cigarettes to control glaucoma cause systemic side-effects, such as increase in heart rate, decrease in blood pressure, and psychotropic effects. Some of these side-effects are significant enough to pose problems, particularly in patients with glaucoma, who are usually elderly. But on the other hand, some of these effects may disappear as tolerance (decreased response with repeated use) develops.

Tolerance to the Intraocular Pressure Reducing Effect

No tolerance was detected to the ocular effects of cannabis in rabbits after 1 year's topical instillation of the synthetic cannabinoids SP-1, SP-106, and SP-204 (Green and Kim, 1977; Green et al., 1977b). Hepler et al. (1976b) noted a ceiling effect in humans, in that the smoking of 22 cannabis cigarettes did not result in a significant decrease in eyeball pressure as compared with a subject who smoked only 2 cigarettes. The area of tolerance will need further study, especially if a cannabinoid preparation with a satisfactorily high ratio of therapeutic to side-effects can be found.

Summary

Cannabis, Δ-9-THC, other cannabinoid derivatives, and their synthetics, reduce intraocular pressure in humans when smoked, or given intravenously or orally. However, there are systemic side-effects as well as psychotropic effects that are of concern. It is not yet clear whether an effective topical preparation can be developed that will not have these side-effects. Future work should determine whether synthetic cannabinoids or cannabinoid analogues can be found that will be effective in treating glaucoma without causing side-effects.

ANTIEMETIC ACTION

Certain cancer chemotherapeutic agents regularly produce nausea and vomiting after oral or intravenous administration. Those that are most severe in that respect are cisplatin, actinomycin D, adriamycin, cyclophosphamide, methotrexate, and the nitrosoureas. Other anticancer compounds may produce nausea less regularly or in less marked fashion.

Because cancer chemotherapy now can produce increased survival in patients with some neoplasms (recurrent or metastatic breast cancer, small cell carcinoma of the lung, ovarian cancer, and others) and substantial cure rates in several (acute lymphoblastic leukemia, Hodgkins disease, germ cell tumors of the testis, etc.) nausea and vomiting that interfere with patients' willingness to continue therapy can be a life-threatening side-effect. Even for those willing to endure the symptoms, they can be extremely unpleasant and debilitating.

Established antiemetics (prochlorperazine and other phenothiazines) are not very effective against drug-induced emesis, and there is a need for new and more reliable antiemetic agents. Metoclopramide, a derivative of procainamide, has recently been shown to be more effective than prochlorperazine in certain situations and seems promising (Gralla et al., 1981).

The suggestion that cannabis might have some useful antiemetic activity in this setting arose about 1973, when patients receiving intensive chemotherapy for acute leukemia observed that their "social" use of cannabis appeared to reduce their customary nausea and vomiting.

Clinical Investigations

Several controlled studies have been reported. In one of the early ones (Sallan et al., 1975), Δ-9-THC in 15- or 20-mg doses by mouth was compared with a placebo in a randomized double-blind crossover trial in 22 patients whose nausea and vomiting had been shown refractory to other antiemetics. In 14 of 20 courses of treatment, patients obtained "complete or partial relief" with Δ-9-THC; in none of 22 courses did patients report benefit with the placebo. It was observed that the antiemetic effect of Δ-9-THC occurred only in association with the "high," and it was necessary to maintain the "high" in order to maintain the antiemetic effect.

In another controlled trial (Chang et al., 1979), 14 of 15 patients with osteogenic sarcoma treated with high-dose methotrexate had less nausea and vomiting with Δ-9-THC than with the placebo. In that study, patients with other tumors being treated with cytoxan and adriamycin did not respond as well. That report and others like it suggested that the antiemetic effect of Δ-9-THC against those chemotherapeutic agents that are moderate in their emetic potential (e.g., methotrexate) was pronounced, but that Δ-9-THC was less effective against those agents with severe emetic properties. In a similar study (Lucas and Laszlo, 1980), 38 of 53 patients with nausea and vomiting refractory to other antiemetics reported good results with Δ-9-THC. Among the failures were those treated with cisplatin, which has been characterized as one of the most emetic agents used in cancer chemotherapy.

In comparison with prochlorperazine, Δ-9-THC has also been reported to be more effective in preventing nausea and vomiting (Ekert et al., 1979; Sallan et al., 1980).

In a larger study (Frytak et al., 1979), of 116 patients treated with 5-fluouracil and methyl-CCNU, Δ-9-THC was said to be no more effective than prochlorperazine. In that study, in which nearly all patients were older than those in the other reported trials, the majority of patients considered the other side-effects of Δ-9-THC so unpleasant that they preferred either prochlorparazine or the placebo.

Another cannabinoid, a synthetic, nabilone, has been provided to several investigators for evaluation an an antiemetic agent; it has been licensed for use in Canada for treatment of nausea associated with cancer treatment. In the largest clinical study to date (Herman et al., 1979), nabilone was compared with prochlorperazine in a double-blind crossover trial. It was found more effective than prochlorperazine. The patients in that study preferred nabilone to prochlorperazine; the predominant side-effects were somnolence, dry mouth, and dizziness. Hallucinations occurred in a few patients. Euphoria of the type associated with cannabis was infrequent in that study. However, a study in dogs has revealed previously unrecognized late neurologic effects of nabilone at high doses (Archer et al., 1981). Monkeys and rats did not show similar toxic effects with long-term administration of nabilone (Archer et al., 1981), and further studies will be necessary to clarify the safety of this new agent.

Levonantradol is yet another synthetic cannabinoid, related to Δ-9-THC, which has been shown in preliminary clinical studies to have antiemetic action in patients with refractory chemotherapy-induced emesis (Diasio et al., 1981).

Uncontrolled Use of Δ-9-THC

In response to public and political pressures, the National Cancer Institute, the United States Drug Enforcement Agency, and the Food and Drug Administration have agreed to a program whereby the National Cancer Institute is making Δ-9-THC available through the pharmacies of approximately 500 teaching hospitals and cancer centers to physicians who wish to use Δ-9-THC in treating the nausea and vomiting of patients receiving cancer chemotherapy. This broad, uncontrolled program, in which no data other than the reporting of severe reactions are to be collected, may make it extremely difficult to obtain continuing valid evaluations of the effectiveness of Δ-9-THC in the management of nausea and vomiting due to cancer chemotherapy. Although the extent of use of Δ-9-THC under this program is difficult to evaluate, informal communication with the National Cancer Institute indicates that Δ-9-THC has been supplied in substantial quantities to several hundred hospital pharmacies. The problem is further complicated by the fact that the legislatures of 23 states have authorized the use of cannabis by any physician for the management of nausea and vomiting due to cancer chemotherapy. It is expected that little reliable information will be derived from such use.

Summary

There seems little doubt that Δ-9-THC and other cannabinoids are active against the severe nausea and vomiting produced by cancer chemotherapeutic agents. The extent of this activity, its relation to other antiemetics, and its relation to the other effects of the cannabinoids have not yet been accurately determined.

Cannabis leaf, smoked or eaten, is also antiemetic but its activity has been even less well determined than that of Δ-9-THC. Studies with other synthetic cannabinoids have barely begun and much remains to be learned in this field.

APPETITE STIMULANT

It has been stated by "social" users that the smoking of cannabis increases appetite. On that basis, there have been sporadic attempts to use it in patients with advanced cancer to overcome their customary debilitating weight loss.

In several of the studies in which Δ-9-THC was used as an antiemetic in patients receiving cancer chemotherapy, they were reported to have increased appetite and food intake. At this time, it is not certain whether that increase was due merely to relief of nausea and vomiting or to stimulation of appetite. One comparison of habitual marijuana users and controls matched for age and educational background showed increased caloric intake and weight gain among the users (Greenberg, et al., 1976). Furthermore, a double-blind controlled study (Hollister, 1971) of smokers of cannabis or placebo cigarettes provided with unlimited quantities of a high-caloric beverage indicated an increase in caloric consumption in those using cannabis compared with those using the placebo; however, the variability was very large and there was some question that cannabis could be considered a clinically significant appetite stimulant.

In another study of the psychological effects of Δ-9-THC in patients with advanced cancer, it was observed that Δ-9-THC appeared to stimulate appetite and retard weight loss (Regelson et al., 1976). In that study many patients refused to complete the 2-week trial because of unacceptable side-effects from Δ-9-THC.

The evidence to date suggests that there may be some influence of cannabis on appetite. However, it is not possible to separate that from the effect on nausea and vomiting. Further studies are in progress in cancer patients whose course is not complicated by nausea and vomiting.

ANTICONVULSANT ACTION

A large number of animal studies have been conducted using cannabis as an anticonvulsant. These can be divided into several categories. The first to be discussed will be maximal electroshock seizures (MES)* both in the rat and mouse (Loewe and Goodman, 1947; Sofia et al., 1971; Fujimoto, 1972; Consroe and Man, 1973; Karler et al., 1973; Chesher and Jackson, 1974; Karler et al., 1974; McCaughran et al., 1974; Karler and Turkanis, 1976; Consroe and Wolkin, 1977; Turkanis et al., 1977). In these studies there is a clear dose-response effect in the protection to MES conferred by cannabinol (CBN) and cannabidiol (CBD). Tolerance to the effect has frequently been reported. However, the tolerance noted with cannabinoids is similar to that seen with phenytoin (DPH). Further, even though tolerance to phenytoin develops with MES, this has not been shown to

*Electrical shock of maximum intensity to cause a major seizure.

MUSCLE RELAXANT ACTION

necdotal reports that cannabis is effective in
r spasticity. Petro (1980) has reported such
has carried out a double-blind study of the
HC on spasticity (Petro and Ellenberger,
ed that 10 mg of Δ-9-THC significantly reduced
clinical measurement and that quadriceps electromyograms
ced a decrease in interference pattern in four patients with
arily extensor spasticity. These are preliminary observations, but they suggest that further and more rigorous investigations of the use of cannabinoids in spasticity should be suggested to test their therapeutic effectiveness.

ANTIASTHMATIC EFFECT

Intensive, chronic smoking of concentrated cannabis produces several adverse effects on the airways, including mild bronchoconstriction. But acute smoking of cannabis as well as the ingestion of Δ-9-THC produces bronchodilation in normals and in subjects with chronic, clinically stable bronchial asthma of minimal to moderate severity (Tashkin et al., 1974). These bronchodilator effects were also investigated in individuals in whom an asthmatic attack was induced experimentally by exercise or methalcholine (Tashkin et al., 1975). Immediately after the development of bronchospasm, subjects smoked a cigarette containing 500 mg of cannabis assayed at either 1 or 2 percent Δ-9-THC.

Methalcholine inhalation promptly caused significant bronchoconstriction (an average decrease in airway conductance of 40-55 percent) and significant hyperinflation (mean increases in thoracic gas volume of 35-43 percent). After placebo smoking or saline inhalation, airway conductance increased only modestly, remaining significantly less than initial control values for 30 to 60 minutes, and thoracic gas volume decreased only gradually, remaining significantly increased for 15 minutes. However, after 2 percent cannabis, and after isoproterenol, there was a prompt return of airway conductance and thoracic gas volume to control values.

Exercise in the asthma-prone individual resulted in average decreases in airway conductance of 30-39 percent and average increase in thoracic gas volume of 25-35 percent. After placebo or saline, there was only a gradual return to control values during 30-60 minutes, but after cannabis, airway conductance and thoracic gas volume returned promptly to preexercise values. Four of the subjects who had previously used cannabis could detect pleasurable sensations after smoking cannabis, which distinguished these effects from those of the placebo cigarette. In that sense these experiments were not strictly blind. The four subjects who had no previous experience with cannabis did not experience any central nervous system effects but did note mild somolence or light-headedness after cannabis. The results of this study suggest that any bronchial irritant effects of be a clinically significant phenomenon. In these studies it is generally found that CBN is less effective against MES and against audiogenic seizures, the latter produced in rodents by loud noise, than CBD. In addition, Turkanis et al. (1977) have emphasized the fact that CBD acts more like DPH than other anticonvulsants and hence would be expected to be effective against major seizures rather than against minor seizures.

There is also extensive animal literature that CBN and CBD will protect against electrically induced, minimal (kindling) seizures (Corcoran et al., 1973; Fried and McIntyre, 1973; Izquierdo et al., 1973; Turkanis et al., 1977, 1979). Reduction of seizures produced by subcortical electrical stimulation in the cat has been reported (Wada et al., 1973). There appears to be much less effect on pentylenetetrazol-induced seizures (Consroe and Man, 1973; Turkanis et al., 1979). Any effect of CBN and CBD on such seizures occurs with maximal toxic doses (Turkanis et al., 1974). Protection against audiogenic seizures (Consroe et al., 1973) and against reflex seizures in the gerbil (Cox et al., 1975) have been reported.

Human studies are largely anecdotal and conflicting. There is one study by Cunha et al. (1980) in which 15 patients suffering from partial complex epilepsy with a temporal focus were randomly divided into two groups. Each patient received, in a double-blind procedure, 200-300 mg of CBD or placebo daily. The drugs were administered for as long as 4 1/2 months. Throughout the study, clinical and laboratory examinations, electroencephalograms, and electrocardiograms were performed at 15- to 30-day intervals. The patients continued their anticonvulsant medications taken before entering the study, on which all them had previously experienced uncontrolled seizures. All patients tolerated CBD well, and there were no signs of toxicity or serious side-effects. Four of the 8 CBD subjects remained nearly free of convulsions during CBD treatment and 3 other patients demonstrated partial improvement in their clinical condition. Cannabidiol was ineffective in 1 patient. The placebo group showed no alteration of seizure frequency. A series of 8 healthy volunteers given CBD showed no effects of the drug.

Summary

There is substantial evidence from animal studies to indicate that cannabinoids are effective in blocking both kindling seizures and MES, and this is particularly true for CBD. MES is a standard testing procedure for evaluation of anticonvulsant drugs. This is strong support for further investigation into the utility of CBD in human epilepsy. The one available carefully controlled human study is in accord with this review.

MUSCLE RELAXANT ACTION

There are widespread, anecdotal reports that cannabis is effective in relieving muscle spasm or spasticity. Petro (1980) has reported such effects in two cases and has carried out a double-blind study of the administration of Δ-9-THC on spasticity (Petro and Ellenberger, 1981). They reported that 10 mg of Δ-9-THC significantly reduced spasticity by clinical measurement and that quadriceps electromyograms demonstrated a decrease in interference pattern in four patients with primarily extensor spasticity. These are preliminary observations, but they suggest that further and more rigorous investigations of the use of cannabinoids in spasticity should be suggested to test their therapeutic effectiveness.

ANTIASTHMATIC EFFECT

Intensive, chronic smoking of concentrated cannabis produces several adverse effects on the airways, including mild bronchoconstriction. But acute smoking of cannabis as well as the ingestion of Δ-9-THC produces bronchodilation in normals and in subjects with chronic, clinically stable bronchial asthma of minimal to moderate severity (Tashkin et al., 1974). These bronchodilator effects were also investigated in individuals in whom an asthmatic attack was induced experimentally by exercise or methalcholine (Tashkin et al., 1975). Immediately after the development of bronchospasm, subjects smoked a cigarette containing 500 mg of cannabis assayed at either 1 or 2 percent Δ-9-THC.

Methalcholine inhalation promptly caused significant bronchoconstriction (an average decrease in airway conductance of 40-55 percent) and significant hyperinflation (mean increases in thoracic gas volume of 35-43 percent). After placebo smoking or saline inhalation, airway conductance increased only modestly, remaining significantly less than initial control values for 30 to 60 minutes, and thoracic gas volume decreased only gradually, remaining significantly increased for 15 minutes. However, after 2 percent cannabis, and after isoproterenol, there was a prompt return of airway conductance and thoracic gas volume to control values.

Exercise in the asthma-prone individual resulted in average decreases in airway conductance of 30-39 percent and average increase in thoracic gas volume of 25-35 percent. After placebo or saline, there was only a gradual return to control values during 30-60 minutes, but after cannabis, airway conductance and thoracic gas volume returned promptly to preexercise values. Four of the subjects who had previously used cannabis could detect pleasurable sensations after smoking cannabis, which distinguished these effects from those of the placebo cigarette. In that sense these experiments were not strictly blind. The four subjects who had no previous experience with cannabis did not experience any central nervous system effects but did note mild somolence or light-headedness after cannabis. The results of this study suggest that any bronchial irritant effects of placebo cannabis smoke were not sufficient to aggravate or perpetuate existing acute bronchospasm to an extent greater than that which might result from the irritant effect of inhaled saline. The results also demonstrate that inhaled Δ-9-THC causes a prompt and complete sustained reversal of methacholine-induced bronchospasm and correction of the associated hyperinflation. These effects were not significantly different from those observed after isoproterenol. although there was a tendency toward a greater degree of bronchial dilation after isoproterenol. Similarly, after inhalation of Δ-9-THC, there was a prompt return of airway conductance and thoracic gas volume during exercise-induced bronchospasm to the preexercise value. After exercise the effects of 10 mg Δ-9-THC was not as efficacious as 1.25 mg isoproterenol.

The way in which Δ-9-THC induces bronchial dilation has not been determined, but previous studies have shown that this effect is not mediated by beta-adrenergic stimulation or inhibition of muscarine receptors (Shapiro et al., 1973). A vagolytic mechanism is possible, as suggested by other studies carried out on the dog salivary gland (Cavero et al., 1972) and on guinea pig ileum (Gill et al., 1970).

Although ingestion of Δ-9-THC in a sesame oil vehicle has produced bronchodilation in asthmatic patients (Tashkin et al., 1974), less dilation was noted than after smaller doses of Δ-9-THC delivered by smoking. Its significant bronchodilator effect notwithstanding, Δ-9-THC does not appear to be suitable for that therapeutic use, because of its psychotropic effects and possibly other side-effects. However, other cannabinoid compounds such as cannabinol and cannabidiol do not produce the central nervous system effects of tachycardia characteristic of cannabis (Hollister, 1973) and deserve further investigation for possible bronchodilator activity.

ANTIANXIETY EFFECT

Users of cannabis have often reported that the drug produces feelings of relaxation and calmness, and some have reported its use to reduce anxiety. A problem with evaluating cannabis as an antianxiety drug, however, is that some subjects report increased anxiety or panic after using cannabis (see Chapter 6). For example, Regelson et al. (1976) found less tension and apprehension in cancer patients after cannabis use; but 6 of 50 subjects receiving Δ-9-THC reported such side-effects as severe dizziness, confused thinking, dissociation, and concern over loss of sanity. In normals, Pillard et al. (1974) found no effects of cannabis on experimentally induced anxiety. Nabilone, a synthetic cannabinoid, was found to reduce experimentally induced anxiety in normal volunteers but it was less effective than diazepam (Nakano et al., 1978). Nabilone was found to be more effective than placebo in patients with psychoneurotic anxiety (Fabre et al., 1978).

There are very few studies of cannabis effects on anxiety. There is no indication at this time that cannabis or nabilone are more effective or reliable than currently available antianxiety medication.

ANTIDEPRESSANT EFFECT

Regelson et al. (1976) reported a significant reduction in self-rated depressive symptoms in cancer patients treated with Δ-9-THC. However, in a carefully controlled trial with four bipolar and four unpolar depressed patients, Kotin et al. (1973) found no anti-depressant activity.

ANALGESIC ACTION

Several animal models have been used to show analgesic effects of cannabis and its analogues (for example, Grunfeld and Edery, 1969; Sofia et al., 1973). Human studies have been conflicting. Milstein et al. (1975) found increase in tolerance to experimentally induced pain after smoking cannabis, while Hill et al. (1974) were unable to detect effects using a different kind of experimental pain. Noyes et al. (1976) found a reduction in pain reports by cancer patients given oral Δ-9-THC; Regelson et al. (1976) also studied cancer patients and found no significant changes in pain after Δ-9-THC.

Those subjects who show analgesic effects of cannabis also show other pharmacological effects such as mental clouding. The literature does not indicate a specific effect of cannabis on pain pathways nor does it suggest that cannabis is likely to be more effective than currently available analgesics.

ALCOHOLISM

Cannabis has been proposed as a treatment for alcoholism (Scher, 1971) based upon case reports and on the observation that cannabis and alcohol were generally not used together. A systematic evaluation (Rosenberg et al., 1978) failed to find cannabis useful in alcoholism. Moreover, recent surveys (see Chapter 2) indicate that currently the abuse of cannabis and alcohol are frequently combined.

OPIATE WITHDRAWAL

Early clinical reports suggested that cannabis might be useful in suppressing the symptoms of opiate withdrawal (Birch, 1889; Thompson and Proctor, 1953). Recently a series of animal studies (Hine et al., 1975a,b; Bhargava, 1976) have found that Δ-9-THC suppresses many of the behavioral manifestations of withdrawal precipitated by naloxone in morphine dependent rodents. This effect is enhanced by cannabidiol (CBD) (Hine et al., 1975a,b), but CBD is not effective alone.

There are no reports of systematic evaluations of cannabis as a treatment of opiate withdrawal in human beings. The animal studies do not present evidence that cannabis is likely to be more effective than currently available treatments for opiate withdrawal.

ANTITUMOR ACTION

There is very little information about the effects of cannabis on neoplasms. In one study (Harris et al., 1976), minor effects were seen on the Lewis Lung Tumor but not in L1210 leukemia. In another study (White et al., 1976), it was found that Δ-9-THC inhibited tumor DNA replication somewhat. In that same study, cannabidiol appeared to have a growth enhancing effect on the Lewis Lung Tumor. These limited studies do not support a view that Δ-9-THC has a useful effect in inhibiting tumor growth.

SUMMARY

Cannabis and its derivatives have shown promise in the treatment of a variety of disorders. The evidence is most impressive in glaucoma, where their mechanism of action appears to be different from the standard drugs; in asthma, where they approach isoproterenol in effectiveness; and in the nausea and vomiting of cancer chemotherapy, where they compare favorably with phenothiazines. Smaller trials have suggested cannabis might also be useful in seizures, spasticity, and other nervous system disorders. Effective doses usually produce psychotropic and cardiovascular effects and can be troublesome, particularly in older patients.

Although marijuana has not been shown unequivocally superior to any existing therapy for any of these conditions, several important aspects of its therapeutic potential should be appreciated. First, its mechanisms of action and its toxicity in several diseases are different from those of drugs now being used to treat those conditions; thus, combined use with other drugs might allow greater therapeutic efficacy without cumulative toxicity. Second, the differences in action suggest new approaches to understanding both the diseases and the drugs used to treat them. Last, there may be an opportunity to synthesize derivatives of marijuana that offer better therapeutic ratios than marijuana itself.

RECOMMENDATIONS FOR RESEARCH

The committee believes that the therapeutic potential of cannabis and its derivatives and synthetic analogues warrants further research along the lines described in this chapter. There also may be significant heuristic benefits to be derived from the study of the biological mechanisms by which these compounds act.

Some therapeutic promise seems to be offered by synthetic cannabinoid analogues. The committee recommends that particular attention be paid to the treatment of chemotherapy-induced nausea and vomiting in cancer patients because current management of this important and widespread problem is inadequate and preliminary studies suggest that cannabinoids may have some special advantage. Cannabinoids or their analogues also may find a place in the management of resistant glaucoma, of severe intractable asthma, and of certain forms of seizures that are resistant to standard therapy. Continued carefully contracted clinical trials in these areas seem worthwhile at this time as do studies of the usefulness of cannabinoids in the treatment of muscle spasticity.

REFERENCES

Archer, R.A., Hanasono, G.K., Lemberger, L., and Sullivan, H.R. Update on nabilone research: the relationship of metabolism to toxicity in dogs, pp. 119-127. In Poster, D.S., Penta, J.S., and Bruno, S. (eds.) Treatment of Cancer Chemotherapy Induced Nausea and Vomiting. New York: Moser Publishing Co., 1981.

Bhargava, H.N. Effect of some cannabinoids on naloxone-precipitated abstinence in morphine-dependent mice. Psychopharmacology 49:267-270, 1976.

Birch, E.A. The use of Indian hemp in the treatment of chronic chloral and chronic opium poisoning. Lancet 1:625, 1889.

Cavero, I., Buckley, J.P., and Jandhyala, B.S. Parasympatholytic activity of (-)-delta-9-transtetrahydrocannabinol in mongrel dogs. Eur. J. Pharmacol. 19:301-304, 1972.

Chang, A.E., Shiling, D.J., Stillman, R.C., et al. Delta-9-tetrahydrocannabinol as an antiemetic in cancer patients receiving high-dose methotrexate: A prospective, randomized evaluation. Ann. Int. Med. 91:819-824, 1979.

Chesher, G.B. and Jackson, D.M. Anticonvulsant effects of cannabinoids in mice: Drug interactions within cannabinoids and cannabinoid interactions with phenytoin. Psychopharmacologia 37:255-264, 1974.

Consroe, P.F. and Man, D.P. Effects of delta-8- and delta-9-tetrahydrocannabinol on experimentally induced seizures. Life Sci. 13:429-439, 1973.

Consroe, P. and Wolkin, A. Cannabidiol--Antiepileptic drug comparisons and interactions in experimentally induced seizures in rats. J. Pharmacol. Exp. Ther. 201:26-32, 1977.

Consroe, P.F., Man, D.P., Chin, L., and Picchioni, A.L. Reduction of audiogenic seizure by delta-8- and delta-9-tetrahydrocannabinols. J. Pharm. Pharmacol. 25:764-765, 1973.

Corcoran, M.E., McCaughran, J.A., Jr., and Wada, J.A. Acute antiepileptic effects of delta-9-tetrahydrocannabinol in rats with kindled seizures. Exp. Neurol. 40:471-483, 1973.

Cox, B., ten Ham, M., Loskota, W.J., and Lomax, P. The anticonvulsant activity of cannabinoids in seizure sensitive gerbils. Proc. West. Pharmacol. Soc. 18:154-157, 1975.

Cunha, J.M., Carlini, E.A., Pereira, A.E., et al. Chronic administration of cannabidiol to healthy volunteers and epileptic patients. Pharmacology 21:175-185, 1980.

Diasio, R.B., Ettinger, D.S., and Satterwhite, B.E. Oral levonantradol in the treatment of chemotherapy-induced emesis: Preliminary observations. J. Clin. Pharmacol. 21:81S-85S, 1981.

Ekert, H., Waters, K.D., Jurk, I.H., et al. Amelioration of cancer chemotherapy-induced nausea and vomiting by delta-9-tetrahydrocannabinol. Med. J. Aust. 2:657-659, 1979.

Fabre, L.F., McLendon, D.M., and Stark, P. Nabilon, a cannabinoid, in the treatment of anxiety: An open-label and double-blind study. Curr. Ther. Res. 24:161-169, 1978.

Fried, P.A. and McIntyre, D.C. Electrical and behavioral attenuation of the anti-convulsant properties of delta-9-THC following chronic administrations. Psychopharmacologia 31:215-227, 1973.

Frytak, S., Moertel, C.G., O'Fallon, J.R., et al. Delta-9-tetrahydrocannabinol as an antiemetic for patients receiving cancer chemotherapy: A comparison with prochlorperazine and a placebo. Ann. Intern. Med. 91:825-830, 1979.

Fujimoto, J.M. Modification of the effects of delta-9-tetrahydrocannabinol by phenobarbital pretreatment in mice. Toxicol. Appl. Pharmacol. 23:623-634, 1972.

Gill, E.W., Paton, W.D.M., and Pertwee, R.G. Preliminary experiments on the chemistry and pharmacology of cannabis. Nature 228:134-136, 1970.

Gralla, R.J., Itri, L.M., Pisko, S.E., et al. Antiemetic efficacy of high-dose metoclopramide: Randomized trials with placebo and prochlorperazine in patients with chemotherapy-induced nausea and vomiting. N. Engl. J. Med. 305:905-909, 1981.

Green, K. The ocular effects of cannabinoids, pp. 175-215. In Zadunaisky, J.A. (ed.) Current Topics in Eye Research. New York: Academic Press, 1979.

Green, K. and Kim, K. Acute dose response of intraocular pressure to topical and oral cannabinoids. Proc. Soc. Exp. Biol. Med. 154:228-231, 1977.

Green, K., Bigger, J.F., Kim, K., and Bowman, K. Cannabinoid penetration and chronic effects in the eye. Exp. Eye Res. 24:197-205, 1977a.

Green, K., Kim, K., Wynn, H., and Shimp, R.G. Intraocular pressure, organ weights, and the chronic use of cannabinoid derivatives in rabbits for one year. Exp. Eye Res. 25:465-471, 1977b.

Green, K., Wynn, H., and Bowman, K.A. A comparison of topical cannabinoids on intraocular pressure. Exp. Eye Res. 27:239-246, 1978.

Greenberg, I., Kuehnle, J., Mendelson, J.H., and Bernstein, J.G. Effects of marihuana use on body weight and calorie intake in humans. Psychopharmacology 49:79-84, 1976.

Grunfeld, Y. and Edery, H. Psychopharmacological activity of some substances extracted from cannabis sativa L (hashish). Electroencephalogr. Clin. Neurophysiol. 27:219-220, 1969.

Harris, L.S., Munson, A.E., and Carchman, R.A. Antitumor properties of cannabinoids, pp. 749-762. In Braude, M.C. and Szara, S. (eds.) Pharmacology of Marihuana. New York: Raven Press, 1976.

Hepler, R.S. and Frank, I.M. Marijuana smoking and intraocular pressure. JAMA 217:1392, 1971.

Hepler, R.S., Frank, I.M., and Ungerleider, J.T. Pupillary constriction after marijuana smoking. Am. J. Ophthalmol. 74:1185-1190, 1972.

Hepler, R.S., Frank, I.M., and Petrus, R. Ocular effects of marijuana smoking, pp. 815-824. In Braude, M.C. and Szara, S. (eds.) Pharmacology of Marihuana. New York: Raven Press, 1976a.

Hepler, R.S. and Petrus, R.J. Experiences with administration of marijuana to glaucoma patients, pp. 63-75. In Cohen, S. and Stillman, R.C. (eds.) The Therapeutic Potential of Marihuana. New York: Plenum Medical Book Company, 1976b.

Herman, T.S., Einhorn, L.H., Jones, S.E., et al. Superiority of nabilone over prochlorperazine as an antiemetic in patients receiving cancer chemotherapy. N. Engl. J. Med. 300:1295-1297, 1979.

Hill, S.Y., Goodwin, D.W., Schwin, R., and Powell, B. Marijuana: CNS depressant or excitant? Am. J. Psychiatry 131:313-315, 1974.

Hine, B., Friedman, E., Torrelio, M., and Gershon, S. Tetrahydrocannabinol-attenuated abstinence and induced rotation in morphine-dependent rats: Possible involvement of dopamine. Neuropharmacology 14:607-610, 1975a.

Hine, B., Friedman, E., Torrelio, M., and Gershon, S. Morphine-dependent rats: Blockade of precipitated abstinence by tetrahydrocannabinol. Science 187:443-445, 1975b.

Hollister, L.E. Hunger and appetite after single doses of marihuana, alcohol, and dextroamphetamine. Clin. Pharmacol. Ther. 12:44-49, 1971.

Hollister, L.E. Cannabidiol and cannabinol in man. Experientia 29:825-826, 1973.

Innemee, H.C., Hermans, A.J.M., and Van Zwieten, P.A. The influence of delta-9-tetrahydrocannabinol on intraocular pressure in the anaesthetized cat. Doc. Ophthalmol. 48:235-241, 1979.

Izquierdo, I., Orsingher, O.A., and Berardi, A.C. Effect of cannabidiol and of other cannabis sativa compounds on hippocampal seizure discharges. Psychopharmacologia 28:95-102, 1973.

Karler, R. and Turkanis, S.A. The development of tolerance and "reverse tolerance" to the anticonvulsant activity of delta-9-tetrahydrocannabinol and cannabidiol, pp. 299-311. In Braude, M.C. and Szara, S. (eds.) Pharmacology of Marihuana. New York: Raven Press, 1976.

Karler, R., Cely, W., and Turkanis, S.A. The anticonvulsant activity of cannabidiol and cannabinol. Life Sci. 13:1527-1531, 1973.

Karler, R., Cely, W., and Turkanis, S.A. Anticonvulsant properties of delta-9-tetrahydrocannabinol and other cannabinoids. Life Sci. 15:931-947, 1974.

Kotin, J., Post, R.M., and Goodwin, F.K. Δ-9-Tetrahydrocannabinol in depressed patients. Arch. Gen. Psychiatry 28:345-348, 1973.

Loewe, S. and Goodman, L.S. Anticonvulsant action of marihuana-active substances. Fed. Proc. 6:352, 1947.

Lucas, V.S. and Laszlo, J. Delta-9-tetrahydrocannabinol for refractory vomiting induced by cancer chemotherapy. JAMA 243:1241-1243, 1980.

McCaughran, J.A., Corcoran, M.E., and Wada, J.A. Anticonvulsant activity of delta-8 and delta-9-tetrahydrocannabinol in rats. Pharmacol. Biochem. Behav. 2:227-233, 1974.

Merritt, J.C. Perry, D.D., Russell, D.N., and Jones, B.F. Tropical Δ-9-tetrahydrocannabinol and aqueous dynamics in glaucoma. J. Clin. Pharmacol. 21:467S-471S, 1981.

Milstein, S.L., MacCannell, K., Karr, G., and Clark, S. Marijuana-produced changes in pain tolerance. Experienced and nonexperienced subjects. Int. Pharmacopsychiat. 10:177-182, 1975.

Nakano, S., Gillespie, H.K., and Hollister, L.E. A model for evaluation of antianxiety drugs with the use of experimentally induced stress: Comparison of nabilon and diazepam. Clin. Pharmacol. Ther. 23:54-62, 1978.

National Society to Prevent Blindness. Facts and Figures, 1980.

Noyes, R., Brunk, S.F., Avery, D.H., and Canter, A. Psychologic effects of oral delta-9-tetrahydrocannabinol in advanced cancer patients. Compr. Psychiatry 17:641-646, 1976.

Perez-Reyes, M., Wagner, D., Wall, M.E., and Davis, K.H. Intravenous administration of cannabinoids and intraocular pressure, pp. 829-832. In Braude, M.C. and Szara, S. (eds.) Pharmacology of Marihuana. New York: Raven Press, 1976.

Petro, D.J. Marihuana as a therapeutic agent for muscle spasm or spasticity. Psychosomatics 21:81-85, 1980.

Petro, D.J. and Ellenberger, C. Treatment of human spasticity with Δ-9-tetrahydrocannabinol. J. Clin. Pharmacol. 21:413S-416S, 1981.

Pillard, R.C., McNair, D.M., and Fisher, S. Does marijuana enhance experimentally induced anxiety? Psychopharmacologia 40:205-210, 1974.

Purnell, W.D. and Gregg, J.M. Delta-9-tetrahydrocannabinol, euphoria and intraocular pressure in man. Ann. Ophthalmol. 7:921-923, 1975.

Regelson, W., Butler, J.R., Shulz, J., et al. Delta-9-tetrahydrocannabinol as an effective antidepressant and appetite-stimulating agent in advanced cancer patients, pp. 763-776. In Braude, M.C. and Szara, S. (eds.) Pharmacology of Marihuana. New York: Raven Press, 1976.

Rosenberg, C.M., Gerrein, J.R., and Schnell, C. Cannabis in the treatment of alcoholism. J. Stud. Alcohol 39:155-1958, 1978.

Sallan, S.E., Zinberg, N.E., and Frei, E. Antiemetic effect of delta-9-tetrahydrocannabinol in patients receiving cancer chemotherapy. N. Engl. J. Med. 293:795-797, 1975.

Sallan, S.E., Cronin, C., Zelen, M., and Zinberg, N.E. Antiemetics in patients receiving chemotherapy for cancer: A randomized comparison of delta-9-tetrahydrocannabinol and prochlorperazine. N. Engl. J. Med. 302:135-138, 1980.

Scher, J. Marijuana as an agent in rehabilitating alcoholics. Am. J. Psychiatry 127:971-972, 1971.

Shapiro, D. The ocular ma nfestations of the cannabinols. Ophthalmologica 168:366-369, 1974.

Shapiro, B.J., Tashkin, D.P., and Frank, I.M. Mechanism of increased specific airway conductance with marijuana smoking in healthy young men. Ann. Int. Med. 78:832-833, 1973.

Sofia, R.D., Solomon, T.A., and Barry, H. The anticonvulsant activity in delta-9-tetrahydrocannabinol in mice. Pharmacologist 13:246, 1971.

Sofia, R.D., Nalepa, S.D., Harakal, J.J., and Vassar, H.B. Anti-edema dna analgesic properties of Δ-9-tetrahyrocannabinol (THC). J. Pharmacol. Exp. Ther. 186:646-655, 1973.

Tashkin, D.P., Shapiro, B.J., and Frank, I.M. Acute effects of smoked marijuana and oral delta-9-tetrahydrocannabinol on specific airway conductance in asthmatic subjects. Am. Rev. Respir. Dis. 109:420-428, 1974.

Tashkin, D.P., Shapiro, B.J., Lee, Y.E., and Harper, C.E. Effects of smoked marijuana in experimentally induced asthma. Am. Rev. Respir. Dis. 112:377-386, 1975.

Thompson, L.J. and Proctor, R.C. The use of pyrahexyl in the treatment of alcoholic and drug withdrawal conditions. N.C. Med. J. 14:520-523, 1953.

Turkanis, S.A., Cely, W., Olsen, D.M., and Karler, R. Anticonvulsant properties of cannabidiol. Res. Commun. Chem. Pathol. Pharmacol. 8:231-246, 1974.

Turkanis, S.A., Chiu, P., Borys, H.K., and Karler, R. Influence of delta-9-tetrahydrocannabinol and cannabidiol on photically evoked after-discharge potentials. Psychopharmacology 52:207-212, 1977.

Turkanis, S.A., Smiley, K.A., Borys, H.K., et al. An electrophysiological analysis of the anticonvulsant action of cannabidiol on limbic seizures in conscious rats. Epilepsia 20:351-363, 1979.

Wada, J.A., Sato, M., and Corcoran, M.E. Antiepileptic properties of delta-9-tetrahydrocannabinol. Exp. Neurol. 39:157-165, 1973.

White, A.C., Munson, J.A., Munson, A.E., et al. Effects of delta-9-tetrahydrocannabinol in Lewis lung adenocarcinoma cells in tissue culture. J. Natl. Cancer Inst. 56:655-658, 1976.

8

FEDERAL SUPPORT OF RESEARCH ON MARIJUANA

PRESENT SOURCES AND AMOUNTS OF SUPPORT

In this chapter the committee has examined sources and amounts of federal support for research on cannabis and the areas of research support. The committee has not analyzed the scientific substance of the work, nor has it examined the strategy of research support or reviewed current unpublished research.

The overall federal support for research on cannabis for the fiscal years 1977, 1978, and 1979 has averaged slightly more than $4 million per year in real dollars (Table 4). During these years, 11 federal agencies allocated funds for this purpose. Of these, the National Institute on Drug Abuse (NIDA) has been the principal agency, accounting for over four-fifths of the total, therefore, our analysis will focus primarily on this agency.

For fiscal years 1975 through 1980, NIDA's support of research on cannabis amounted to $4.5, $2.9, $3.9, $3.6, $3.5, and $3.8 million, respectively, in real dollars, but in constant 1981 dollars, corrected by the GNP deflator, the same figures were $7.0, $4.2, $5.4 $4.6, $4.2, and $4.1 (Table 5). Although the total research budget of this agency for those years increased by approximately $12 million (real dollars), the percent spent on cannabis declined from 14.2 to 8.2 (Table 5). During the same period, the total number of projects on cannabis supported by NIDA was reduced by approximately 50 percent; however, the cost per project increased from $42,700 to $71,400 (real dollars). This increased cost per project is still somewhat lower than the mean cost of all projects funded by the National Institutes of Health in 1980 (Leventhal, 1981).

Table 6 shows the NIDA extramural research programs for fiscal years 1975 through 1981, allocated according to the type of drug being studied. In FY 1975 research on cannabis was allocated only 13 percent of the total extramural budget, whereas narcotics and narcotic antagonists received more than 40 percent. Thereafter, the percentage devoted to cannabis declined, to a low of 8 percent in FY 1979, but started to rise again slightly in FY 1980 and FY 1981. In the last year, an estimated 11 percent of the budget was spent on cannabis research. The percent of the budget allocated to narcotics and narcotic antagonists has declined steadily, while the percentages

TABLE 4 Cannabis Research by Federal Agency: FY 1977-1979 (real dollars in thousands)

	Total (77) No. of grants	Funds	Percent	Total (78) No. of grants	Funds	Percent	Total (79) No. of grants	Funds	Percent
ADAMHA[b]									
NIDA	75	3,910	90	64	3,596	88	65	3,536	84
NIMH	8	167	4	8	214	5	7	207	5
NIAAA	2	8	a	5	85	2	6	122	3
NIH									
NCI	4	91	2	2	80	2	2	85	2
NEI	--	--	0	3	68	2	1	36	1
NICHD	--	--	0	1	13	a	1	15	a
NIRR	--	--	0	2	26	0	--	--	0
NIGMS	--	--	0	--	--	0	1	9	a
OTHER AGENCIES									
VA	7	52	1	6	26	1	8	25	1
DOT	5	55	1	1	--	a	2	104	2
USDA	1	41	1	-	--	0	1	85	2
TOTAL	102	4,354		92	4,106		94	4,202	

[a]less than 1 percent.
[b]

ADAMHA Alcohol, Drug Abuse and Mental Health Administration
DHHS Department of Health and Human Services
DOT Department of Transportation
NCI National Cancer Institute
NEI National Eye Institute
NIAAA National Institute on Alcohol Abuse and Alcoholism
NICHD National Institute of Child Health and Human Development
NIDA National Institute on Drug Abuse
NIGMS National Institute of General Medical Sciences
NIH National Institutes of Health
NIMH National Institute of Mental Health
NIRR National Institute of Research Resources
VA Veterans Administration
USDA Department of Agriculture

Source: Adapted from information provided by NIDA.

TABLE 5 Total Research and Research on Cannabis in NIDA Budget

	FY '73	FY '74	FY '75	FY '76	FY '77	FY '78	FY '79	FY '80	FY '81
Total NIDA research budget (real dollars, thousands)	31,600	34,000	34,046	33,760	33,994	33,986	42,930	45,972	40,400
Total NIDA research budget (constant 1981 dollars, thousands)	58,500	58,700	53,500	49,600	46,800	43,800	51,000	50,300	40,400
Cannabis research budget (real dollars, thousands)	a	a	4,483	2,853	3,940	3,596	3,536	3,788	a
Cannabis research budget (constant 1981 dollars, thousands)	a	a	7,043	4,191	5,421	4,636	4,201	4,144	a
Percent cannabis research	a	a	14.2	9.1	11.6	10.6	8.2	8.2	a
Total cannabis projects (real dollars, thousands)	a	a	105	82	75	64	65	53	a
Mean cannabis project cost (real dollars, thousands)	a	a	42.70	34.8	52.5	56.2	54.4	71.5[b]	a
Mean cannabis project cost (constant 1981 dollars, thousands)	a	a	67.1	51.1	72.3	72.5	64.6	78.2	a

[a] Data unavailable at present time.
[b] Mean NIH Project Cost (1980) was 105.

Source: Adapted from information provided by NIDA.

TABLE 6 NIDA Extramural Research Program, Distribution by Drug (real dollars in thousands)

Drug Class	FY 1975 Amount	%	FY 1976 Amount	%	FY 1977 Amount	%	FY 1978 Amount	%	FY 1979 Amount	%	FY 1980 Amount	%	FY 1981[a] Amount	%
Cannabis	4,104	13	3,694	12	3,532	11	3,114	10	3,263	[illegible]	3,683	9	4,500	11
Depressants	1,642	5	1,527	5	1,976	6	1,557	5	1,123	3	1,495	4	1,000	3
Hallucinogens	316	1	729	2	1,572	5	1,515	5	2,358	6	2,865	7	3,000	7
Narcotics	9,787	31	11,298	36	11,766	37	9,341	30	8,947	23	10,667	25	10,000	25
Narcotic antagonists	3,473	11	3,061	10	3,017	10	3,526	11	3,879	10	2,304	5	2,800	7
Stimulants	1,926	6	2,360	8	2,291	7	2,535	8	2,778	7	3,277	8	4,000	10
Volatiles/solvents	158	1	363	1	496	2	556	2	294	1	278	1	500	1
Tobacco	--	--	--	--	110	0	934	3	1,130	3	2,973	7	3,200	8
Endogenous substances	--	--	--	--	--	--	1,337	4	2,717	7	2,607	6	3,400	8
Polydrug, unspecified, other	10,169	32	8,166	26	6,731	22	6,723	22	12,286	32	11,875	28	8,008	20
TOTAL	31,575	100	31,198	100	31,491	100	31,138	100	38,775	100	42,024	100	40,408	100

[a]Estimate.

Source: Adapted from information provided by NIDA.

devoted to hallucinogens, stimulants, and "endogenous substances" have increased.

In FY '80, only $3,683,000 (9 percent) of the extramural budget was devoted to cannabis research. Almost as much was spent that year by NIDA on stimulants and on tobacco. For comparison, the National Cancer Institute's budget for its program "Smoking and Health" was $13.2 million in FY '80, of which $3.9 million was allocated for tobacco research (Little, 1981). The National Heart, Lung, and Blood Institute allocated $8.2 million to study the effects of cigarette smoking on the cardiovascular repiratory system (Hurd, 1981).

AREAS OF RESEARCH SUPPORT

Cannabis research essentially began in the late 1960s with a National Institute of Mental Health program to produce "pedigreed" cannabis for research investigators. NIDA, which was created in 1972, started with an extramural budget of $29.6 million and an intramural budget of $4.0 million for fiscal year 1973 (Ludford, 1981). In the early 1970s, NIDA's major thrusts were (a) supplying (to researchers) standardized marijuana of a known concentration of Δ-9-THC and of known genetic stock, (b) facilitating administrative mechanisms, and (c) attempting to understand the problem of drug abuse, e.g., how many people use the drug, what are the acute effects, and what are its implications (Petersen, 1981).

Recently, NIDA's emphasis has shifted to studying certain groups, e.g., children, adolescents, and pregnant women, especially with respect to the long-term effects of cannabis on these groups (Petersen, 1981). The NIDA program plan for fiscal year 1982 stresses that chronic and acute studies need to be conducted on the effects of cannabis and other drugs of abuse on women and adolescents, with a special emphasis on: (a) in-depth behavioral and biological studies of the amotivational syndrome ("burn-out"), and (b) the development of approaches to treatment. Also specifically targeted are studies of the effects on brain function and structure.

Table 7 presents the NIDA projects on cannabis for fiscal years 1978, 1979, and 1980 stratified by research goal. These research goals are defined in the footnote to the table. For fiscal years 1978, 1979, and 1980, most of the money devoted to research on cannabis (approximately $3 million annually) was spent in three areas: (1) hazards of cannabis use, (2) basic research, and (3) research support. This last goal includes the growth, processing, packaging, and distribution of cannabis, as well as the development of the Δ-9-THC capsule. It is instructive to compare this distribution of cannabis funds with the distribution of the total research funds of NIDA. In FY '80, research on hazards took only 12 percent of the total NIDA research budget, basic research 42 percent, and research support 19 percent (Pollin, 1981).

The allocation of funds, by research topic, for fiscal years 1978, 1979, and 19[illegible], is presented in Table 8. The largest proportion of the funds has been allocated to two research topics: (1) drug

TABLE 7 NIDA Cannabis Projects by Research Goal: FY 1978-1980 (real dollars in thousands)

Goals	FY 1978	FY 1979	FY 1980
1. Epidemiology	238	54	61
2. Etiology	145	133	136
3. Prevention	77		48
4. Hazards	916	990	1,236
5. Therapeutic uses of cannabis	43	49	50
6. Treatment of cannabis abuse	11	2	82
7. Basic research	972	1,295	1,036
8. General research support	1,194	1,013	1,139
TOTAL	3,596	3,536	3,788

1. Epidemiology--to determine the incidence, prevalence, trends, and distribution of drug abuse by sex, race, geographic origin, and other special characteristics.

2. Etiology--to determine the etiologic factors associated with drug abuse, including those combinations of biological, psychological, and societal factors most associated with increased risk for misuse and/or abuse of drugs.

3. Prevention--to develop and test new strategies and methods which might decrease, postpone, or modify drug-abusing behavior

4. Hazards--to determine the hazards of drug abuse to the physical and mental health of the individual and its adverse effects on society.

5. Therapeutic uses--to study the effectiveness and safety of cannabis in the treatment of various medical conditions.

6. Treatment--to determine the most effective therapeutic procedures for reducing drug abuse including new and innovative treatment methods and development of more effective drugs to be used in treatment.

7. Basic research--to advance basic knowledge of the pharmacology, biochemistry, and neurophysiology of drugs, the basic mechanisms involved in drug tolerance, and dependence and the underlying processes involved in addictive and/or habitual behaviors.

8. Research support--to develop the methodological and support resources required to further drug abuse research; to provide for the publication and evaluation of research results, the analysis and supply of controlled substances, and the development of chemical methods to detect and assay drugs.

Source: Adapted from information provided by NIDA.

TABLE 8 NIDA Cannabinoid Projects by Research Topic: FY 1978-1980 (real dollars in thousands)

	FY 1978	FY 1979	FY 1980
Assay and models	482	302	268
Drug development, synthesis, and distribution	706	756	950
Psychophysiology	54	76	16
Performance (esp. driving)	193	111	76
Reproduction and development	491	864	849
Behavioral studies	124	62	15
Other drug effects/toxicity	397	347	440
Metabolism and pharmacokinetics	261	446	259
Immunology	69	85	--
Drug interactions	--	64	97
Chemistry	67	58	103
Mechanism of tolerance and dependence	285	174	134
Cultural/ethnic	195	45	69
Patterns and lifestyle	57	80	127
Crime/law	137	66	337
Abuse liability	76	--	48
TOTAL	3,594[a]	3,536	3,788

[a]Due to rounding of numbers, the total value is not exactly the same as in Table 7.

Source: Adapted from information provided by NIDA.

development, synthesis, and distribution; and (2) drug effects on reproduction and development.

Grants, Contracts, and Intramural Projects

Tables 9 through 11 compare the number of grants, contracts, and intramural projects on cannabis, as well as the funds expended by each agency for fiscal years 1977, 1978, and 1979. In each of these years, most of the extramural awards and most of the money involved investigator-initiated research grants. The ratio of grant to contract funds rose during this period from approximately 1.5 in FY '77 to almost 3.0 in FY '79. For NIDA as a whole, that ratio has consistently been much higher; in FY '79, for example, the funding of grants was more than five times that of contracts.

Support of investigator-initiated research grants requires that grant applications be approved by a peer review committee. In the peer review process, each approved grant is given a priority score based on scientific merit of the proposal (scaled from 100 to 500, with 100 the highest). This priority score determines the order in which available funds are dispersed. The award rate for all drug research supported by NIDA is shown in Table 12. The percentage of grants recommended for approval has increased slightly over recent years, as has the total number of grant applications. However, the percent of approved grants that has been funded has gone down sharply, as shown in the table. For FY '81 it is estimated that only 25 percent of all applicants were ultimately funded. The priority score at the 90th percentile of funded applications has also been declining, and in 1981 was estimated at 190. These data suggest that there has been no decline in the quality of funded grants--if anything, the quality has risen during the past few years.

The number of investigator-initiated projects has decreased slightly but still exceeds the number of contracts and intramural projects. Grants generally are for a period of 3 years (renewable on a year-to-year basis), with a maximum period of 5 years (Petersen, 1981). Contract projects are funded on a year-to-year basis and are mainly concerned with the growth, processing, packaging, and distribution of cannabis, as well as with the development of the Δ-9-THC capsule.* A few studies are conducted on toxicology and pharmacokinetics (Petersen, 1981). For fiscal years 1977, 1978, and 1979, the number of contracts has declined: 16, 14, and 10, respectively. However, the requests for proposals for fiscal years 1980 and 1981 have increased to 12 and 14, respectively (Ludford, 1981).

Intramural projects account for a small portion of the budget; for fiscal years 1977, 1978, and 1979, they have been declining.

---

*NIDA has requested that the NIH take over the cost and distribution of the drugs for clinical studies (Snyder, 1981).

TABLE 9 Cannabinoid Research by Agency: FY 1977
(real dollars in thousands)

	Grants		Contracts		Intramural		Total	
	No.	Funds	No.	Funds	No.	Funds	No.	Funds
ADAMHA								
NIDA	55	2,267	16	1,629	4	44	75	3,940
NIMH	8	167	--	--	--	--	8	167
NIAAA	2	8	--	--	--	--	2	8
NIH								
NCI	4	91	--	--	--	--	4	91
NEI	--	--	--	--	--	--	--	--
NCHD	--	--	--	--	--	--	--	--
NIRR	--	--	--	--	--	--	--	--
NIGMS	--	--	--	--	--	--	--	--
OTHER AGENCIES								
VA	--	--	--	--	7	52	7	52
DOT	--	--	2	55	--	--	2	55
USDA	--	--	--	--	1	41	1	41
TOTAL	69	2,533	18	1,684	12	137	99	4,354

Source: Adapted from information provided by NIDA.

SUMMARY OF FINDINGS

Total federal support for research on cannabis has been declining in real dollars over the past 3 years. Most of that support comes from the NIDA research budget, which allocates approximately 10 percent of its resources to this purpose. The current level of funding, under 4 million dollars, supports only about 50 extramural projects and represents only one-tenth of the total research program of NIDA. This decline in support has inexplicably occurred during a period when the concern of the public and of all levels of government seems to be rising. It cannot be explained by lack of interest in the field, for research grant applications have risen; neither can it be

TABLE 10 Cannabinoid Research By Agency: FY 1978
(real dollars in thousands)

	Grants		Contracts		Intramural		Total	
	No.	Funds	No.	Funds	No.	Funds	No.	Funds
ADAMHA								
NIDA	47	2,104	14	1,460	3	30	64	3,594
NIMH	5	158	--	--	3	56	8	214
NIAAA	5	85	--	--	--	--	5	85
NIH								
NCI	2	80	--	--	--	--	2	80
NEI	3	68	--	--	--	--	3	68
NCHD	1	13	--	--	--	--	1	13
NIRR	2	26	--	--	--	--	2	26
NIGMS	--	--	--	--	--	--	--	--
OTHER AGENCIES								
VA	--	--	--	--	6	26	6	26
DOT	--	--	1	[a]	--	--	1	[a]
USDA	--	--	--	--	--	--	--	--
TOTAL	65	2,534	15	1,460	12	112	92	4,106

[a]Indicates a funding level of less than $1000.

Source: Adapted from information provided by NIDA.

attributed to lack of scientific opportunity; for every area we have studied, the committee has identified important questions that seem amenable to new research efforts. (Many of these have been enumerated in the preceding chapters.)

In FY '80, NIDA spent a nearly equal amount on stimulant drugs and more than four times as much on narcotics and narcotic antagonists. Most of the cannabis research is devoted to three areas in approximately equal amounts: (1) growth, processing and distribution; (2) hazards of cannabis use; and (3) basic research. Three quarters of all the federal research money devoted to cannabis goes to

TABLE 11 Cannabinoid Research by Agency: FY 1979
(real dollars in thousands)

	Grants		Contracts[a]		Intramural		Total	
	No.	Funds	No.	Funds	No.	Funds	No.	Funds
ADAMHA								
NIDA	54	2,608	10	925	1	3	65	3,536
NIMH	4	145	--	--	3	62	7	207
NIAAA	6	122	--	--	--	--	6	122
NIH								
NCI	2	85	--	--	--	--	2	85
NEI	1	36	--	--	--	--	1	36
NICHD	1	15	--	--	--	--	1	15
NIRR	--	--	--	--	--	--	--	--
NIGMS	1	9	--	--	--	--	1	9
OTHER AGENCIES								
VA	--	--	--	--	8	25	8	25
DOT	--	--	2	104	--	--	2	104
USDA	--	--	1	85	--	--	1	85
TOTAL	69	3,020	13	1,114	12	90	94	4,224

[a]FY '80: RFP 12
FY '81: RFP 14

Source: Adapted from information provided by NIDA.

investigator-initiated extramural research grants, and most of the rest to extramural contracts. There is relatively little intramural research. The fraction of NIDA grants approved is about 60 percent, but the fraction funded is slightly more than half of that. The total number of cannabis research grants is declining steadily as support (in constant dollars) continues to fall and the average cost of a project (in constant dollars) goes up.

The committee believes that the magnitude of the problem, and the extent and depth of public concern about the consequences of marijuana use warrant more support of research in this field.

TABLE 12 Drug Abuse Research Grant Award Rates and Priority Scores

	1979 Actual	1980 Actual	1981 Estimate	1982 Estimate
Applicants received (number)	359	369	382	360
Percent recommended for approval	59	62	63	62
Percent funded of those approved during year	63	57	40	27
Percent funded of all applicants	37	35	25	20
90 percent priority score	244	230	190	170

Source: Adapted from information provided by NIDA.

Emphasis should be on studies of human beings and other primates, and investigator-initiated research grants should continue to be the primary vehicle of support.

RECOMMENDATIONS

In view of the demonstrated high potential of risk to human health that has been associated with the use of cannabis, the existing funds allocated to such research are not appropriate. The committee's recommendations to federal agencies regarding support of cannabis-related research are:

- More support of cannabis research is needed. Properly allocated, it could pay large dividends in new knowledge and could help to dispel present ignorance in many critical areas. Without this new information, the present level of public anxiety and controversy over the use of marijuana is not likely to be resolved in the forseeable future. Furthermore, we are not likely to improve our present slow progress in developing information about possible therapeutic uses of cannabis and its analogues without the stimulus of increased research grant support. At the end of each of the chapters, we have pointed out opportunities or problems that are ripe at this time.
- A larger proportion of NIDA resources could justifiably be allocated to cannabis research. Without wishing to minimize the value of any of the other drug research programs now supported by NIDA, we believe that the magnitude and social urgency of the marijuana problem warrant a higher priority for cannabis research

than it has apparently received to date. A drug that is currently used by about a third of all American high school seniors, and daily by about one in eleven, deserves more study than we currently are giving it. No other illicit drug is used as widely by our youth, and yet NIDA spent only 9 percent of its research budget on it in FY '80.

• NIDA would be advised to continue its recent policy of reducing the relative proportion of contracts and emphasizing grants. Although we believe that there is need for federal initiatives in stimulating work in neglected areas of current concern, the bulk of research suport should continue to go to investigator-initiated projects.

• The duration for investigator-initiated research should be lengthened beyond the average 3-year period in order to attract and hold good researchers.

• Other agencies should contribute funds for the production, processing, and distribution of cannabis.

• A scientific advisory group should be formed to assist in providing scientific evidence and guidance to the director of NIDA.

• An increased interagency effort targeted toward specific problems not readily addressed by other approaches is required. These would include, for example, human long-term studies, as well as studies in epidemiology, prevention, and treatment. Funds should be contributed by all agencies.

• Research on human beings and other primates should be encouraged, particularly studies in the young. There is a special need at this time for good epidemiological studies that follow identifiable cohorts of marijuana users over a period of time.

REFERENCES

Hurd, Susan. National Heart, Lung, and Blood Institute. Bethesda, Md. Personal communication, 1981.

Little, Francine. National Cancer Institute, Bethesda, Md. Personal communication, 1981.

Leventhal, Carl. National Institute of Arthritis, Metabolism, and Digestive Diseases, Bethesda, Md. Personal communication, 1981.

Ludford, Jacqueline. National Institute on Drug Abuse, Rockville, MD. Personal communication, 1981.

Petersen, Robert. National Institute on Drug Abuse, Rockville, Md. Personal communication, 1981.

Pollin, W. Statement on Drug Abuse Research before the Subcommittee on Alcoholism and Drug Abuse, Committee on Labor and Human Resources. United States Senate, July 27, 1981.

Snyder, Marvin. National Institute on Drug Abuse, Bethesda, Md. Personal communication, 1981.

Appendix

A

WORK OF THE COMMITTEE

To conduct this study, the Institute of Medicine established a committee of experts drawn from relevant disciplines, including clinical medicine, epidemiology, pharmacology, psychiatry, and toxicology. This steering committee's expertise was augmented by consultants, as well as by many other persons serving as panel members. Six panels, each chaired by a committee member, were formed to carry out a detailed analysis of such special issues as the effects of cannabis use on behavioral and psychosocial development, on reproductive and fetal biology, on cardiovascular and respiratory systems, and to consider neurobiologic, genetic, oncogenic, and cytogenetic issues, and cell biology, including pharmacologic and immunologic aspects. During the early months of the study, the panels met to apportion writing responsibilities, and established the scope and focus of each panel's undertaking. The chronology of the panel meetings follows.

February 3, 1981: Panel on Behavioral and Psychosocial Issues met in Washington
February 18, 1981: Panel on Neurobiological Issues met in Washington
February 26, 1981: Panel on Cardiovascular and Respiratory Issues met in New York City
February 27, 1981: Panel on Genetic/Oncogenic/Cytogenetic Issues met in Washington
March 11, 1981: Panel on Reproductive and Fetal Issues met in Boston
March 16, 1981: Subpanel on Intrapersonal Variables and Social Behavior of the Panel on Behavioral and Psychosocial Issues met in Los Angeles
March 23, 1981: Panel on Cell Biology/Pharmacological and Immunological Issues met in Boston
April 14, 1981: Panel on Behavioral and Psychosocial Issues met in Washington

The steering committee, in the meantime, nominated additional candidates for membership on the panels and committee at its first meeting on December 1, 1980. Subsequently, four more meetings were held, on April 15, 1981, June 2-3, 1981, August 31-September 1, 1981, and October 26, 1981. The first two were held in Washington, the third meeting was held in Woods Hole, Massachusetts, and the final meeting was held in Washington.

The committee made full use of research in other countries as well as the United States. A special effort was made to coordinate activities with the staff of the Addiction Research Foundation/World Health Organization Conference on Adverse Health and Behavioral Consequences of Cannabis Use. The group's draft report and working papers were made available to the IOM committee. The mandate of this group was to consider the scientific, clinical, and epidemiological information about potential and actual hazards to health.

Because of widespread public interest in the IOM study, a notice was placed in the February 24, 1981, Federal Register to solicit information from the public and from professional groups on the health-related effects of cannabis use. Approximately 90 responses were received from professional organizations, lawyers, medical doctors, scientists, other professionals, and parents. The responses can be divided into three categories:

1. The dangers of marijuana. The majority of responses came from people and groups opposed to cannabis use. Many parents of cannabis smokers (and ex-cannabis smokers) submitted statements about their personal experiences and observations. Included among the groups that responded are the National Federation of Parents for Drug Free Youth, Georgia Congress of Parents and Teachers, the American Lung Association, Drug Information Program of the Crusade Against Crime, the Committees of Correspondence, Phoenix House Foundation, and Pride.

2. The therapeutic potential of marijuana. Responses were received from medical doctors, as well as individuals or their parents, reporting that cannabis had alleviated pain from various medical problems—rheumatoid arthritis, migraine headaches, multiple sclerosis—and had in some cases lessened the side-effects of drugs used in chemotherapy. In most cases the marijuana had to be obtained by unauthorized means, making many of the victims and their families uncomfortable. Several respondents were from the State of Michigan, where a cannabis therapeutic research program has recently been authorized by the state legislature. Responses were also received from the Alliance for Cannabis Therapeutics and the American Medical Association.

3. Support of general use and legalization of marijuana. Responses in this regard were received from lawyers and other individuals, as well as the following organizations: the Ethiopian Zion Coptic Church, the Cannabis Institute of America, the National Organization for the Reform of Marijuana Laws, and the publication High Times. One writer contended that perhaps more people would submit statements if their anonymity were assured.

Appendix

B

ACCESS TO Δ-9-THC AND MARIJUANA FOR RESEARCH AND TREATMENT

The investigational use in human subjects of Δ-9-THC and marijuana are controlled by the Federal Food, Drug, and Cosmetic Act and the Investigational New Drug Regulations issued under that Act. In addition, Δ-9-THC and marijuana are controlled under the provisions of the Controlled Substances Act and currently are controlled in Schedule I of the Controlled Substances Act. Schedule I drugs are those that have: (1) high potential for abuse, (2) no currently accepted medical use in treatment in the United States, and (3) lack of accepted safety for use under medical supervision.

Basically two agencies work together for enforcing the controls of the Act: the Food and Drug Administration (FDA) in the Department of Health and Human Services and the Drug Enforcement Administration (DEA) in the Department of Justice. The Department of Justice was petitioned to reconsider the rescheduling of Δ-9-THC and marijuana in 1972, but to date there has been no change. However, DEA and FDA are now under court order to reconsider this situation. An FDA advisory meeting, held in June 1981, considered the scheduling status of the Δ-9-THC capsule only (Federal Register, 1981). The committee recommended that the Δ-9-THC capsule be changed from Schedule I to Schedule II status when a new drug application for Δ-9-THC is approved by FDA. Schedule II drugs are those that have: (1) a high potential for abuse, (2) a currently accepted medical use in treatment in the United States or a currently accepted medical use with severe restrictions, and (3) abuse that may lead to severe psychological or physical dependence.

Complaints and concerns were expressed to the study committee about the supply and distribution of marijuana and Δ-9-THC for treating chemotherapy side-effects in cancer patients. On the one hand, physicians said that there was poor cooperation from federal agencies engaged in controlling and supplying the drug (Koller, 1981; Monsma, 1981), particularly with respect to (1) potency of Δ-9-THC received (concentrations were too low to be effective), and (2) uncertainty and irregularity of the shipments of the drug. On the other hand, some clinicians felt that it was premature to release Δ-9-THC for use in cancer patients (Moertel, 1981; Cook, 1981) because:

- specific indications have not been established, in that the way in which chemotherapeutic agents cause nausea and vomiting is not known;
- specific populations of patients have not been established;
- effective dose schedules have not been established;
- safety of treatment at doses effective for antiemetic purposes remains in question;
- reported peer-reviewed experience is contradictory and still fragmentary; and
- controlled, randomized, prospective studies have not been conducted.

Depending upon the use of the drug, two different agencies are in charge of supplying marijuana cigarettes and Δ-9-THC capsules; the National Institute on Drug Abuse (NIDA) controls the supply of marijuana cigarettes and/or Δ-9-THC capsules for basic research, and the National Cancer Institute (NCI) controls the supply of Δ-9-THC capsules for cancer treatment. The processes of obtaining supplies from each agency (or for each purpose) differ.

OBTAINING THE MARIJUANA CIGARETTES*

To obtain marijuana cigarettes for basic research,† an investigator must register with DEA (apply for a license), file a Notice of Claimed Investigation Exemption for a New Drug (IND)†† with FDA, and submit an order for drug substance to NIDA. The agencies suggest that all the paperwork be filed concurrently in order not to unnecessarily delay the process. FDA analyzes the scientific protocol and determines if the project has scientific merit, if the researcher is qualified, and if IND requirements are satisfied. DEA sends an agent to supply the order forms, to determine from local police records whether the investigator has a drug trafficking record, and to see if the investigator has provisions for keeping the drug secure from theft. On notification of approval by FDA and DEA, NIDA will supply the drug. The entire process is supposed to take from 30 days to 6 months, including the visit from the DEA (Tocus, 1981). However, some investigators have contended it can take longer.

To obtain marijuana cigarettes (or Δ-9-THC capsules) for investigational treatment of glaucoma, multiple sclerosis, or

---

*Concentrations of Δ-9-THC range between 0.5 and 2.8 percent; the marijuana cigarettes contain other cannabinoids, as well as other chemicals.

†DEA and FDA do not fund research. Federal agencies that have supported cannabis research in FY 1979 (in order of percent cannabinoid research) are: NIDA (84), NIMH (5), NIAA (3), NCI (2), DOT (2), USDA (2), NEI (1), NICHG and NIGMS (less than 1).

††Twelve states hold their own IND as of September 1981.

anorexia, the physician must go through the basic research route. In view of the possible contaminant problems with aspergillus and salmonella, it may be necessary to provide sterilized marijuana cigarettes to patients.

OBTAINING THE Δ-9-THC CAPSULES*

As a Schedule I drug, Δ-9-THC can only be used for investigational purposes. However, some cancer patients undergoing chemotherapy treatment and resistant to standard antiemetic drugs benefit from the antiemetic properties of Δ-9-THC. Therefore, a system has been established for the distribution of Δ-9-THC capsules to chemotherapy patients within the guidelines of the Schedule I restrictions.

A physician who wants to dispense Δ-9-THC capsules to his cancer patients does so under NCI Group C distribution system (Group C Guidelines, 1980). The physician sends an FDA registration form to a DEA-approved hospital pharmacy. The pharmacy forwards the application to NCI, which holds its own IND. NCI evaluates the credentials of the physician, and, if approving, informs the pharmacy to supply the physician. This process, under emergency situations, can take as little as 24 hours (Abraham, 1981). A physician may also obtain marijuana cigarettes for cancer patients in an NCI-approved treatment program. More than 500 hospitals have been invited to participate (Abraham, 1981), and about 300 have clearance from DEA (Gunby, 1981). Shipments began late last fall (Gunby, 1981). More than 1,500 physicians have applied, and 1,000 have been approved by DEA (Gunby, 1981). The doses available in capsule form are 2.5 and 5 mg.

At least one company has submitted a New Drug Application (NDA) to the FDA for manufacture of a synthetic Δ-9-THC capsule to treat cancer patients (Federal Register, 1981; Tocus, 1981). If an NDA for Δ-9-THC is approved, a Schedule I status will no longer be appropriate. In fact, the Drug Abuse Advisory Committee† recommended that the Δ-9-THC capsule be changed from Schedule I to a Schedule II status when an NDA is approved by FDA.

---

*Purity of Δ-9-THC capsules is better than 96 percent (97-98 percent, C. Turner, 1981, and 100 percent, D. Abraham, 1981).
†The committee advises the Commissioner of Food and Drugs regarding the scientific and medical evaluation of all information gathered by the Department of Health and Human Services and the Department of Justice with regard to safety, efficacy, and abuse potential of drugs and other substances and recommends action to be taken by the Department of Health and Human Services with regard to the marketing, investigation, and control of such drugs or other substances.

SUPPLIERS OF MARIJUANA CIGARETTES AND Δ-9-THC CAPSULES

Marijuana cigarettes are supplied to NIDA by Research Triangle Institute, which stores and distributes them (Davignon, 1981).

Many contractors are engaged in the synthesis, storage, and distribution of Δ-9-THC capsules to NCI. Manufacture is done by Aerojet Propulsion Labs (large scale) and Arthur D. Little (small scale). Stanford Research Institute assays Δ-9-THC. Banner Gelatin encapsulates it. Flow Laboratories stores and ships Δ-9-THC to DEA-approved hospital pharmacies.

REFERENCES

Abraham, David. Investigational Drug Branch, Health Science Administration, National Cancer Institute, Bethesda, Md. Personal communication, 1981.

Cook, D.A. Private practice, Bay City, Mich. Personal communication, 1981.

Davignon, Paul. Chief, Pharmaceutical Resources Branch, National Cancer Institute, Bethesda, Md. Personal communication, 1981.

Federal Register, Volume 46, Number 31, February 24, 1981. Study of the health-related effects of marijuana use, pp. 13816-13818, 1981.

Group C Guidelines for the use of Δ-9-Tetrahydrocannabinol NSC134454 for nausea and vomiting induced by antineoplastic chemotherapy. Investigational Drug Branch, Cancer Therapy Evaluation Program, Division of Cancer Treatment, National Cancer Institute, Bethesda, Md., September, 1980.

Gunby, P. Many cancer patients receiving THC as antiemetic. JAMA 245:1515-1518, 1981.

Koller, C.A. Assistant Professor of Internal Medicine, Division of Hematology and Oncology. University of Michigan, Ann Arbor, Mich. Personal communication, 1981.

Moertel, C.G. Director, Mayo Comprehensive Cancer Center; Professor of Oncology, Mayo Medical School; Chairman, Department of Oncology, Mayo Clinic, Rochester, Minn. Personal communication, 1981.

Monsma, Stephen V. Senator, State Senate of Michigan, Lansing, Mich. Personal communication, 1981.

Tocus, Edward C. Chief, Drug Abuse Staff, Food and Drug Administration, Rockville, Md. Personal communication, 1981.

Turner, Carleton. Director, Research Institute of Pharmaceutical Sciences, University of Mississippi, Oxford, Miss. Personal communication, 1981.

Appendix

C

LONGITUDINAL STUDIES

Appendix C is a review of prospective longitudinal studies of drug use in normal populations listed by completion status, type of sample (school sample, community sample), age of respondents, and year of first contact. Some of the studies are ongoing.

Characteristics of Longitudinal Studies of Drug Use in Normal Populations Listed by Completion Status, Type of Sample, Age of Respondents, and Year of First Contact.

Part 1. Completed Studies: School Samples

Principal Investigators	Population Characteristics	Grade/Age at T1 of Sample Eligible for Panel	Year of First Contact	Year of Last Contact	Total Number of Contacts	Interval Between Contacts	Size of Sample T1 Eligible for Panel	Size of Matched Panel	Methods of Data Collection[a]	Drugs Inquired About
Kellam	All entering public and parochial school first-grade children in a black community in Chicago with low income and high unemployment	Grade 1	1966	1975-1976	5	3 times during first grade 2 years 7 years	1,241	705	Home interviews; school tests (IQ, achievement) and grades; ratings by teacher, clinician, mother (T1-T5); police records, questionnaires (T5)	Cigarettes, beer or wine, hard liquor, marijuana, LSD, other psychedelics, uppers, downers, tranquilizers, cocaine, heroin and other opiates, glue, cough syrup
Smith	Students from grades 4-12 in 6 school systems in greater Boston area, predominantly white and middle-class	Grades 4-11	1969	1973	2-5	1 year	12,000 (approx.)	Variable	Self-administered questionnaires in classrooms; school records; peers' ratings of students' personalities	Cigarettes, liquor, marijuana, ups, downs, psychedelics opiates, inhalants, nonprescription drug store products
Kaplan	Seventh grade students from 18 of 36 junior high schools of the Houston Independent School District	Grade 7	1971	1973	3	1 year	7,620	3,1[illegible]8	Self-administered questionnaires in classrooms	Beer or wine, liquor, marijuana, narcotics
Jessor and Jessor	High school study: random sample of students from grades 7-12 of 3 junior and 3 senior high schools in a small city in the Rocky Mountains, almost all of Anglo-American, middle-class background	Grades 7-9 Grades 10-11	1969 1969	1972 1972	4 2-3	1 year 1 year	589 262	483 Variable	Self-administered questionnaires outside of class, school records	Beer or wine, hard liquor, marijuana, amphetamines, LSD, other psychedelics, cocaine, and heroin
Elinson and Josephson	Students from 3 junior and 18 senior high schools purposefully selected to represent varied regions, community sizes, socioeconomic levels, and racial compositions but not to represent the United States	Grades 7-10	1971	1973	2	2 years	18,363	8,136	Self-administered questionnaires in classrooms	Cigarettes, beer or wine, hard liquor, marijuana or hashish, amphetamines, methedrine, barbiturates, LSD, other psychedelics, cocaine, heroin, inhalants

Annis and Watson	Students of 3 public high schools in a northern Ontario city and dropouts from same classes	Grade 9	(Not Given)	(Not Given)	2	13 months	915	886	Self-administered questionnaires in class; interviews with dropouts at T2	Alcohol, marijuana, tobacco, solvents, hallucinogens, barbiturates, opiates
Kandel	(1) Multistage random sample of New York State public secondary school students from 18 schools and data from mothers or fathers; best school friend in subsample of 5 schools	Grades 9-12	1971	1972	2	6 months	8,206	5,423	Self-administered questionnaires in classrooms (adolescents). Mailed questionnaires (parents)	Cigarettes, beer or wine, hard liquor, marijauna, hashish, amphetamines, methedrine, barbiturates, tranquillizers, LSD, other psychedelics, cocaine, heroin, other narcotics, inhalants, cough syrup
	(2) 1972 Senior class (Third wave)	Grade 12	1971	1973	3	7-12 months	2,386	1,635	Self-administered questionnaires (T1, T2); mailed questionnaires (T3)	Same
Johnston	Youth in Transition cohort--A national random sample of boys in 87 public high schools in continental United States in 1966; drug components added in 1970 and 1974	Grade 10	1966	1974	5	2 years 1 year 1 year 4 years	2,213	1,608	Interviews (T1, T2,T4); self-administered questionnaires (T1-T4); mailed questionnaires (T5); ability tests (T1)	Cigarettes, beer, wine, hard liquor marijuana, amphetamines, barbiturates, hallucinogens, methaqualone, cocaine, heroin
Britt and Campbell	North Carolina high school seniors who expressed an intention to attend college in fall	Grade 12	1961	1962	2	1 year	2,300	1,420	Self-administered questionnaires, (unclear whether in or out of class)	Alcohol
Gulas and King	Seniors at Dartmouth College matched retrospectively to their freshman-year records	College freshmen	Not Given (prior to 1976)	Not Given	2	4 years	90	90	Mailed questionnaires	Marijuana, amphetamines, barbiturates, hallucinogens
Haagen	College juniors at Wesleyan University matched retrospectively to their freshman-and-sophomore-year records	College freshmen	1965	1968	2	3 years	70	70	Self-administered questionnaires; test data on file at Office of Psychological Service	Tobacco, alcohol, marijuana, hallucinogens
Garfield and Garfield	Random sample at large private suburban residential western university	College students	1966-1967	1970-1971	4	1 year	300	T2-100 T3-201 T4-100	Personally administered questionnaires	Alcohol, marijuana, hashish, LSD, mescaline

[a]The same methods were used in all waves of data collection of a study, unless specific times are indicated.

Characteristics of Longitudinal Studies of Drug Use in Normal Populations Listed by Completion Status, Type of Sample, Age of Respondents, and Year of First Contact.

Part 1. Completed Studies: School Samples

Principal Investigators	Population Characteristics	Grade/Age at T1 of Sample Eligible for Panel	Year of First Contact	Year of Last Contact	Total Number of Contacts	Interval Between Contacts	Size of Sample T1 Eligible for Panel	Size of Matched Panel	Methods of Data Collection	Drugs Inquired About
Grupp	Random sample of 10% of students at Illinois State University not reporting marijuana use	College undergraduates and graduate students	1969	1973	3	2 years	127	T2-120 T3-103	Personal interviews at T1, T2; mailed questionnaires for those out of area at T2, and for everyone at T3	Marijuana
Goldstein	Students enrolled at Carnegie-Mellon University (class of 1972)	College freshmen	1968	1972	4	Approx: 9 months 18 months 30 months	770	417	Self-administered questionnaires, outside of class (mail technique preserving anonymity)	Beer, hard liquor, marijuana (incl. hashish), tranquilizers and barbiturates, amphetamines, hallucinogens, narcotics, tobacco
Groves	Full-time students at predominantly white nonspecialized colleges with projected enrollment of over 1,000 (1970)	College freshmen and juniors	1970	1971	2	1 year	7,948	3,961	Mailed questionnaires	Caffeine, alcohol, marijuana, hashish methedrine, other amphetamines, barbiturates, sedatives, tranquilizers, LSD, other psychedelics, cocaine, opium, heroin, other narcotics, cough syrups
Mellinger	(1) Probability sample of male freshmen of University of California at Berkeley in Fall 1970	College freshmen	1970	1973	2	3 1/2 years	960	834	Personal interviews and self-administered forms; school records; mailed questionnaires	Tobacco, alcohol, marijuana or hashish, amphetamines, barbiturates, sedatives, psychedelics, cocaine, heroin, opium, other opiates, inhalants
	(2) Probability sample of senior men in class of 1971	College seniors	1971	1973	2	2 1/2 years	986	821	Same	Same
Jessor and Jessor	College study--random sample of arts and science university students in a small Rocky Mountain city	College freshmen	1970	1973	4	1 year	276	226	Self-administered questionnaires; school records	Beer or wine, hard liquor, marijuana, amphetamines, LSD, other psychedelics, cocaine, heroin

Schuckit	Random samples of incoming freshmen at:									
	(1) Washington University in St. Louis	College freshmen	1970	1974	4	1 year	158	Not Given	Semistructured interviews; mailed questionnaires to nonresidents	Tobacco, alcohol, marijuana, hashish, amphetamines, speed, LSD, mescaline, psilocybin, STP, MDA, opiates, medicinal drugs
	(2) University of California at San Diego	College freshmen	1971	1975	4	1 year	222	1[illegible]		
Ginsberg and Greenley	Students enrolled at University of Wisconsin-Madison 1971-1974	College freshmen and sophomores	1971	1974	2	2 years	319	276	Mailed questionnaires	Marijuana
Sadava	(1) College freshmen in an English-language Roman Catholic college in province of Quebec	College freshmen	Not Given (prior to 1973)	Not Given	2	6 months	358	319	Self-administered questionnaires in classrooms	Cannabis, psychedelics, amphetamines, alcohol
	(2) Undergraduates at a small Ontario university in introductory psychology course	College freshmen and sophomores	1972	1973	2	6 months	467	374	Self-administered questionnaires	Alcohol, tobacco, marijuana and other illicit drugs
Kay	Random sample of male students entering Lehigh University	College freshmen	1971 1972 1973	1974 1974 1974	4 3 2	6 months: 1-T2; 1 year; T2-T3, T1-T4	130 124 112	68 85 98	Self-administered questionnaires, adjective check list, California Psychological Inventory	Marijuana
Moos	Entering classes of two universities	College freshmen	Not Given	Not Given	3	9 months 3 years	1,296	T2-886 T3-567	Self-administered questionnaires, outside class	Alcohol

Characteristics of Longitudinal Studies of Drug Use in Normal Populations Listed by Completion Status, Type of Sample, Age of Respondents, and Year of First Contact.

Part 2. Completed Studies: Community Samples

Principal Investigators	Population Characteristics	Grade/Age at T1 of Sample Eligible for Panel	Year of First Contact	Year of Last Contact	Total Number of Contacts	Interval Between Contacts	Size of Sample T1 Eligible for Panel	Size of Matched Panel	Methods of Data Collection	Drugs Inquired About
Lukoff and Brook	Samples of ghetto community stratified for ethnicity, social class, and contiguity with deviance:									
	(1) Children	13-17 yrs	1973	1975-1976	2	3 years	403	183	Household interviews	Marijuana, ups, downs, psychedelics, heroin
	(2) Mothers	30-45 yrs					284	183		
Brunswick	Representative community sample of Harlem youth	16-17 years old	1969-1970	1975-1976	2	6 years	664	536	Household interviews	Alcohol, marijuana, amphetamines, barbiturates, acid, cocaine, heroin, glue
Sieber	19 year old conscripts born in canton of Zurich who report some alcohol/drug use at initial contact	19 years	1971	1974	2	3 years	1,413	841	Self-administered questionnaires T1; mailed questionnaires T2	Alcohol, tobacco, marijuana
Robins	(3) Vietnam veterans random sample of army enlisted males who returned from Vietnam to the United States in September 1971, and a supplementary random sample from all men returning that month whose urine had been detected as positive for morphine prior to leaving Vietnam. T2 sampled from reduced T1 target population restricted to men inducted since 1969 and from the 25 more populous states	20 years (mean)	1972	1974 1975	2	2 years	605	571	Interviews; urine samples; military and Veterans' Administration records	Cigarettes, alcohol, marijuana, amphetamines, barbiturates, tranquilizers, hallucinogens, cocaine, narcotics

	(2) Control group at T2--sample of non-veterans matched on Selective Service Board, draft eligibility, age, and education	Matched to veterans	1974-1975	--	1	--	302	284	Interviews; urine samples; Selective Service Records	Same
Cahalan *et al.*	(1) National probability sample of United States adult population; (T2) sampled from reduced T1 target population N=1,810, with abstainers and very infrequent drinkers subsampled at a lesser rate	21 and over	1964-1965	1967	2	2 years	1,810	1,359	Household interviews (T1); mail questionnaires	Drinking patterns, practices, and problems
	(2) National probability sample of white males aged 21-59, with oversampling of urban areas	21-59 years old	1969	1973	2	4 years	978	725	Same	Same
	(3) Probability sample of white males, aged 21-59, in San Francisco	21-59 years old	1967-1968	1972	2	4 years	786	615	Same	Same

Characteristics of Longitudinal Studies of Drug Use in Normal Populations Listed by Completion Status, Type of Sample, Age of Respondents, and Year of First Contact.

Part 3. Ongoing Studies: A--Within Adolescence, Adulthood

Principal Investigators	Population Characteristics	Grade/Age at T1 of Sample Eligible for Panel	Year of First Contact	Year of Last Contact	Total Number of Contacts	Interval Between Contacts	Size of Sample T1 Eligible for Panel	Size of Matched Panel	Methods of Data Collection	Drugs Inquired About
Huba and Bentler	Students in the greater Los Angeles area with oversampling of lower socio-economic schools	Grades 7-9	1976	1980	4	1 year 2 years 1 year	1,634	768	Self-administered questionnaires from the students, parents (T1,T4) and peers (T1,T2)	Cigarettes, beer, wine, liquor, marijuana, hashish, coffee, minor and major tranquilizers, barbiturates, sedatives, antidepressants, amphetamines, non-amphetamines, uppers, LSD, other psychedelics, sniffing stuff, amyl nitrate, nonprescription: sleeping pills, stimulants, cough medicine, cold medicine, cocaine, heroin, other narcotics, PCP, coca paste
Lukoff and Brook	Quota sample from 6 states (Connecticut, Kansas, New Jersey, New York, Ohio, and South Carolina). Approximately equal numbers of males and females, blacks and whites of middle socioeconomic status	Grades 9-10	1979	1981	2	2 years	932	Not yet completed	Self administered questionnaires	Alcohol, cigarettes, marijuana, amphetamines, barbiturates, LSD, other psychedelics, heroin, other narcotics, tranquilizers, quaaludes, cocaine, inhalants
Clayton and Voss	Nationally representative sample of men born between 1944 and 1954 inclusive, who registered with Selective Service upon age 18	20-30 years old	1974-1975	1982	2	6-7 years	450	Not yet completed	Personal interviews	Cigarettes, alcohol, marijuana, psychedelics, stimulants, sedatives, heroin, other opiates, cocaine, tranquilizers, inhalants

Carpenter, Lester, Pandina, and Labouvie	Cohort-sequential design--Random samples of New Jersey adolescents-- a) 9 cohorts born 1967-75 b) 3 cohorts born 1964-66 c) 3 cohorts born 1961-63 d) 3 control groups at T4	a) 12 years b) 15 years c) 18 years	1979	ongoing	14 telephone 8 onsite	1 year 3 years until age 24; 6 years after age 24	a) 1,350 b) 450 c) 450 d) 150	Not yet completed	On-site: -personal interviews -self-administered questionnaires -behavioral tests -blood sample -psychological test -medical exams Telephone contact: -major life events -alcohol and drug taking outcomes	Alcohol, cigarettes, marijuana, amphetamines, barbiturates, LSD, other psychedelics, heroin, other narcotics, tranquilizers, quaaludes, cocaine, inhalants, PCP, amyl and butyl nitrates, over-the-counter psychotherapeutics, caffeine
Elliott	National Youth Survey-National probability multistage cluster sample of dwellings	11-17 years	[illegible]	1980	5	1 year	1,725	T2-1655 T3-1626 T4-1543 T5-1494	Personal structured interviews	Tobacco, beer, wine, liquor, marijuana, hallucinogens, cocaine, heroin, medical and nonmedical use of amphetamines, barbiturates
Jessor, Jessor, and Donovan	Young adult follow-up. High school sample--random sample of students from grades 7-9 of 3 junior high schools in a small city in the Rocky Mountains, almost all of Anglo-American, middle class background	Grades 7-9	1969	1981[a]	6	1 year 1 year 1 year 7 years 2 years	432	Not yet completed	T1-T4--Self-administered questionnaires in school (high school sample) in small groups (college sample)	Beer, wine, hard liquor, marijuana, LSD, amphetamines, cocaine, heroin, tranquilizers, barbiturates, morphine
	College sample--random sample of freshman class arts and science university students in a small Rocky Mountain city	College freshmen	1970	1981[a]	6	1 year 1 year 1 year 6 years 2 years	205	not yet completed	T5,T6--Adult follow-ups: mailed self-administered questionnaires	

[a]Future contacts planned, if funds available.

Characteristics of Longitudinal Studies of Drug Use in Normal Populations Listed by Completion Status, Type of Sample, Age of Respondents, and Year of First Contact.

Part 3. Ongoing Studies: B--From Adolescence to Young Adulthood

Principal Investigators	Population Characteristics	Grade/Age at T1 of Sample Eligible for Panel	Year of First Contact	Year of Last Contact	Total Number of Contacts	Interval Between Contacts	Size of Sample T1 Eligible for Panel	Size of Matched Panel	Methods of Data Collection	Drugs Inquired About
Johnston and Bachman	Monitoring the Future--cohort sequential design. Successive nationally representative cohorts of high school seniors from 115 public and 15 private high schools; repeated annually; entire senior classes in schools with 300 seniors, and subsamples (N=300) in larger schools	Grade 12	1975-ongoing	ongoing	11 for each cohort	1 year for each cohort (2 yrs for each cohort 1/2 sample)	2,400 (target for each cohort; 1,200 for each cohort 1/2 sample)	Not yet completed	T1--Self-administered questionnaires in classrooms T2, adult follow-ups --Mailed questionnaires	Alcohol, cigarettes, marijuana, amphetamines, barbiturates, LSD, other psychedelics, heroin, other narcotics, tranquilizers, quaaludes, cocaine, inhalants, PCP, amyl and butyl nitrates, over-the-counter psychotherapeutics, caffeine
Kandel	Multistage random sample of adolescents enrolled in New York public secondary school selected from 18 schools a) regular students b) absentees	Grades 10-11	1971	1980[a]	3	6 months 9 years	a) 1,321 b) 330	1,081 244	T1,T2--Self-administered questionnaires in classrooms T3--Adult follow-up--Household interviews	Cigarettes, beer or wine, hard liquor, marijuana, hashish, methedrine, LSD, other psychedelics, cocaine, heroin, other narcotics, inhalants, cough syrup, stimulants, sedatives and tranquilizers (medical and non-medical use)

Kaplan	Seventh grade students enrolled in 18 of 36 junior high schools of the Houston Independent School District	Grade 7	1971	1981-1982	4	1 year 1 year 9-11 years	9,300	Not yet completed	T1-T3--Self-administered questionnaires T4--Adult follow-up--Household interviews	Marijuana/hashish, barbiturates, inhalants, hallucinogens, amphetamines, tranquilizers, heroin, other narcotics, quaaludes, cocaine
Lauer and Akers	All students in 2 junior high schools, 1 senior high school in small Iowa city	7-12	1980	1984	5	1 year	2,194	Not yet complet-ed	Self-administered questionnaires in classroom Saliva test	Cigarettes, chewing tobacco, snuff, cigars/pipe
Schlegel	Random sample of students in 2 school boards (urban, rural) in southern Ontario	9-12	1974	1980[a]	7	4 months 4 months 6 months 1 year 2 years 2 years	1,781	918	(T1-T4) Self-administered questionnaires in classroom. (T5-T7) Mailed self-administered questionnaires	Beer, wine, liquor, cigarettes, amphetamines, barbiturates, marijuana, hallucinogens, tranquilizers, heroin, glue
Smith	Students and former students in middle-class predominantly white school district in the greater Boston area	Grades 8-10	1969	1981	4-6	1 year 1 year 1 year 1 year 8 years	1,935	Not yet completed	T1-T5--Self-administered questionnaires, peer ratings of personality, school records T6--Adult follow-up - Mailed questionnaires	Cigarettes, beer, wine, liquor, marijuana, hashish, ups, downs, tripping stuff, cocaine, heroin and other opiates, drug store medicine, sniffing stuff, combination drugs

[a]Future contacts planned, if funds available.

Appendix

D

PARAQUAT ISSUE

Paraquat is a herbicide that is used throughout the world. It is available in an aerosol form, granules, and a water-soluble concentrate. As a result of accidental or suicidal swallowing of the water-soluble concentrate, more than 500 human fatalities have occurred (Harley et al., 1977). In contrast, neither inhalation of the spray nor ingestion of paraquat granules has been shown to be of clinical importance (Fairshter and Wilson, 1975).

About 60 percent of the marijuana consumed in the United States is grown in Mexico. Since 1975, in the attempt to reduce the illegal production of marijuana, the Mexican government has been spraying marijuana fields from airplanes. The herbicide kills the treated plants within 1 or 2 days. Marijuana producers have resorted to harvesting the plants soon after spraying, minimizing exposure to sunshine, so that they are not destroyed. The paraquat persists on the dried leaves. Samples of marijuana confiscated at the U.S.-Mexico border have disclosed that about 21 percent of the confiscated marijuana was contaminated with paraquat in varying concentrations.

Paraquat damages the lungs, heart, kidneys, adrenal glands, central nervous system, liver, skeletal muscle, and spleen. In general, all effects but those on the lungs are transitory. The changes in the lungs of humans after ingestion appear to be dose-related: small amounts of the swallowed chemical may cause modest and reversible lung damage; in contrast, larger quantities cause lethal pulmonary fibrosis. An important element in paraquat toxicity is the fact that it is concentrated in the lungs where it does particular damage to the alveolar lining. In many respects, probably including the mechanism by which it damages the lungs, its effects resemble those of oxygen toxicity but seem to be less reversible (Smith and Heath, 1976).

With respect to marijuana, the use of paraquat as a herbicide entails the possibility of risk to two populations: (1) those who spray the paraquat and the workers in the fields who are exposed to an environment containing the paraquat spray, and (2) the marijuana smoker. To date, no toxic effects attributable to paraquat, per se, have been proved in either population. However, the observations thus far relate to the acute hazards of paraquat inhalation and do not provide any assurance about the long-term effects. Indeed, observations on other inhaled toxins suggest that exposure for many years may be prerequisite for the development of clinical disability.

An important question with respect to the toxic effects of paraquat on the lungs is how much of the paraquat survives combustion and is transferred in the smoke to the gas-exchanging surfaces of the lungs. Studies conducted by NIDA indicate that as much as 0.2 percent of the paraquat in a marijuana cigarette appeared in a condensate of smoke prepared under laboratory conditions. The results suggested that a typical marijuana cigarette contaminated at approximately 500 ppm--a reasonable degree of contamination--would produce smoke containing up to 1 mg of paraquat. This experimental evidence has led to the prediction that a human smoker of five marijuana cigarettes per day would expose the lungs to approximately 5 mg of paraquat. Laboratory evidence derived from hamsters suggests the possibility of damaging the distal part of the airways (the bronchioles and the proximal alveolar ducts) by this exposure. These experiments and predictions suggest that an individual who continued to smoke paraquat-contaminated cigarettes would be a candidate for serious lung injury. The prospect probably would be greatly heightened by the toxic effects of the combusted marijuana.

There are only a few observations of experimental animals that bear directly on the effects of inhaled paraquat (Kimbrough and Gaines, 1970; Zavala and Rhodes, 1978). These suggest that similar lesions are produced by ingested paraquat and by paraquat introduced into the airways. For example, the introduction of minute quantities of paraquat dichloride intrabronchially, in concentrations ranging from 10 mg to 100 mg, elicited focal pulmonary edema, hemorrhage, and fibrosis (Zavala and Rhodes, 1978). The smaller doses are within the range to which a smoker of marijuana contaminated by paraquat might be exposed. However, the experimental evidence is not entirely relevant on several accounts: (1) paraquat arriving at the lung surfaces by inhalation from contaminated air or after smoking must be carried in the form of smoke, gas, or small droplets, because larger droplets, such as the aerosols used in agriculture, are apt to precipitate out in proximal airways, which are protected by cilia and mucus; (2) the intrabronchial installation of paraquat in a solution provides a different pattern of access to the gas-exchanging surfaces of the lungs than does inhalation of smoke, gas, or droplets; (3) because of its water solubility, paraquat that escapes pyrolyzation during smoking would be expected to be taken up by the tracheal bronchial tree and its branches before reaching the alveoli unless carried in the form of smoke, gas, or small droplets.

In essence, the evidence concerning the injurious effects of paraquat inhaled after either spraying or smoking is too meager for conclusions. The observations available since 1975 have not proved that paraquat, per se, is harmful to the lungs. On the other hand, the clinical experience to date, coupled with the increasing understanding of the biochemical basis for paraquat toxicity, raises the serious possibility that continued exposure to inhaled paraquat is likely to be harmful to the lungs, that the predominant effect will be diffuse interstitial fibrosis, and that if exposure is sufficiently intense over years, respiratory insufficiency, disability, and death may reasonably be expected to ensue.

REFERENCES

Fairshter, R.D. and Wilson, A.F. Paraquat poisoning: Manifestations and therapy. Am. J. Med. 59:751-753, 1975.

Harley, J.B., Grinspan, S., and Root, R.K. Paraquat suicide in a young woman: Results of therapy directed against the superoxide radical. Yale J. Biol. Med. 50:481-488, 1977.

Kimbrough, R.D. and Gaines, T.B. Toxicity of paraquat to rats and its effect on rat lungs. Toxicol. Appl. Pharmacol. 17:679-690, 1970.

Smith, P. and Heath, D. Paraquat. CRC Crit. Rev. Toxicol. 4:411-445, 1976.

Zavala, D.C. and Rhodes, M.L. An effect of paraquat on the lungs of rabbits. Chest 74:418-420, 1978.