

SB

32

file 2

The Most Relevant
Information on Medical, ~~and~~
Usage, Constitution, Legal

Finding #	MORGAN	Jones	McBry	BONAR	Mikuriya	Segal
1	T	T	T	T	T	T
2	?	T	?	T	T	T
3	F	T	?	T	F	F
4	F	?	?	T	F	F
5	F	F	F	T	F	F
6	?	T	F	T	F	?
7	T	T	T	T	—	T
8	F	F	?	T	F	F
9	F	F	F	?	F	F
10	F	?	?	T	?	F
11	—	?	?	T	F/T	?
12	—	T	?	T	T	T
13	—	?	?	T	F	F
14	—	T	T	T	—	T

Forest S. Tennant, Jr., M.D., Dr. P.H.
Community Health Projects, Inc.
336 1/2 South Glendora Avenue
West Covina, California 91790
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April 29, 1988

Rep. Niilo Koponen and
Rep. Johnny Ellis
House HESS Committee
Alaska State Legislature
Juneau, Alaska 99811

RE: New Medical Information on Marijuana

Dear Rep. Koponen and Ellis:

I am pleased to provide my opinion relative to new medical information on marijuana.

In contrast to the 1970's, the latter part of the 1980's has witnessed a new medical event and that is the emergence of marijuana dependence among large numbers of persons. This has been primarily evidenced by marijuana addicts applying for medical detoxification. The seeking of treatment for marijuana addiction was something rarely observed in the 1970's, but it is now commonplace primarily due to the fact that the potency of marijuana has increased to a point that dependence is relatively easy to achieve. I have attached a recent article on marijuana dependence written by me.

In addition to the emergence of marijuana dependence as a serious public health problem, there are two other new findings with marijuana:

1. It's breakdown products or metabolites remain in the blood for at least two or three days after smoking;
2. Chronic marijuana use depletes certain brain chemicals.

In contrast to previous reports and beliefs, many medical authorities now believe that the breakdown or metabolite products are not inactive. Even though these breakdown products do not cause changes in blood pressure, pulse rate, or produce euphoria, they likely exert some type of activity on brain chemical function and they likely produce eye changes. For example, we have been able to document effects on the eye (non-reactive pupil; non-convergence) for two to four days after a joint is smoked. In a study conducted at Stanford University trained pilots performed very poorly on a flight simulator twenty-four hours after smoking a joint and this is likely due to the fact that the breakdown products are still exerting some type of adverse neurologic activity and likely effects on the eye.

April 29, 1988

Rep. Niilo Koponen and

Rep. Johnny Ellis

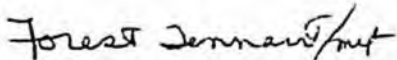
Page 2

A number of studies now document that the chronic use of marijuana reduces or depletes the brain levels of certain chemicals. Just how permanent these changes can be after drug use has stopped is uncertain, but there is growing scientific evidence that permanent biochemical changes can result from the chronic use of marijuana and some other psychoactive drugs.

The new findings about marijuana dictate that steps be taken in Alaska to protect the public health. The current law in Alaska allows any person to take marijuana in any dosage and chronicity that they desire. This effectively means that you have more control over nicotine and alcohol than you do marijuana. The major problem with your current law, in my opinion, is that it symbolically gives the public, particularly the teenagers, the idea that marijuana is perfectly safe and less harmful than nicotine and alcohol which is not necessarily the case.

The overall trend in the United States is to pass laws which bring down the overall levels of intake of all of the common drugs. For example, the new law prohibiting smoking on flights of less than two hours is a case which attempts to lower the intake of nicotine. It certainly appears to me that Alaska can modernize their marijuana law and reduce the overall intake of marijuana in Alaska and this should be the ultimate goal of new legislation.

Respectfully submitted,



Forest Tennant, M.D., Dr., P.H.

Attachment

FST/mlf

INTERNAL MEDICINE
ENDOCRINOLOGY

JEANNE R. BONAR, M.D.
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561-1363

April 25, 1988

Hess Committee
Alaska State Legislature
Committee on Health, Education and Social Services

Attn: Representative Niilo Koponen
Representative Johnny Ellis

Dear Representative Koponen and Representative Ellis:

Thank you very much for hearing my testimony on April 15, 1988 by teleconference. You asked me to testify only on the medical findings, and I tried to limit my discussion to specific proofs of medical toxicity related to marijuana. With the exception of Dr. Jacobs, the pediatrician from California, the psychiatrists who testified did not present scientific knowledge. Psychiatrists look at drug research from a different perspective than an internist/pediatrician. As an internist and endocrinologist, I have been more involved with the specific toxicology side effects. When a psychiatrist sees side effects from a drug or drug abuse, he would be bound by ethics to refer that patient to an internist or pediatrician who could evaluate any medical complications.

I have enclosed a humorous excerpt from Art Buchwald which is entertaining but gives you a message. It is called "Smoking and Research." He describes a situation in a research laboratory where they throw out the "sick rats" to prove their point that smoking is not harmful. I implore you not to overlook the "sick rats."

Legislators do not have the expertise to evaluate the medical literature. The sheer volume of medical literature and implications of complications of toxicity to marijuana is impressive. Many of the articles are published in referee journals. By that term I mean the article is reviewed by other experts and evaluated for authenticity. Dr. Zinberg remarked that a lot of the research was poorly done, and I will have to concur there is a lot of medical research that is poorly done. More commonly the psychiatric research is extremely poor, and not objective. They base conclusions on anecdotal and subjective or clinical impressions.

The burden of proof is on the Representatives in the Alaska state legislature to prove that marijuana is safe, rather than for the experts to say it is toxic and offer you proof of ill effects. It is your responsibility now to make that decision, and I do not envy you. I would advise you to say strongly that this is a toxic drug and should not be used in the home. There is certainly new medical evidence in several areas, endocrinology, immunology, and genetics. There is no doubt the marijuana cigarette contains a higher amount of carcinogens (a setup for lung cancer).

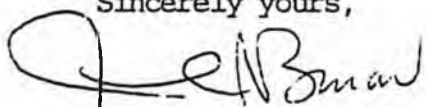
Although a few responsible, well meaning adults could conceivably use marijuana occasionally at home, and derive some pleasurable experiences, I do not think that is of benefit to the society as a whole, and the risk you are taking to continue to legalize the use of this drug strongly outweighs the benefits. It would be irresponsible to not act immediately on this evidence.

There is a distinction between adult use and adolescent use in practice. If an adult is smoking marijuana in the home, the adolescents are more likely to abuse it. There are many reports of cases of children (toddlers to adolescents) getting high on marijuana just from inhaling their parents' smoke.

Another distinction you have to make is between chronic abusers and acute abusers. The chronic affects of marijuana are probably considerably worse than just the occasional smoker. All studies seem to implicate the chronic use is seriously detrimental. Soe people are just occasional users. More adolescents fail to mature when using THC and may turn into a chronic abuser.

I thank you for allowing me to participate in the teleconference, and I hope I will be in contact with you concerning the toxicity of marijuana. I am enclosing several research publications and review articles on marijuana toxicity. I urge you to act promptly to protect the public from this health hazard. We criticize the FDA for withholding drugs, but their caution has protected millions from disaster. A prime example is the Thalidomide crisis that caused so many birth defects in Europe in the sixties.

Sincerely yours,

A handwritten signature in dark ink, appearing to read "Jeanne R. Bonar". The signature is fluid and cursive, with a large initial "J" and "B".

JEANNE R. BONAR, M.D.

ceb

ANSWERS TO FINDINGS ON SENATE BILL 32
J.R. Donar, M.D.

1. True.
2. True.
3. True.
4. True. The critics of this statement state there are pre-existing personality conditions that lead troubled individuals to become frequent users of marijuana. As with alcohol, there are probably primary and secondary reasons for drug abuse. The secondary reason would be problems such as depression which leads someone into alcoholism or drug abuse. These are the minority. The primary abuse is unexplained, and no one has developed a true prototype or model of pre-existing factors that is universal to all.
5. There are case reports of cardiac death related to the use of marijuana. There are also some rare case reports of over-ingestion of hemp producing death. No one specifically can point to a tobacco cigarette and say, "This caused a death". There are toxic side effects that aggravate other factors which bring about potentially lethal conditions.; emphysema, bronchitis, lung cancer and heart disease are all related to cigarette smoking and Marijuana smoking.
6. True.
7. True.
8. True. Marijuana may cause schizophrenia, etc. Again, proponents of the use of marijuana say these conditions were pre-existing. Even if this is true, the fact that THC precipitates an acute psychotic behavior which goes into remission when the drug is removed certainly makes it a severely dangerous drug.
9. This is the statement concerning lung cancer and marijuana. Carcinogenic factors are 3 to 10 times as potent in marijuana cigarettes, depending on the mix and blend of the cigarette, as they are in regular cigarettes. To state a cigarette may cause lung cancer in three years is only presumptive. It is true it is more carcinogenic.
10. True.
11. True. Squamous metaplasia occurs in the lungs. The irreversible changes in the brain have been found in primates because such experimentation cannot be done on humans.
12. True. These condition are more severe in chronic users.
13. True. Many people smoke marijuana cigarettes in enclosed spaces such as cars and bathrooms which increases the hazards to the children present.
14. True.

Smoking and Research

Art Buchwald

Despite the overwhelming evidence that smoking can cause cancer, heart disease, and other fatal illnesses, there are still some physicians in the United States who maintain that all the facts are not in, and the medical profession is overreacting. Most of these doctors are employed by the tobacco interests, and some people are skeptical about their research.

I don't happen to be one of them. I believe that the fact that a doctor is on the tobacco industry's payroll doesn't mean he is not as objective about smoking as someone who isn't.

Take my friend Dr. Heinrich Applebaum, who gets one hundred thousand dollars a year to defend the cigarette manufacturers' interests. He took me through his lab the other day.

There were hundreds of white rats in cage, jumping about and playing and munching on tobacco leaves.

"Have you ever seen happier rats in your life?" he asked me.

"Never," I admitted. "Do they all smoke?"

"A pack a day," he said proudly. "They don't get anything to eat unless they smoke first."

"And none of them contract cancer or heart disease?"

"They better not. If one of our rats gets sick, we throw it out of the program."

"But how do you know if smoking was not the cause of its illness if you throw it away?"

"It's a question of priorities. When you're looking for scientific answers to medical problems, you don't waste your time on sick rats."

A lab assistant came up and showed Dr. Applebaum a rat that seemed to be expiring.

"What do you think, Doctor?"

"Get it out of here. It could have yellow fever."

"It doesn't appear to have yellow fever."

"Then maybe it's typhus."

"Should I do an autopsy on it?"

"Who do you think you are, Dr. Noguchi? We're running a laboratory here, not a coroner's office."

The lab assistant disappeared.

Dr. Applebaum seemed upset. "I run into that all day long. Every time a rat comes down with something, some smart aleck tries to find out if it was caused by cigarettes. Nobody ever wants to leave well enough alone."

"Maybe they're just being thorough?" I suggested. "Haven't you ever found a rat that died from a smoking-related disease?"

"Not since I've been working for the tobacco industry. When I took this job, they gave me carte blanche to find out all the facts, plus a bonus of twenty-five dollars for every rat I could prove died of natural causes. I also get one thousand dollars every time I go on television to attack the surgeon general's report on smoking. So I call them as I see them, because my scientific reputation is at stake."

"Then why is the entire medical establishment against you?"

"It's simple. If they blame smoking for somebody's heart

attack they won't be sued for malpractice."

"Doctor, will you come over to cage Two hundred thirty? None of the rats seem to be moving," a lab assistant said.

We walked over. Dr. Applebaum said, "What have you been feeding them?"

"Milk and cheese," the assistant replied.

"Just as I suspected. Look for calcium kidney stones."

"Suppose I don't find any?"

"Then you can get yourself another job."

Art Buchwald

from White House Staff

Putnam

1983

To: Alaska State Legislature
House of Representatives
Committee on Health, Education
and Social Services
Pouch V
Juneau, AK 99811

From: Tod H. Mikuriya, M.D.
1168 Sterling Avenue
Berkeley, CA 94708

Date: April 15, 1988

Re: Senate Bill 32 (Hess)

Thank you for the opportunity of testifying yesterday via teleconference regarding the medical aspects of cannabis.

I am in sympathetic understanding of the legislator who complained of the bewildering contradictory evidence on the subject. Regretfully, things have not changed since I began researching the effects of cannabis during my sophomore year in medical school in 1959. Review of the medical literature in that year revealed a significant bias against the medicinal use and for the adverse effects coinciding with the national efforts to criminalize marijuana in 1937.

That federal effort resulted in the City of New York setting up a blue ribbon panel of medical, psychiatric, psychological, and social services experts to study the real vs fantasied hazards of marijuana use. The result of this commission started in 1938 facilitated by the New York Academy of Medicine in response to concerns expressed by mayor Fiorello LaGuardia was reported six years later after a well-funded careful study. It was rejected and condemned by Harry Anslinger, head of the Federal Bureau of Narcotics.

Things have not changed much since.

My book "Marijuana Medical Papers 1839-1972" which are attached under separate cover describes medicinal applications commonly recognized in all the lists of drugs such as the U.S. Pharmacopeia prior to being purged. The official contemporary federal stance is that these listings and descriptions are "folk medicine". The resultant policy is to classify crude cannabis preparation as new drugs to avoid the dissonance of having the substances "grandfathered" in under FDA regulations.

Deprived of availability to the physician as a medicinal tool, clinical ignorance has prevailed permitting the ascendance of the moral pharmacologists and the "send them a signal" school of drug propaganda which prevails today.

The "Findings" in section 1 are the flawed products resulting from this defective information derived from this bias.

1. marijuana and other cannabis preparations may contain over 420 different compounds.

Irrelevant. So do all complex organic compounds. One could go crazy with fear analyzing one's food using a specious premise of complexity of compounds in itself constituting a threat.

2. THC is insoluble in water, soluble in fat and goes into the fatty tissues where it takes as long as 30 days to be eliminated from the body.

True, but the connection between presence of inactive breakdown products with dysfunction has yet to be shown. The slow breakdown may be a factor to prevent the drug from being addictive as compared with the water soluble opioids.

3. the buildup of THC in the system means accumulation of higher drug levels

leach at any time after a single dose.

False. Three wrongs don't make a right- just three times as wrong. There is no "buildup" which redundantly does not mean accumulation and ignores the rapid conversion from THC to inactive metabolite. The origin of finding #3 appears to be the product of contamination of a grade school level science class with a commercial for floor wax.

4. the buildup of THC causes the user to smoke more marijuana to achieve the desired high and may result in loss of sleep, appetite, and initiative, as well as moodiness and depression.

False & bizarrely contradictory. If anything LESS marijuana is needed to achieve the desired high as described in the literature starting from the 1944 Mayor's Committee report. How could this be if we were to believe finding #3? Perhaps finding 4 was used to cover cases not explained by finding 3.

5. it is possible for a human being to overdose from the use of marijuana, especially if it is used in conjunction with alcohol, because it increases the effects of alcohol;

False, confused and mixed up with alcohol. Both drugs have distinctly different profiles of pharmacologic activity. Some interactions may be synergistic, others antagonistic and highly dependent on dose level of each.

6. the THC content of commonly obtainable marijuana has increased from less than one percent 10 years ago to as high as 10 percent today;

False. See attached prepublication copy of Cannabis 1988 Old Drug "New" Langner to appear in the current Journal of Psychoactive Drugs.

7. No comment.

8. Review of the literature does not support the notion that the use of cannabis causes schizophrenia. Starting with the first large scale inquiry on the subject by the Indian Hemp Drugs Commission 1893-1896 by the British Government, and every health commission that has studied the very same issue subsequently has concluded there is no causal connection.

Cannabis in large doses in naive subjects is a familiar theme in the early medical literature that has an initial acute intoxication phase which may include symptoms of illusions and hallucinations. (Marijuana Medical Papers 1839-1972)

These stimulating symptoms of oral cannabis overdose give way to a sedative effect roughly complementary to the initial excitatory effects: the more stimulating the initial effects, the deeper the resulting sedation.

The question of the analgesic aspects of the experience are probably overstated in that the decrease in sensitivity to painful stimuli is absent unless there is "superdose" level intoxication.

Otherwise the analgesic effects are probably most useful on pain originating from irritability of the central nervous system or possibly local effects on certain blood vessels in covering of the brain.

9. False. There are no reputable studies that cannabis may cause lung cancer in 3 years.

10. Still Unknown. There is no epidemiologic data to support the in vitro studies that claim teratogenicity. A study of the

quality and longevity of the Framingham, Massachusetts study that conclusively established the connection between tobacco smoking and lung cancer and other illnesses is desperately needed to look into this issue.

11. No irreversible changes in the brain have been proven.

There is clearly a hazard from the irritation to the tracheobronchial tree from smoked marijuana with high levels of chronic use causing sinusitis, bronchitis and pharyngitis.

Increase in heart rate is dose related but should pose no hazards unless an individual was unusually susceptible because of preexisting heart disease.

There is no evidence to support the assertion that there is decreased circulation.

12. Cannabis in either overdose or use by a naive subject can induce loss of memory, anxiety, panic, paranoia, and psychosis which wears off as soon as the effects of the drug enter the sedative phase.

Cannabis in chronic use patterns is clearly an effective anxiolytic or minor tranquilizer and sedative. This is the effect sought by most users. Indeed in many individuals the chronic sedative effects will adversely effect thinking, reading comprehension or any activity, requiring sustained mental acuity.

Indeed some individuals will attempt to self-medicate away feelings of anxiety and depression and this will lead to a psychological dependence that may be harmful.

13. The assertion that the use of even small amounts of marijuana by adults in the home subjects children present to a substantial health hazards is without foundation and cannot be demonstrated.

14. No comment.

I am sympathetic to legislators confused by the contradictory information that bombards them concerning the medical aspects of cannabis. This has been an issue that has confronted me since I started studying the drug since 1937. I have found the clinical descriptions during the era when cannabis was available for general prescription from 1840 to 1940.

Review of the type and content of research discloses a heavy investment to depict cannabis as a "killer weed" without medicinal redeeming importance. I consider this an abuse of the medical profession by special interest groups within the enforcement/corrections community whose existence depend on the current social policy.

Tod H. Mikuriya, M.D.

6:10pm Apr 18, 1988

Section 1. FINDINGS. (a) The legislature finds that

(1) marijuana and other cannabis preparations contain

(a) over 420 different compounds; including 60 cannabinoids that have mind-altering properties;

(b) tetrahydrocannabinol (THC), one of the pharmacologically active ingredients in marijuana, has increased in strength and potency from less than 1% to as high or higher than 10% in commonly obtainable marijuana today;

(c) (THC) is fat or lipid soluble and is attracted to lipid tissues of the body which include the brain, testicles, ovaries, liver, kidneys, heart and bone marrow. The half-life for marijuana is 4-8 days. Metabolites of THC take as long as 30 days to be eliminated;

(d) that marijuana use leads to the development of tolerance where more marijuana or stronger marijuana is needed to achieve the same effect or "high"

(2) current findings resulting from medical and laboratory research

(a) respiratory and cardiovascular systems;

(1) sinusities, pharyngitis, bronchitis and emphysema are associated with chronic marijuana use;

(2) evidence suggests that habitual marijuana smoking may be a factor in the development of bronchogenic carcinoma;

(3) during a marijuana "high" the heart rate increases from 70-80 beats per minute to as much as 130-150 beats a minute (tachycardia);

(b) reproductive system

(1) marijuana affects the network of glands and hormones which are involved in reproduction;

(2) the pregnant woman who uses marijuana takes an increased risk, marijuana's chemicals pass across the placenta to the developing fetus;

(c) brain

(1) THC accumulates in brain cell membranes;

(2) Neurons, the most specialized and complex cells in the body, are affected more than any other cells by substances which alter or block cell membranes;

(3) the resulting affects include the impairment of visual tracking and depth perception and a reduction in coordination, reaction time and vigilance making it dangerous to drive, fly or operate machinery;

(4) damage may include irreversible changes of the brain which interfere with reading comprehension verbal and mathematical problem solving, perception of time and distance short term memory and the ability to concentrate. Chronic use also reduces motivation;

(5) Psychological effects may include anxiety, panic, paranoia, psychosis, illusions and hallucinations. Recent studies link marijuana to schizophrenia.

(d) immune system

(1) marijuana use depresses the immune system;

(2) alters fundamental cellular defenses against disease;

(3) social impact - public health and welfare

(a) 70 resolutions have been received from student organization, school boards, municipal assemblies, police organizations, health and social service organizations, citizen drug task forces and civic organizations;

(b) The Department of Law, Criminal Justice Planning Agency's 1981 Crime In Alaska states that juvenile arrests were up- 19% from 1980, with possession of marijuana accounting for over 85% of all juvenile arrests.

(c) Surveys conducted in 1981 and 1982 by Dr. Benard Segal indicated that 47.4% of Alaskan youth between 12-17 reported having used marijuana compared to the national average of 26.7%.

(d) In a follow-up survey in 1987 conducted in the Fairbanks's North Star School District, 47.8% of the students, grade 7-12, reported having used marijuana in 1987 compared to 40.1 in 1982.

(e) In a follow-up survey in 1987 conducted in the Juneau School District 69.4% of the students grades 7-12 reported having used marijuana in 1987 compared to 68.7% in 1982.

(f) In Dr. Segal's 1987 Juneau School District Survey, marijuana continued to show the highest overall prevalence.

(g) The present findings in Juneau also indicted in downtown trend in age of initiation into drug use. Previously age 13 was the peak year for initiation into drugs but present findings indicates age 12 to be the critical year.

(4) The Legislature further finds:

(a) The Federal Drug Enforcement Agency has classified marijuana and other cannabis preparations Schedule I, due to high potential for abuse and addiction.

(b) The Undersecretary for International Narcotic Affairs, Department of State, during an address in Anchorage stated, "Several foreign countries have questioned the sincerity of the United States regarding suppression of illicit drugs by calling attention to Alaska's legislation of small amounts of marijuana. This is significant because the United States is a signatory nation to two international conventions concerning control of narcotics—the Single Convention on Narcotic Drugs of 1961 and the Psychotropic Substance Act of 1971, which include outlawing marijuana.

- (c) In the Alaska State Trooper's Drug Report to the Alaska Legislature, January 1, 1986-June 30, 1987 a marijuana eradication program was described. This program and the efforts of drug enforcement units throughout the state, led to the seizure of 3,600 marijuana plants with an estimated value of over \$866,000.

Alaska State Legislature

SENATOR PAUL FISCHER, Chairman
SENATOR JOE JOSEPHSON, Vice Chairman
SENATOR LLOYD JONES
SENATOR JAY KERTULLA
SENATOR RICK HALFORD



P. O. BOX 1
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STATE CAPITOL
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Senate Committee on Health, Education and Social Services

REFERENCES FOR LEGISLATIVE FINDINGS TO CS SB 32 (HESS)

Subsection (a)

1. Marijuana and Health, Institute of Medicine, National Academy Press, 1982. Page 10
2. Institute, page 20.
3. Institute, page 26
4. original (original bill finding, see House Research Report #87.158)
5. original
6. Institute, page 16. Also, conversation with officials at state crime lab.
7. Conversation with crime lab officials.
8. original
9. original
10. original
11. original
12. original
13. original
14. 21 U.S.C. 812.

Subsection (b)

1. Essentially a conclusion
2. "Patterns of Drug Use: Community Survey", Center for Alcohol and Addiction Studies, UAA; Benard Segal, Ph.D., editor; 1983. Also "Patterns of Drug Use: School Survey", same publisher and editor.

3. Same as 2.

4. Conversation with Teresa Johnson, Anchorage School District, March 1987. Includes elements of a legislative conclusion and finding.

5. Conclusion.

6. A conclusion

Consult the attached House Research Agency report dated February 27, 1987 for those items marked as being from the original bill.



ALASKA STATE LEGISLATURE
HOUSE OF REPRESENTATIVES
RESEARCH AGENCY

P.O. Box Y, State Capitol
Juneau, Alaska 99811-3100
Mail Stop 3100
(907) 465-3991

February 27, 1987

MEMORANDUM

TO: Representative Terry Martin

ATTN: John Manley

FROM: Penelope Weyhrauch
Legislative Analyst

RE: Findings on Marijuana (House Bill 55)
Research Request 87.158

You asked us to substantiate the findings on marijuana included in House Bill 55. I have addressed each of the findings included in the bill with the most applicable research available to me. Wherever possible, I have presented the research without paraphrasing it. For this reason, the memorandum may not read smoothly. As you requested, I have not included any research which disputes the findings set out in the bill.

1. Delta-9-tetrahydrocannabinol (THC), the mind-altering ingredient in marijuana, is not soluble in water, but goes into the fatty tissues of the brain, testicles, ovaries, and other internal organs, and takes 30 days to be eliminated from the body.

According to Dr. W.D.M. Paton, Professor of Pharmacology at Oxford University, "the various cannabinoid substances are highly soluble in fat, but have a low solubility in water".¹ Other research shows that "THC--the principal psychoactive ingredient of marijuana...tends to accumulate in the brain and gonads and other fatty tissues."²

¹George K. Russell, "Marihuana Today--A Compilation of Medical Findings for the Layman," p. 45.

²Senator Eastland, Chairman of the Internal Security Subcommittee of the United States Senate, May 1974, summarizing testimony given before the Subcommittee. Quoted in "Marihuana Today", p. 14.

Research completed by the National Institute on Drug Abuse shows that THC tends to remain for long periods of time in fatty tissues. Five days after a single injection of THC, 20 percent of the THC remains stored in body fats. Complete elimination of a single dose can take 30 days.³

2. The buildup of THC in the body causes the user to smoke more marijuana to achieve the desired high and may result in loss of sleep, appetite, initiative, as well as moodiness and depression.

Studies indicate that a tolerance to THC can develop, when increasing doses of a drug are required to produce the same effect.⁴ "It appears now, both in animals and in humans, that tolerance develops quite rapidly to many of the effects of THC. The more frequent the administration and the higher the dose the more rapidly it develops, but even subjects smoking as little as one marijuana cigarette per day in a laboratory experiment demonstrate tolerance on some behavioral and physiologic dimensions."⁵

To maintain constant blood levels of THC, healthy subjects were given doses of the oral equivalent of several marijuana cigarettes a day. Within hours after the last dose of THC, subjects showed "irritability, restlessness, decreased appetite, sleep disturbances, sweating, tremor, nausea, vomiting and diarrhea."⁶

3. It is possible for a human being to overdose from the use of marijuana especially if it is used in conjunction with alcohol, because it increases the effects of alcohol.

"We have found that...behaviors are linked behaviors, so that the consumption of any substance, licit or illicit, is positively correlated with an increased consumption of all other substances."⁷ "Taking the total of animal and human research, simultaneous use of both alcohol and marijuana

³"Marijuana Research Findings: 1980," Research Monograph Series 31, National Institute on Drug Abuse, U.S. Department of Health and Human Services, p. 57.

⁴"Marijuana Today," pp. 73 - 74.

⁵"Marijuana Research Findings: 1980," p. 74.

⁶"Marijuana Research Findings: 1980," p. 75. See also "Marijuana and Health," Report of a Study by a Committee of the Institute of Medicine, Division of Health Sciences Policy, 1982, p. 27.

⁷R.L. DuPont, testimony before the Senate Subcommittee on Internal Security, May 1975, ref. 90, pp. 461-471. Quoted in "Marijuana Today," p. 16.

typically has more profound effect than the use of either alone."⁸ "From the evidence it can be said that these two psychochemicals add to the effects of each other. This is common 'street' knowledge, and it is confirmed in the laboratory. The degree of intoxication is increased, and it lasts longer. This means that behavior and psychomotor functioning are more impaired."⁹

4. The THC content of a marijuana cigarette 10 years ago was one percent, but it is as high as 10 percent per cigarette today.

"The marijuana used today is many times--five to ten times--stronger than in the 60s. At the beginning of the drug movement, marijuana with THC content as low as .02 to .5 percent was commonly available and marijuana with two percent THC was considered 'real good grass.' Now confiscated marijuana analyzed in government laboratories has been found to have THC content as high as 14 percent."¹⁰

"'Street' marijuana has increased markedly in potency over the past five years. Confiscated materials in 1975 rarely exceeded one percent THC content. By 1979, samples as high as five percent THC content were common. 'Hash oil,' a marijuana extract unavailable a decade ago, has been found to have a THC content as high as 28 percent, with more typical samples analyzed by University of Mississippi chemists ranging from 15 to 20 percent THC."¹¹

5. Marijuana causes schizophrenia, illusions, and hallucinations, including a dulling of the senses, creating the possibility that the user is unable to respond to body signals, such as pain.

"The acute anxiety reaction that may occur during marijuana intoxication can include paranoid delusions,... a full blown acute toxic psychosis with loss of contact with reality, delusions, hallucinations... These acute reactions seem to occur most frequently in individuals who are under stress, depressed, or have a history of schizophrenia."¹²

⁸"Marijuana Research Findings: 1980," pp. 38, and 170.

⁹Sidney Cohen, M.D., and Phyllis J. Lessin, "Marijuana and Alcohol," American Council for Drug Education, 1982, p. 21.

¹⁰Helen C. Jones, "On Marijuana Reconsidered," Executive Health, Volume 10, Number 5, February, 1984.

¹¹"Marijuana Research Findings: 1980," p. 2.

¹²"Marijuana Research Findings: 1980," pp. 71-72. See also "Marijuana and Health," p. 126.

One researcher described a higher dose-related phase of cannabis intoxication as "...the appearance of delusions, labile emotions, particularly anxiety, decreased impulse control and, at the highest doses, profound sensory illusions and hallucinations."¹³ Dr. Harris Isbell, with the University of Kentucky Medical Center, confirmed these findings, stating that "...the data in our experiments definitely indicate that the psychotomimetic (capable of inducing altered states of consciousness) effects of THC are dependent on dosage and that sufficiently high doses can cause psychotic reactions in any individual." Dr. Isbell classified cannabis among the hallucinogens.¹⁴

One report stated that "...acute psychotic behavior resembling schizophrenic psychosis..." had been reported.¹⁵ Another said that "Sufficient clinical information is available to recommend abstinence for schizophrenics in remission, because of the danger of relapse."¹⁶

6. Although it may take a heavy cigarette smoker as long as 20 years to develop lung cancer, one marijuana cigarette a day may cause lung cancer in three years.

"Recent clinical evidence and findings from several research laboratories demonstrate that cannabis inhalation may have seriously damaging effects on human lung tissue... The damage is described as 'pre-cancerous.' The caustic and irritating effects of cannabis smoke are well known to users, and recent work has shown that 'like tar from tobacco cigarettes, reefer tar is carcinogenic when painted onto mouse skin.' Benzopyrene, a potent carcinogenic agent, is 50 percent more concentrated in the smoke of marijuana than smoke from varieties of high tar Kentucky tobacco."¹⁷

Dr. Cecile Leuchtenberger of the Swiss Institute for Experimental Cancer Research exposed small portions of excised mouse lung tissue to standardized puffs of marijuana. She summarized her work by stating: "The observations that marijuana cigarette smoke stimulates irregular growth in the respiratory system which resembles closely precancerous lesions would indicate that long-term inhalation of marijuana cigarette smoke may either directly evoke lung cancer or may at least contribute to the development of lung cancer."¹⁸

¹³"Marijuana Research Findings: 1980," p. 62.

¹⁴"Marijuana Today," p. 24.

¹⁵Robert G. Heath, M.D., "Marijuana and the Brain," The American Council on Marijuana and Other Psychoactive Drugs, 1981, p. 6.

¹⁶"Drug Abuse and Drug Abuse Research," The first in a Series of Triennial Reports to Congress, Department of Health and Human Services, 1984, p. 77.

¹⁷"Marijuana Today," pp. 54 - 55.

¹⁸"Marijuana Today," pp. 55 - 56.

"According to researchers at the American Health Foundation, marijuana smoke contains 50 percent more cancer-producing hydrocarbons than tobacco smoke."¹⁹ Further, "...abnormalities suggestive of cancerous lesions have been recorded."²⁰

7. THC affects eggs, sperm, sexual hormones, and the development of a fetus, and marijuana use may result in deformed or undersized offspring.

"Studies have shown that THC accumulates in the ovaries of the female, where it will kill and injure eggs" and that a "...significant decrease in sperm concentration and total sperm count occurs."²¹ "This effect is apparently accompanied by a decline in sperm motility and an increase in abnormal sperm forms."²²

"Studies with laboratory animals clearly show that the crude drug marijuana and THC...inhibit secretion of the pituitary hormones, luteinizing hormone and follicle stimulating hormone as well as prolactin. These changes in pituitary hormone levels produce decreases in sex steroid hormones and cause disruption of ovulation and spermatogenesis. With chronic drug use, disruption of sex accessory organs (e.g., uterus and vagina in the female; prostate gland and seminal vesicles in the male) has also been observed."²³

Other studies show that "...the risks of pregnancy loss and other adverse effects on the fetus are increased by marijuana use...significant changes consistent with retardation of fetal growth and development have been observed."²⁴

"Low maternal weight gain during pregnancy, maternal illnesses during pregnancy, and cigarette and marijuana smoking during pregnancy were consistently related to adverse fetal development. Women who used marijuana during pregnancy delivered infants with significantly smaller

¹⁹"On Marijuana Reconsidered," p. 2.

²⁰"Marijuana and Health," p. 63. See also "Effects of Long Term Marijuana Use", p. 156, and, "Marijuana and Health," pp. 3, and 62.

²¹"Marijuana," Narcotic Information Bulletin, No.1-80, p. 2.

²²Carol Grace Smith, Ph.D. and Ricardo H. Asch, M.D., "Marijuana and Reproduction," the American Council for Drug Education, 1982, pp. 16, 17.

²³"Marijuana and Reproduction," p. 7.

²⁴"Marijuana and Reproduction", p. 8.

birth weight, body length and head circumference, as well as infants who were five times more likely to have features compatible with the fetal alcohol syndrome."²⁵

"In males, marijuana has been found temporarily to lower testosterone, the principal male sex hormone, decrease sperm count, cause abnormalities in the sperm...In women, a study of marijuana users done at the Masters and Johnson Institute found that the drug disrupted the menstrual cycle...At the University of California, Davis, Dr. Ethel Sassenrath, on exposing pregnant rhesus monkeys (who have a reproductive system similar to humans), to THC in doses equal to one or two marijuana cigarettes a day for humans, found significantly lower weight gains during pregnancy and 40 percent of the conceptions ending in miscarriages, fetal deaths, stillbirths, or infant deaths shortly after birth."

8. Other physical reactions to marijuana include irreversible changes in the brain, sinusitis, pharyngitis, bronchitis, emphysema, increased heart rate, and decreased blood circulation.

One study stated that "The findings reported here indicate that exposure to ...THC...at doses commensurate with those used by human marijuana smokers, produces permanent changes in brain function and structure of monkeys, a subhuman primate close to man."²⁶

Testimony on this subject before the Senate Subcommittee on Internal Security was summarized by finding that: "1) Chronic cannabis smoking can produce sinusitis, pharyngitis, bronchitis, emphysema and other respiratory difficulties in a year or less, as opposed to ten or twenty years of cigarette smoking to produce similar complications; and 2) Cannabis smoke, or cannabis smoke mixed with (tobacco) cigarette smoke, is far more damaging to lung tissue than tobacco smoke alone."²⁷

"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."²⁸

²⁵"Marijuana and Reproduction," p. 16, 17.

²⁶Robert G. Heath, M.D., "Marijuana and the Brain," The American Council on Marijuana and Other Psychoactive Drugs, Inc., 1981, p. 10.

²⁷"Marijuana Today," p. 14. See also "Marijuana and Health," p. 60.

²⁸"Marijuana and Health," p. 3.

9. Other psychological reactions to marijuana include loss of memory, impairment in thinking, reading comprehension, and verbal and arithmetic problem solving; impairment of perception of distance and time; and anxiety, panic, paranoia, psychosis, and psychological dependence.

Dr. Ronald C. Bloodworth, Clinical Director at the Psychiatric Institute of Atlanta, reported that "...Many heavy users suffer from distorted emotional responses, disordered thinking, and loss of memory and motivation." Dr. Bloodworth also reported that there is enough evidence to confirm that psychologic dependence is common among marijuana users and that physical dependence can also occur.²⁹

Other studies concur with Dr. Bloodworth's findings: "...cannabis intoxication...impairs judgments of distance and time, memory for recent events, ability to learn new information, and physical coordination,"³⁰ and, "...several studies have shown that marijuana intoxication impairs driving, flying and other complex skilled activities. Many elements of effective psychomotor performance are worsened by the drug because of decrements in recent memory, tracking performance, glare recovery, motor coordination, depth perception, time sense, and peripheral vision."³¹

"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."³²

"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."³³

Another study reported that "16 percent of regular users reported anxiety, fearfulness, confusion, dependency, or aggressive urges as a usual occurrence. Acute paranoid reactions under controlled conditions has also been reported."³⁴

²⁹"On Marijuana Reconsidered," p. 4.

³⁰"Marijuana Research Findings: 1980," page 67..

³¹"Marijuana Research Findings: 1980," p.71.

³²"Marijuana and Health," p. 116.

³³"Marijuana and Health," p. 121.

³⁴"Marijuana and Health," pp. 122 to 123.

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"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 schizophrenia-like picture with delusions and hallucinations."³⁶

"Although infrequent..psychiatric problems can emerge. Acute anxiety and panic states from use of the drug are known, especially in persons who have never used marijuana before. Acute paranoid states will occur at times in experienced smokers who have previously used the drug without untoward reaction."³⁷

* * *

I hope this information is useful to you. If you would like excerpts from the articles cited in this memorandum, please contact our agency.

³⁶"Marijuana and Health," p. 124.

³⁷"Effects of Long Term Marijuana Use," p. 158..



ALASKA STATE LEGISLATURE
HOUSE OF REPRESENTATIVES
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April 4, 1988

MEMORANDUM

TO: Representatives Johnny Ellis and Niilo Koponen
Co-Chairs, House Health, Education and Social Services Committee

FROM: Karla Hart *KH*
Legislative Analyst

RE: Findings on Marijuana (Senate Bill 32) and Comparison With Alcohol
and Tobacco
Research Request 88.212

As part of the House Health Education and Social Services Committee's preparation for hearings on the recriminalization of marijuana, you asked us to discuss the findings on marijuana included in CSSB 32 (HESS) and, where appropriate, to present similar information on alcohol and tobacco.¹ I have addressed each of the findings included in the bill with the most applicable research available to me.² Under each finding below, research which supports the finding is presented first, followed by

¹"The roles of tetrahydrocannabinol (THC) in marijuana, ethanol in alcoholic beverages, and nicotine in tobacco products are similar in terms of drug abuse or addiction," according to the National Institute of Drug Abuse (NIDA) in: Drug Abuse and Drug Abuse Research, The first in a Series of Triennial Reports to Congress, U.S. Department of Health and Human Services, DHSS (ADM) 85-1372, 1984, p. 97.

²This memorandum incorporates portions of House Research Memorandum 87.167 and presents material in a similar format. In addition to material gathered independently, I have incorporated material provided by Alaskans for a Drug Free Youth and the National Organization for the Reform of Marijuana Laws. Prior to March 16, I asked for access to Senator Fischer's materials on marijuana. Because permission was not granted until the afternoon of March 30, I was unable to examine his files due to the memorandum deadline.

research which disputes the finding or presents additional information which you may wish to consider. Wherever possible, I have presented the research without paraphrasing it.

Section 1. FINDINGS. (a) The legislature finds that marijuana use is a serious health problem for the following reasons, each of which constitutes a legitimate and compelling state interest:

- 1) Marijuana and other cannabis preparations may contain over 420 different compounds.

Support. C.E. Turner found that marijuana "...is quite complex, containing at least 421 individual compounds. Sixty-one of the chemicals which have been identified in the plant--the cannabinoids--are specific to cannabis...."³ "And when marijuana is smoked, the 421 chemicals turn into still more chemicals. Over 2,000 of them."⁴

Other Considerations. According to Jon Gettman, National Director of NORML, "there is no correlation, let alone a causal relationship, between the number of compounds a substance contains and its capacity to pose a serious health hazard. However, it must be pointed out that refined pharmaceuticals tend to be more toxic and hazardous to the body than natural substances--which tend to be more easily metabolized. Coca leaves and opium, for example, are less toxic than their refined by-products, cocaine and heroin. It could be argued that the lower the number of compounds present in a substance the more dangerous it is, but this would be equally as fallacious."⁵

Hundreds of compounds exist in just about everything humans eat. As Marlys Schneider, Chemistry Department, University of Alaska Fairbanks, explained, this complexity is often advantageous because the concentration of any single, and potentially harmful, compound is diluted. She added that the harmfulness of a substance is determined by how much of it is present, not what it is.⁶

³C. E. Turner, "Chemistry and metabolism of marijuana," in: Marijuana Research Findings: 1980, ed. R. C. Peterson, Washington, D.C., U.S. Government Printing Office, 1980.

⁴Peggy Mann, Pot Safari: A Visit to the Top Marijuana Researchers in the U.S., New York, Woodmere Press, 1985, p. 12.

⁵Jon B. Gettman, Director, National Organization for the Reform of Marijuana Laws, personal communication, March 17, 1988.

⁶Marlys Schneider, Chemistry Department, University of Alaska Fairbanks, personal communication, March 18, 1988.

Alcohol. Ethanol is a single chemical.⁷

Tobacco. "Tobacco smoke contains over 1,500 chemical compounds, including heavy metals from the soil in which the tobacco is grown, chemicals added in the processing of tobacco, from bacterial or fungal contamination and products of combustion of the plant material. The principal components of tobacco smoke may be characterized under the headings of volatile compounds (or gases), water-soluble agents and fat-soluble and insoluble particles ("tars")."⁸

- 2) Tetrahydrocannabinol (THC), one of the pharmacologically active compounds in marijuana, is not soluble in water, but goes into the fatty tissues of the brain, testicles, ovaries, and other internal organs and takes as long as 30 days to be eliminated from the body.

Support. According to Dr. W.D.M. Paton, Professor of Pharmacology at Oxford University, "the various cannabinoid substances are highly soluble in fat, but have a low solubility in water."⁹ Other research shows that "THC--the principal psychoactive ingredient of marijuana...tends to accumulate in the brain and gonads and other fatty tissues."¹⁰

Research completed by the National Institute on Drug Abuse (NIDA) shows that THC tends to remain for long periods of time in fatty tissues. Five days after a single injection of THC, 20 percent of the THC remains stored in body fats. Complete elimination of a single dose can take 30 days.¹¹

I did not find any research which disputes this finding.

⁷Mann, Pot Safari, p. 12.

⁸Donald P. Tashkin, and Sidney Cohen, Marijuana Smoking and Its Effects on the Lungs, New York, The American Council on Marijuana and Other Psychoactive Drugs, 1981, p. 8.

⁹George K. Russell, Marijuana Today: A Compilation of Medical Findings for the Layman, rev. ed., New York, The Myrin Institute for Adult Education, 1983, p. 45.

¹⁰Senator Eastland, Chairman of the Internal Security Subcommittee of the United States Senate, May 1974, summarizing testimony given before the Subcommittee. Quoted in Marijuana Today, p. 14.

¹¹Robert C. Petersen, ed., Marijuana Research Findings: 1980, National Institute on Drug Abuse Research Monograph 31, Washington, D.C., U.S. Government Printing Office, DHSS (ADM)80-1001, 1980, p. 57.

Other Considerations. One of the NIDA's four "high priority research questions" in a 1987 publication was that the "significance of the cumulation of cannabinoids in lipid tissues over years requires clarification; for example, does the retention of THC and its congeners in lipid membranes of the gonads and neurons produce undesired changes?"¹²

Alcohol. Alcohol is water soluble and is taken into the blood stream, metabolized and washed out of the body in a few hours.¹³

Tobacco. Nicotine is also water soluble.

- 3) The buildup of THC in the system means that repeated administration of even small doses may lead to an accumulation of the drug higher than levels reached at any time after a single dose.

Note. "Drugs that are slowly cleared are not necessarily inherently more toxic than drugs that are rapidly cleared. However, slow clearance may make for cumulative toxicity (assuming that some of the metabolites have biological activity). Many useful therapeutic drugs are cleared slowly from the body; for example, many benzodiazepines. Therapeutic drugs having this characteristic sometimes cause problems when their dosage schedules are not properly regulated. Thus, slow elimination and the possibility of drug accumulation become even more significant with a drug such as marijuana which is administered in doses and on a dosage schedule controlled by the individual user and by custom rather than as recommended and monitored by a physician."¹⁴

¹²Drug Abuse and Drug Abuse Research, The second triennial report to Congress from the Secretary, U.S. Department of Health and Human Services, Rockville, Md, National Institute on Drug Abuse, DHSS (ADM)87-1486. 1987, p. 88.

¹³Mann, Pot Safari, p. 49.

¹⁴Marijuana Research Findings: 1980, pp. 58-59.

Support. This finding is largely a quote from a National Academy of Sciences Report.¹⁵ In other words, "If a person is using marijuana more often than once a month, ... then residue levels of THC are not only retained, but also build up in the user's body."¹⁶ "There's one other substance which has as much staying power [as THC] in the body cells. DDT. But because it clings on in the body cells [about as long as THC], it was banned."¹⁷

Other Considerations. The psychoactive components in marijuana are metabolized fairly quickly according to Dr. Arthur McBay, North Carolina's chief medical examiner.¹⁸ Jon Gettman, NORML, explains that the "high" associated with marijuana lasts for approximately four hours and repeated doses, therefore, do not have a cumulative psychoactive effect if administered less frequently than every four hours.¹⁹

Alcohol and Tobacco. Because both ethanol and nicotine are largely water soluble they do not "buildup" in the system.

- 4) The buildup of THC in the body causes the user to smoke more marijuana to achieve the desired high and may result in loss of sleep, appetite, and initiative, as well as moodiness and depression.

Note. "Tolerance...is present if one witnesses a diminished response to a particular dose of a drug after one or more prior administrations of this drug. Tolerance can also be said to be present if a larger dose of [a drug] is necessary to produce a particular intensity of physiologic or

¹⁵Institute of Medicine, Marijuana and Health, Washington, D.C., National Academy Press, 1982, p. 20.

¹⁶Robert L. DuPont, Jr., Getting Tough on Gateway Drugs: A Guide for the Family, Washington, D.C., American Psychiatric Press, Inc., 1984, p. 68.

¹⁷Mann, Pot Safari, p. 22.

¹⁸Arthur McBay, as quoted by Jon Lettman, NORML, personal communication, March 25, 1988.

¹⁹Lettman, personal communication, March 25, 1988.

behavioral response in an individual who has previously consumed [the drug] as compared to the dose that was necessary to produce such response in this individual prior to the consumption of the [drug]."²⁰

Support. Studies indicate that a tolerance to THC can develop, and increasing doses of a drug are required to produce the same effect.²¹ "It appears now, both in animals and in humans, that tolerance develops quite rapidly to many of the effects of THC. The more frequent the administration and the higher the dose the more rapidly it develops, but even subjects smoking as little as one marijuana cigarette per day in a laboratory experiment demonstrate tolerance on some behavioral and physiologic dimensions."²² Other research stated that "...lethargy and loss of goal directedness persists during the interval between intoxications with marijuana and is generally reversible after months of abstinence."²³

Other Considerations. I did not find any research which directly disputes this finding. In fact, there is an "amotivational syndrome" which describes personality changes seen in some daily users of marijuana. "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. 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."²⁴

²⁰Boris Tabakoff and Jeffrey D. Rothstein, "Biology of Tolerance and Dependence," in Medical and Social Aspects of Alcohol Abuse, edited by Boris Tabakoff, Patricia B. Sutker and Carrie L. Randall, New York, Plenum Press, 1983, pp. 187-188.

²¹Russell, Marijuana Today, pp. 73-74.

²²Marijuana Research Findings: 1980, p. 74.

²³Drug Abuse and Drug Abuse Research, The first in a series of triennial reports to Congress from the Secretary, U.S. Department of Health and Human Services, Rockville, Md, National Institute on Drug Abuse, DHSS (ADM)85-1372, 1984, p. 88.

²⁴Marijuana and Health, pp. 124-125.

Alcohol. A wide range of ethanol tolerances has been proven to develop in humans.²⁵ "Alcohol intoxication has a profound effect on sleep....Sleep disturbances in alcoholics may persist...for up to one or two years after termination of chronic drinking."²⁶ "The consumption of ethanol can produce nutrient imbalance because alcoholic beverages are almost entirely devoid of essential nutrients other than calories and hence are also 'empty' in nutrient value."²⁷

Tobacco. Tolerance to nicotine develops with repeated use. Symptoms of tobacco withdrawal include irritability, anxiety, difficulty concentrating, headaches, gastrointestinal disturbances, insomnia, fatigue, aggressiveness, and impaired performance on such psychomotor and learning tests as simulated driving, vigilance, and pair-associate learning.²⁸

- 5) It is possible for a human being to overdose from the use of marijuana, especially if it is used in conjunction with alcohol, because it increases the effects of alcohol.

Comment. The term overdose is vague--Webster's Dictionary defines overdose as "too great a dose."

Support. Some studies have found that "...behaviors are linked behaviors, so that the consumption of any substance, licit or illicit, is positively correlated with an increased consumption of all other substances."²⁹ "Taking the total of animal and human research, simultaneous use of both alcohol and marijuana typically has more profound effects than the use of either alone. However, the magnitude and duration of the effect may vary depending on the dosages of the two drugs involved, the type of effect measured, and the time intervals involved in administering the drugs. As

²⁵Tabakoff and Rothstein, "Biology of Tolerance And Dependence," in Medical and Social Aspects of Alcohol Abuse, pp. 187-216.

²⁶Ibid., pp. 203-204.

²⁷Ting-Kai Li, "The Absorption, Distribution, and Metabolism of Ethanol and Its Effects on Nutrition and Hepatic Function," in Medical and Social Aspects of Alcohol Abuse, p. 69.

²⁸Drug Abuse and Drug Abuse Research, 1987, p. 97-98.

²⁹R. L. DuPont, testimony before the Senate Subcommittee on Internal Security, May 1975, ref. 90, pp. 461-471. Quoted in Russell, Marijuana Today, p. 16.

with either drug alone, there are also undoubtedly individual differences in response to the drugs in combination."³⁰

Dispute. "No human being is known to have died of an overdose [of marijuana]. By extrapolation from animal experiments, the ratio of lethal to effective (intoxicating) dose is estimated to be on the order of thousands to one."³¹ "Delta-9-THC and related cannabinoids have very low lethal toxicity. ...The lack of well-authenticated cases of human deaths from acute delta-9-THC or cannabis overdose is consistent with the [described] animal data."³² Drawing from research conducted on the relationship between marijuana and alcohol, Dr. Sidney Cohen, of the Neuropsychiatric Institute, University of California at Los Angeles, concluded that "no evidence is at hand to indicate a greater life-threatening aspect to combined use over and above the toxicity of each drug used alone."³³

Dr. Cohen also stated that "there is little evidence that these drugs [marijuana and alcohol] antagonize the psychic effects of each other although one study has found such an effect at certain dosage levels. Nor has any investigation found evidence for a potentiating action (in which the combined effect is greater than the sum of the dosages of the two drugs). The current belief is that, when used together, the drugs are generally additive (the combined effect is the sum of the two doses)."³⁴

Alcohol. "Alcohol in large doses is an anesthetic, in less amounts it behaves as a sedative. As with all sedatives, it appears to stimulate thought and activity shortly after its ingestion. This biphasic effect produces an initial activation of social and verbal behavior associated with some lightening of mood and relaxation of tensions. As intake continues, sedation and a reduced contact with the environment occur, the

³⁰Marijuana Research Findings: 1980, pp. 38 and 170.

³¹"Marijuana," The Harvard Medical School Mental Health Letter, Vol. 4, No. 5, November 1987, p. 2.

³²Marijuana and Health, p. 24.

³³Sidney Cohen and Phyllis J. Lessin, Marijuana and Alcohol, Rockville, Md, The American Council for Drug Education, 1982, p. 23.

³⁴Ibid., p. 13.

end stage of which is coma and death."³⁵ "Fortunately for many users of alcohol, before this fatal level of anesthesia is reached, the vomiting center of the brain is activated, and--reinforced by the stomach irritation also produced by overdrinking--causes the user to vomit. The lives of many who overdose on alcohol are thus saved."³⁶

Other Considerations. "Since marijuana suppresses the brain's vomiting center, it is possible that people stoned on marijuana may, when also drinking large amounts of alcohol, not vomit before they pass out. This can cause a raised risk of deaths due to alcohol overdose."³⁷ "However, marijuana appears to be an insufficient deterrent to vomiting when excessive quantities of alcohol are involved."³⁸

Tobacco. I did not find any discussion of nicotine overdoses.

- 6) The THC content of commonly available marijuana has increased from less than one percent 10 years ago to as high as 10 percent today.

Support. The reports and studies reviewed indicate that the THC content in marijuana in the United States has increased during the last twenty years. "The marijuana used today is many times--five to ten times--stronger than in the 60s. At the beginning of the drug movement, marijuana with THC content as low as .02 to .5 percent was commonly available and marijuana with two percent THC was considered 'real good grass.' Now confiscated marijuana analyzed in government laboratories has been found to have THC content as high as 14 percent."³⁹

"'Street' marijuana has increased markedly in potency over the past five years. Confiscated materials in 1975 rarely exceeded one percent THC content. By 1979, samples as high as five percent THC content were common. 'Hash oil,' a marijuana extract unavailable a decade ago, has been found to have a THC content as high as 28 percent, with more typical samples analyzed by University of Mississippi chemists ranging from 15 to 20 percent THC."⁴⁰

³⁵Ibid., pp. 9-10.

³⁶DuPont, Getting Tough, p. 108.

³⁷Ibid., p. 109.

³⁸Gettman, personal communication, March 17, 1988.

³⁹Helen C. Jones, "On Marijuana Reconsidered," Executive Health, Vol. 10, No. 5, February, 1984.

⁴⁰Marijuana Research Findings: 1980, p. 2.

Dispute. In an upcoming article in the Journal of Psychoactive Drugs, Tod Mikuriya, M.D. and Michael Aldrich, Ph.D., "...show that the range of [marijuana] potencies available [in the early 1970s] (marijuana 0.1 to 7.8 percent, averaging 2.0 to 5.0 percent by 1975) was approximately the same as that reported now."⁴¹ "It is not useful to compare average low potencies with the full range of potencies available in reality. Nor is it valid to cite the low end of the range then as a baseline to compare with the high end of the range now."⁴²

Other Considerations. The THC content of a marijuana cigarette will vary greatly depending on the type of marijuana. Thus, the THC content of a marijuana cigarette today could be more or less than 10 percent per cigarette. Dr. Mikuriya notes that "An important consideration in regard to the potency issue is auto-titration, the adjustment of dose by the individual user to obtain maximal effects and avoid unpleasant ones," and he provides observations on the practice of auto-titration."⁴³

Tobacco. "Studies have demonstrated that many smokers who switch to lower 'tar' and nicotine cigarettes will compensate for the loss in smoke nicotine (and possibly other agents) by intensifying their smoke intake, puffing more frequently, and drawing larger volumes per puff."⁴⁴

- 7) Marijuana with THC content higher than one percent is generally available in the state, through both importation and local cultivation.

Support. Sergeant Swanson, Alaska State Troopers, said that according to the U.S. Drug Enforcement Agency, the average THC content in marijuana in

⁴¹Tod Mikuriya and Michael Aldrich, "Cannabis 1988: Old Drug, "New Dangers" -- The Potency Question," to be printed in Journal of Psychoactive Drugs, April 1988, (p. 17 of manuscript).

⁴²Ibid.

⁴³Ibid., pp. 16-17.

⁴⁴The Health Consequences of Smoking: The Changing Cigarette, a report of the Surgeon General, U.S. Department of Health and Human Services, Washington, D.C., U.S. Government Printing Office, DHHS(PHS) 81-50156, 1981, p. 97.

the United States is 1.8 percent. He is not aware of any studies of THC content on marijuana generally available in Alaska; however, he said the majority (estimates 90 percent) of the marijuana in Alaska is imported from source states such as California, Oregon, Washington and Hawaii. Sergeant Swanson added that Alaska marijuana growers appear to be following the nationwide trend of applying cultivation techniques to maximize THC content.⁴⁵

I did not find any research which disputes this finding.

- 8) Marijuana may cause schizophrenia, illusions, and hallucinations, including a dulling of the senses, creating the possibility that the user is unable to respond to body signals, such as pain.

Note. Wayne McCollum, Juneau Mental Health Center, said that the cause of schizophrenia is still unknown--the main theory is the existence of a genetic propensity or susceptibility. Psychosis is a major mental disorder in which the personality is very seriously disorganized and contact with reality is usually impaired. Schizophrenia is a functional psychosis (lack of apparent organic cause). Psychosis may also have organic causes such as brain damage, hypothermia or electrolyte imbalance. Dr. McCollum said there was no relationship between psychosis and an inability to respond to pain.⁴⁶

Support. Some researchers report that "The acute anxiety reaction that may occur during marijuana intoxication can include paranoid delusions,... a full blown acute toxic psychosis with loss of contact with reality, delusions, hallucinations...These acute reactions seem to occur most frequently in individuals who are under stress, depressed, or have a history of schizophrenia."⁴⁷

One researcher described a higher dose-related phase of cannabis intoxication as "...the appearance of delusions, labile emotions, particularly anxiety, decreased impulse control and, at the highest doses, profound

⁴⁵Sergeant Swanson, Alaska State Troopers, Anchorage, personal communication, March 24, 1988.

⁴⁶Wayne McCollum, Juneau Mental Health Center, personal communication, March 29, 1988.

⁴⁷Marijuana Research Findings: 1980, pp. 71-72. See also Marijuana and Health, p. 126.

sensory illusions and hallucinations."⁴⁸ Dr. Harris Isbell, with the University of Kentucky Medical Center, confirmed these findings, stating that "...the data in our experiments definitely indicate that the psychotomimetic (capable of inducing altered states of consciousness) effects of THC are dependent on dosage and that sufficiently high doses can cause psychotic reactions in any individual." Dr. Isbell classified cannabis among the hallucinogens.⁴⁹

One report stated that "...acute psychotic behavior resembling schizophrenic psychosis..." had been reported.⁵⁰ Another report said that "Sufficient clinical information is available to recommend abstinence for schizophrenics in remission, because of the danger of relapse."⁵¹

Another report states that "An acute brain syndrome associated with cannabis intoxication [which includes a] clouding of mental processes...has been reported. It is thought to be dose-related (much more likely at unusually high doses) and to be determined more by the size of the dose than by pre-existing personality." These symptoms have ... "not been frequently reported in the United States, possibly because until recently very strong cannabis materials were less readily available here than in some overseas locations. Acute brain syndrome also diminishes as the toxic effects of the drug wear off."⁵²

Other Considerations. A report by the National Institute on Drug Abuse states that "...it is often difficult to distinguish the role of cannabis from that of pre-existing psychological problems or other environmental precipitants in marijuana-related psychological difficulties. Frequently, heavy marijuana users are also those who have had emotional problems prior to use."⁵³

⁴⁸Marijuana Research Findings: 1980, p. 62.

⁴⁹Russell, Marijuana Today, p. 24.

⁵⁰Robert G. Heath, Marijuana and the Brain, Rockville, Md., The American Council on Marijuana and Other Psychoactive Drugs, 1981, p. 6.

⁵¹Drug Abuse and Drug Abuse Research, 1984, p. 77.

⁵²Marijuana Research Findings: 1980, p. 26.

⁵³Ibid., p. 27.

The American Psychiatric Association notes that "Descriptions of cannabis psychoses vary by culture, and most reports suggest a persistent delirium, which includes bizarre behavior and the potential for violence and panic feelings in the absence of a 'typical' schizophrenia-like psychotic state. There is fairly general agreement that persons suffering from marijuana psychosis do not develop psychotic symptoms characteristic of schizophrenia."⁵⁴

Alcohol. "About 25% of patients undergoing ethanol withdrawal manifest symptoms of sensory disorganization. These patients may suffer from nightmares and from illusions or hallucinations....Hallucinations may occur even while the patient is clear-thinking and oriented....Patients with delirium tremens hallucinations may be difficult to distinguish from those with schizophrenic disorders....Rarely, auditory hallucinations may persist after an individual has recovered from symptoms of alcohol withdrawal and is no longer drinking. This syndrome is known as alcohol hallucinosis, and these patients may go on to develop schizophrenia."⁵⁵

Tobacco. I did not find any related information on tobacco or nicotine.

- 9) Although it may take a heavy cigarette smoker as long as 20 years to develop lung cancer, one marijuana cigarette a day may cause lung cancer in three years.

Note. I did not find any research which directly supports this finding. The following addresses the topic of marijuana as a causative factor in cancer.

Support. "Several lines of evidence strongly suggest that habitual marijuana smoking may be a causative factor in the development of bronchogenic carcinoma [bronchial cancer]. [This] possibility is further supported by the several-fold greater deposition in the lower respiratory tract of tar particulates from the smoke of one marijuana joint compared to that from one tobacco cigarette. However, there is a long lag period between initiation of daily exposure to tobacco tar and the development of frank neoplasia. Moreover, smoking-related pulmonary malignancy will develop in only a small, albeit significant, percentage of smokers. For

⁵⁴American Psychiatric Association, "Position Statement on Psychoactive Substance Abuse and Dependence: Update on Marijuana and Cocaine," American Journal of Psychiatry, Vol. 144, No. 5, May 1987, p. 699.

⁵⁵Tabakoff and Rothstein, "Biology of Tolerance and Dependence," in Medical and Social Aspects of Alcohol Abuse, pp. 202-203.

this reason it will be difficult to document empirically a link between heavy, habitual marijuana smoking and lung cancer.⁵⁶

"Benzopyrene, a potent carcinogenic agent, is 50 percent more concentrated in the smoke of marijuana than smoke from varieties of high tar Kentucky tobacco."⁵⁷ "According to researchers at the American Health Foundation, marijuana smoke contains 50 percent more cancer-producing hydrocarbons than tobacco smoke."⁵⁸ Further, "...abnormalities suggestive of cancerous lesions have been recorded."⁵⁹

Dispute. A report by the National Institute of Drug Abuse states that "...there is as yet no direct evidence that it [marijuana] can play a causal role in lung cancer."⁶⁰ The Institute of Medicine also reported that "...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."⁶¹

⁵⁶Donald P. Tashkin et al., "How the Lungs are Affected by Marijuana Smoking," The Journal of Respiratory Diseases, November 1987, p. 106.

⁵⁷Russell, Marijuana Today, pp. 54-55.

⁵⁸Jones, "On Marijuana Reconsidered," p. 2.

⁵⁹Marijuana and Health, p. 63.

⁶⁰Marijuana Research Findings: 1980, p. 3.

⁶¹Marijuana and Health, p. 63-64. "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."

Tobacco. "Research indicates that cigarette smoking causes cancer of the lung, larynx, oral cavity, and esophagus, and is significantly associated with pancreas, urinary bladder, and kidney cancer in both men and women."⁶²

Other Considerations. Dr. Wu and others note that "Long-term adverse pulmonary consequences of tobacco smoking have been shown to be related to dose. For example, the incidence of chronic obstructive pulmonary disease or bronchogenic carcinoma in smokers of fewer than 5 to 10 cigarettes a day is substantially less than in habitual smokers of more than 20 tobacco cigarettes a day. Although regular tobacco smokers consume more than 15 tobacco cigarettes a day, most current smokers of marijuana smoke less than 1 marijuana cigarette a day. Even among the estimated 6 million daily smokers of marijuana in the United States, smoking more than five marijuana cigarettes a day is unusual."⁶³ They found "the net respiratory burden of particulates was approximately four times greater during marijuana smoking than tobacco smoking."⁶⁴ "Accordingly, despite the presence of four times the tar and carbon monoxide of a tobacco cigarette, a single marijuana cigarette consumed daily presents less of a health risk than a quarter of a pack of tobacco cigarettes."⁶⁵ Dr. DuPont notes that "...more than 80 percent of marijuana smokers also smoke tobacco cigarettes...."⁶⁶

Alcohol. "Heavy drinkers have an increased risk of cancer of the mouth, esophagus, stomach, liver, and bladder. This risk is even greater if they also smoke cigarettes, as many heavy drinkers do...the risk of cancers is increased for drinkers, and it is increased for smokers, but for those who are both drinkers and smokers, the extra risk is not merely additive--it

⁶²The Health Consequences of Smoking: The Changing Cigarette, a report of the Surgeon General, U.S. Department of Health and Human Services, Washington, D.C., U.S. Government Printing Office, DHHS(PHS)81-50156, 1981, p. 79.

⁶³Tzu-Chin Wu et al., "Pulmonary Hazards of Smoking Marijuana as Compared with Tobacco," The New England Journal of Medicine, February 11, 1988, p. 349.

⁶⁴Ibid., p. 350.

⁶⁵Gettman, personal communication, March 25, 1988.

⁶⁶Dupont, Getting Tough, p. 69.

appears to be multiplicative. Alcohol also acts as a promoter of cancers in the lungs, the pancreas, the intestines, and the prostate."⁶⁷

- 10) THC affects eggs, sperm, sexual hormones, and the development of a fetus, and marijuana use may result in deformed or undersized offspring.

Effects on the Reproductive System.

Support. Several writers state that "Studies have shown that THC accumulates in the ovaries of the female, where it will kill and injure eggs" and that, in males, a "...significant decrease in sperm concentration and total sperm count occurs."⁶⁸ "This effect is apparently accompanied by a decline in sperm motility and an increase in abnormal sperm forms."⁶⁹

"Studies with laboratory animals clearly show that the crude drug marijuana and THC...inhibit secretion of the pituitary hormones, luteinizing hormone and follicle stimulating hormone, as well as prolactin. These changes in pituitary hormone levels produce decreases in sex steroid hormones and cause disruption of ovulation and spermatogenesis. With chronic drug use, disruption of sex accessory organs (e.g., uterus and vagina in the female; prostate gland and seminal vesicles in the male) has also been observed."⁷⁰

Dispute. "In men, a single dose of THC lowers sperm count and the level of testosterone and other hormones. Tolerances to this effect apparently develop; in the [1980] Costa Rican study, marijuana smokers and controls had the same testosterone levels. Although smokers in that study began using marijuana at an average age of 15, it had not affected their masculine development. There is no evidence that the changes in sperm count and testosterone produced by marijuana affect sexual performance or fertility."⁷¹

⁶⁷Dupont, Getting Tough, pp. 110-111.

⁶⁸Marijuana, Narcotic Information Bulletin, No.1-80, p. 2.

⁶⁹Carol Grace Smith and Ricardo H. Asch, Marijuana and Reproduction, Rockville, Md., The American Council for Drug Education, 1982, pp. 16-17.

⁷⁰Ibid., p. 7.

⁷¹"Marijuana," The Harvard Medical School, p. 4.

Other Considerations. Researchers have found that "...many of the endocrine effects caused by the chronic treatment of animals with THC are reversible or decrease as tolerance to the drug develops. Still, many questions remain regarding the long-term consequences of use, for example, on sperm formation, psychosexual maturation, and sex organ function. Until these and other issues are resolved, marijuana consumption by adolescents or males with marginal fertility poses uncertain reproductive hazards."⁷²

Alcohol. "Hypoandrogenization is commonly seen in chronic alcoholic men. Thus 70% to 80% experience decreased libido and/or impotence. Reproductive failure...is common, with 70% to 80% demonstrating both testicular atrophy and infertility. Histologic studies...demonstrate loss of mature [sperm], many of which have an abnormal morphology."⁷³ "In addition to being hypogonadal, chronic alcoholic men are often grossly hyperestrogenized."⁷⁴ "[Some] signs of chronic alcoholism, unlike the transient impotence experienced with an acute alcoholic bout, persist in the absence of intoxication and are due to alcohol-induced tissue injury....Testosterone concentrations can be shown to fall in normal male volunteers within hours of their ingesting sufficient alcohol to produce hangover."⁷⁵

"In contrast to the male, the alcoholic female is not superfeminized but instead shows severe gonadal failure commonly manifested by oligoamenorrhea, loss of secondary sexual characteristics..., and, in addition, infertility."⁷⁶

Tobacco. "Spermatogenesis, sperm morphology, sperm motility and androgen secretion appear to be altered in men who smoke. [A researcher] has demonstrated decreased sperm density, a cigarette-dose-dependent decrease

⁷²Drug Abuse and Drug Abuse Research, 1987, p. 79.

⁷³David H. Van Thiel, "Effects of Ethanol upon Organ Systems Other than the Central Nervous System," in Medical and Social Aspects of Alcohol Abuse, p. 111.

⁷⁴Ibid, p. 113.

⁷⁵Ibid, p. 111.

⁷⁶Ibid, p. 115.

in sperm motility, and a cigarette-dose-dependent increased abnormal sperm morphology among smokers."⁷⁷

"Several epidemiological studies have suggested that smoking decreases fertility in women....a 46 percent excess of infertility was found in women who smoked....Experimental studies have demonstrated alterations in luteinizing hormone release and a decreased ovulatory response in rats exposed to tobacco smoke."⁷⁸

Effects on the Developing Fetus and Offspring

Note. It has been found that "...tobacco and marijuana smoking, and alcohol and other drug abuse frequently occur in the same women. Therefore, some of the adverse effects on fetal development attributed to maternal drinking or smoking may be due to an interaction with marijuana and other psychoactive substances. When a number of these substances are consumed together, their toxic effects on the fetus may be additive."⁷⁹

Support. Several reports state that "...the risks of pregnancy loss and other adverse effects on the fetus are increased by marijuana use... significant changes consistent with retardation of fetal growth and development have been observed."⁸⁰ "Low maternal weight gain during pregnancy, maternal illnesses during pregnancy, and cigarette and marijuana smoking during pregnancy were consistently related to adverse fetal development. Women who used marijuana during pregnancy delivered infants with significantly smaller birth weight, body length and head circumference, as well as infants who were five times more likely to have features compatible with the fetal alcohol syndrome."⁸¹ Maternal marijuana use has been

⁷⁷The Health Consequences of Smoking for Women, a report of the Surgeon General, U.S. Department of Health and Social Services, Rockville, Md., Public Health Service, 1980, pp. 236-237.

⁷⁸Ibid, pp. 235-236.

⁷⁹R. Hingston et al., "Effects on Fetal Development of Maternal Marijuana use during Pregnancy," 1984, cited in Drug Abuse and Drug Abuse Research, 1987, p. 80.

⁸⁰Smith, Marijuana and Reproduction, p. 8.

⁸¹Ibid., pp. 16-17.

found to be the strongest independent predictor of fetal alcohol syndrome (FAS). "It was a better predictor of the FAS than alcohol use."⁸²

At the University of California-Davis, Dr. Ethel Sassenrath, on exposing pregnant rhesus monkeys (who have a reproductive system similar to humans), to THC in doses equal to one or two marijuana cigarettes a day for humans, found significantly lower weight gains during pregnancy and 40 percent of the conceptions ending in miscarriages, fetal deaths, stillbirths, or infant deaths shortly after birth.⁸³

Dispute. A report which does not support this finding states that "...Cannabis is teratogenic at high doses in animals."⁸⁴ Gross malformations in human infants due to prenatal exposure to cannabis are not yet completely proven."⁸⁵ "In another investigation no particular effects of maternal marijuana use upon the newborn were found except for a decrease in length and an increase in male infants delivered in the marijuana group."⁸⁶ "There are also reports of low birth weight, prematurity, and even a condition resembling the fetal alcohol syndrome in some children of women who smoke marijuana heavily during pregnancy. The significance of these reports is unclear because controls are lacking and other circumstances make it hard to attribute causes."⁸⁷

Alcohol. "On the basis of numerous clinical and epidemiological studies, it appears that in utero alcohol exposure can result in a wide range of effects, with the full-blown FAS at one extreme and the only barely perceptible FAE [fetal alcohol effects] as the other end of the continuum is approached. Such variability may be due to differences in in utero blood alcohol exposure, daily exposure versus binge drinking, genetic

⁸²R. Hingston, et al., 1982 and 1985, cited in Drug Abuse and Drug Abuse Research, 1987, p. 80.

⁸³Russell, Marijuana Today, p. 61.

⁸⁴Teratogenic is producing malformed babies.

⁸⁵E.L. Abel, "Effects of prenatal exposure to cannabinoids," 1985, cited in Drug Abuse and Drug Abuse Research, 1987, p. 80.

⁸⁶K. Tennes et al, "Marijuana: Prenatal and Postnatal Exposure in the Human," 1985, cited in Drug Abuse and Drug Abuse Research, 1987, p. 81.

⁸⁷"Marijuana," The Harvard Medical School, p. 4.

sensitivity, gestational time of exposure, interactions with other drugs, nutritional status, and so on."⁸⁸

Tobacco. "Smoking is a major risk factor for low birth weight and, consequently, fetal morbidity and mortality. Tobacco smoke may influence the fetus either through alterations in maternal physiology that limit the nutrient flow to the fetus or by the transplacental passage of smoke components that have direct effect on the fetus."⁸⁹ "Studies have identified specific areas in which the effects of maternal smoking during pregnancy may occur. These include fetal growth, most often determined by comparing birth weights of smokers' babies with those of otherwise similar nonsmokers' babies; spontaneous abortions, fetal deaths, and neonatal deaths; pregnancy complications, including those that predispose to preterm delivery; possible effects on lactation; and long term effects on surviving children."⁹⁰

- 11) Other physical reactions to marijuana include irreversible changes in the brain, sinusitis, pharyngitis, bronchitis, emphysema, increased heart rate, and decreased blood circulation.

Irreversible Changes in the Brain

Support. One report which supports this finding stated that "...exposure to...THC...at doses commensurate with those used by human marijuana smokers, produces permanent changes in brain function and structure of monkeys, a subhuman primate close to man."⁹¹

Dispute. The Institute of Medicine, in their summary on marijuana's effect on the brain stated that "There is no persuasive evidence that marijuana causes morphological changes in the brain...studies on users of marijuana reveal no gross changes in brain structure. Electron micrographic studies of monkey brains indicating morphologic changes are

⁸⁸Ernest L. Abel, Carrie L. Randall and Edward P. Riley, "Alcohol Consumption and Prenatal Development," in Medical and Social Aspects of Alcohol Abuse, p. 223.

⁸⁹The Health Consequences of Using Smokeless Tobacco, A Report of the Advisory Committee to the Surgeon General, U.S. Department of Health and Human Services, Bethesda, Md., National Institute of Health Publication No. 86-2874, 1986, p. 178.

⁹⁰The Health Consequences of Smoking for Women, p. 191.

⁹¹Heath, Marijuana and the Brain, p. 10.

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...Current evidence has shown marijuana causes some chemical changes in [the] brain...At high doses marijuana also has been shown to affect nucleoprotein synthesis."⁹²

Other Considerations. "There are too few reliable data presently available to permit a valid conclusion concerning marijuana use and cerebral atrophy, but the seriousness of such an effect, if it exists, should make it an important priority for further neurological study."⁹³ The 1987 NIDA report to Congress also notes the need for further research on marijuana's effects on the brain.⁹⁴ Dr. Heath explains two difficulties in studying the effects of marijuana on the human brain "...1) In order to see what effect, if any, pot is having on brain cells--you have to kill the subject, cut up the brain, and look at cells under a high-powered electron microscope....." and 2) even when humans die and leave their bodies to science, there is a lack of controls--no way to prove if damage is found that it came from marijuana rather than alcohol or other drugs."⁹⁵

Alcohol. "Long term consumption of alcoholic beverages can lead to a number of pathologic conditions of the brain. Among them are a number of neurologic diseases,....Some of these diseases result from nutritional deficiencies, while others result from a direct neurotoxic effect of ethanol. Studies in both humans and experimental animals have demonstrated the presence of cerebral atrophy after long-term ethanol consumption and the loss of cells in certain parts of the brain, especially the hippocampus and cerebellum. Other investigations suggest that the loss of certain receptors specific for a given neurotransmitter or other biologically active substance might contribute to some of the medical complications associated with chronic ethanol usage."⁹⁶

⁹²Marijuana and Health, p. 89.

⁹³Russell, Marijuana Today, p. 53.

⁹⁴Drug Abuse and Drug Abuse Research, 1987, pp. 84-85.

⁹⁵Mann, Pot Safari, p. 23-24.

⁹⁶Walter A. Hunt, "Ethanol and the Central Nervous System," in Medical and Social Aspects of Alcohol Abuse, p. 155.

Tobacco. I did not find any material relating to nicotine or tobacco caused pathologies of the brain.

Pulmonary Effects

Support. "Short-term use of marijuana causes bronchodilation, an alteration in ventilatory control, and a substantial increase in end-expired carbon monoxide. Long-term use produces tachyphylaxis and airflow obstruction, and potentiates [increases the effect of] tobacco in causing airway hyperreactivity. Marijuana smoking appears to have its major impact on the large airways, in contrast to tobacco smoking, which primarily affects the peripheral airways and alveolated regions. Bronchoscopic studies of the mucosa of marijuana smokers have revealed abnormalities such as loss of cilia, basal cell and goblet cell hyperplasia, squamous metaplasia, and inflammation."⁹⁷

I found no information to dispute these findings.

Tobacco. Dr. C. Everett Coop, the Surgeon General, estimated "that 80 and 90 percent of chronic lung disease in the country is directly attributed to cigarette smoking..."⁹⁸

Alcohol. "Chronic obstructive pulmonary disease is common among males who abuse ethanol and especially among those who smoke. Until recently chronic alcohol abuse has been a disease limited to males, most of whom also smoke; thus the finding of an association between chronic obstructive lung disease and alcohol abuse would not be particularly surprising. Other pulmonary problems are also common in alcoholics....With advanced liver disease, cyanosis, hyper-ventilation, and hypoxia due to pulmonary arteriovenous fistula are a common occurrence."⁹⁹

⁹⁷Donald P. Tashkin, Henry Gong, Jr. and Suzanne E. G. Fligiel, "How the Lungs are Affected by Marijuana Smoking," The Journal of Respiratory Diseases, Vol. 8, No. 11, November 1987, p. 87.

⁹⁸"The Chronology of U.S. Warning Against Cigarettes," World Health, October 1984.

⁹⁹Van Thiel, "Effects of Ethanol Upon Organ Systems," in Medical and Social Aspects of Alcohol Abuse, pp. 110-111.

Cardiovascular Effects

Support. "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."¹⁰⁰

Other Considerations. The Institute of Medicine summarized their findings on marijuana's effects on the cardiovascular system with the following: "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...Evidence abounds that marijuana increased 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."

Alcohol. "The cardiovascular effects of alcohol are minimal but, under certain circumstances, may hasten death. Even lethal quantities of alcohol do not significantly impair myocardial function; the heart usually continues to contract for some time after respiratory movements have stopped."¹⁰¹

Tobacco. A Surgeon General's report states "It has long been known that nicotine elevates blood pressure and heart rate and may increase the onset of angina pectoris attacks. The effects of carbon monoxide in reducing the oxygen-carrying capacity of the blood are well known."¹⁰²

- 12) Other psychological reactions to marijuana include loss of memory, anxiety, panic, paranoia, psychosis, psychological dependence, and impairment in thinking, reading comprehension, verbal and arithmetic problem solving, and perception of distance and time.

Note. See related information above, sections (a)(4) and (8).

¹⁰⁰Marijuana and Health, p. 72.

¹⁰¹Frederick G. Hofman, A Handbook on Drug and Alcohol Abuse: The Biomedical Aspects, 2nd ed. rev., New York, Oxford University Press, 1983, pp. 103-104.

¹⁰²The Health Consequences of Smoking, 1981, p. 46.

Support. Dr. Ronald C. Bloodworth, Clinical Director at the Psychiatric Institute of Atlanta, reported that "...Many heavy users suffer from distorted emotional responses, disordered thinking, and loss of memory and motivation." Dr. Bloodworth also reported that there is enough evidence to confirm that psychologic dependence is common among marijuana users and that physical dependence can also occur.¹⁰³

Other studies concur with Dr. Bloodworth's findings: "...cannabis intoxication...impairs judgments of distance and time, memory for recent events, ability to learn new information, and physical coordination,"¹⁰⁴ and, "...several studies have shown that marijuana intoxication impairs driving, flying and other complex skilled activities. Many elements of effective psychomotor performance are worsened by the drug because of decrements in recent memory, tracking performance, glare recovery, motor coordination, depth perception, time sense, and peripheral vision."¹⁰⁵

"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."¹⁰⁶

"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."¹⁰⁷

Another study reported that "16 percent of regular users reported anxiety, fearfulness, confusion, dependency, or aggressive urges as a usual occurrence. Acute paranoic reactions under controlled conditions has also been reported."¹⁰⁸

"Cannabis psychosis refers to a chronic psychotic condition (out of contact with reality) reportedly seen in heavy marijuana users, but extending

¹⁰³Jones, "On Marijuana Reconsidered," p. 4.

¹⁰⁴Marijuana Research Findings: 1980, page 67.

¹⁰⁵Ibid, p. 71.

¹⁰⁶Marijuana and Health, p. 116.

¹⁰⁷Ibid., p. 121.

¹⁰⁸Ibid., pp. 122-123.

beyond the period of acute intoxication. Some authors have described a schizophrenia-like picture with delusions and hallucinations."¹⁰⁹

"Although infrequent..psychiatric problems can emerge. Acute anxiety and panic states from use of the drug are known, especially in persons who have never used marijuana before. Acute paranoid states will occur at times in experienced smokers who have previously used the drug without untoward reaction."¹¹⁰

Other Considerations. "The pure chronic marijuana user is hard to find. Heavy marijuana users are typically either in a state of transition toward the use of other mind-altering substances, or are already multiple drug abusers who happen to believe that marijuana is producing the difficulties that require treatment. These concerns include panicky feelings, especially about changes in time sense, difficulties in sensing how other people are responding to the individual, or fears of losing control."¹¹¹

Alcohol. "Ethanol has a most profound effect on the central nervous system. It acts as a depressant of neural function in a number of ways, an effect that is made obvious by ethanol's disruption of behavior. Apparent stimulatory effects--which include feelings of euphoria, talkativeness, and relief of tension--are observed after low doses of ethanol. Agressiveness can also be seen after ethanol consumption....With increasing doses of ethanol, there is a progressive reduction in motor coordination, including disturbances in gait, equilibrium, and reaction time. Learning, memory, and speech are impaired as well."¹¹² "More direct studies of the effect of ethanol on anxiety have not been conclusive; results seem to depend on the experimental design used."¹¹³

Tobacco. "Most drugs of abuse have, or have had, therapeutic uses. Nicotine is no exception....As an anxiety reducing drug, nicotine appears to diminish responses to stress and to enhance mood. It also reduces

¹⁰⁹Ibid., p. 124.

¹¹⁰Cohen, "Effects of Long Term Marijuana Use," p. 158.

¹¹¹Drug Abuse and Drug Abuse Research, 1987, p. 86.

¹¹²Hunt, "Ethanol and The Central Nervous System," in Medical and Social Aspects of Alcohol Abuse, p. 155.

¹¹³Ibid., p. 136.

aggressive responses in experimental situations. Nicotine improves performances involving speed, reaction time, vigilance and concentration. Such effects are strongest in smokers deprived of cigarettes, but also occur when nicotine is administered to nonsmokers or when the nicotine dose of smokers is increased....Since nicotine (as tobacco) is so widely legally available, is inexpensive, and its doses are so easily regulated, it is a very convenient means of self-medication. These combined properties probably add to the abuse liability of tobacco, thus making treating tobacco dependence especially difficult.¹¹⁴

- 13) The use of even small amounts of marijuana by adults in the home subjects children present to a substantial health hazard.

Note. "Small amounts," "substantial" and "health hazard" are all undefined terms which make this finding extremely ambiguous and therefore, difficult to respond to.

Passive Smoking. The 1983 Surgeon General's report "cited 'very solid' evidence that 'passive smoking' poses a health problem to non-smokers, and especially to children. Those from smoking households have been shown to be more susceptible to respiratory diseases than those whose parents are non-smokers."¹¹⁵ This finding is based on cigarette smoking. I did not have access to any current information on passive marijuana smoking.

- 14) Marijuana and tetrahydrocannabinols have been found by the United States Congress to possess a high potential for abuse.

Support. Marijuana is currently classified as a Schedule I drug (no medical usefulness, high potential for abuse) under Title 21, U.S. Code Section 812 (c)(10). "The removal of THC from Schedule I to Schedule II (medical usefulness, high potential for abuse) is underway."¹¹⁶

Alcohol. I did not locate a Congressional finding on alcohol's potential for abuse; however, the heading "alcoholics and alcoholism" in the U.S. Code index contains five pages of entries.

¹¹⁴Drug Abuse and Drug Abuse Research, 1987, pp. 98-99.

¹¹⁵As quoted in "The Chronology of U.S. Warning," World Health, October 1984.

¹¹⁶Drug Abuse and Drug Abuse Research, 1987, p. 77.

Tobacco. "Taken together, data collected on the various psychometric instruments confirm that nicotine is psychoactive, is a euphoriant, and is appropriately categorized as a drug with potential to produce abuse or addictive behavior."¹¹⁷ "When systematically compared to prototypic drugs of abuse, tobacco is similar on most usual, and all critical, points of comparison."¹¹⁸

(b) The legislature further finds that:

- 1) Patterns of marijuana use in the state have changed over the past decade.

Without defining the patterns of use and the type change, this statement is extremely ambiguous. I am unable to respond without presuming the author's meaning.

- 2) The daily use of marijuana in the state has increased to as high as four percent among the general population and as high as six percent among secondary school students.

Matt Felix, Coordinator, State Office of Alcoholism and Drug Abuse said that the only valid studies of drug use in Alaska of which he is aware were conducted by Dr. Bernard Segal, The Center for Alcohol and Addiction Studies, University of Alaska Anchorage. In 1982-83, surveys on the patterns of drug use in communities and schools were conducted. In 1987 Dr. Segal again conducted school surveys--the comprehensive report on his findings should be completed by mid-April. None of Dr. Segal's surveys asked about the daily use of marijuana; therefore, I am unable to confirm the figures presented in this finding.

Dr. Segal's Adolescent Drug-Taking Behavior Followup Study results for Juneau and Fairbanks have been released.¹¹⁹ Data on lifetime experiences with marijuana, alcohol and tobacco are presented below:

¹¹⁷Drug Abuse and Drug Abuse Research, 1983, p. 94.

¹¹⁸Drug Abuse and Drug Abuse Research, 1987, p. 94.

¹¹⁹Bernard Segal, "Adolescent Drug-Taking Behavior Followup Study: Juneau" (October 1987) and "Fairbanks North Star Borough School District" (Preliminary Report, January 1988), mimeographed, available from School District Superintendents.

Lifetime Experiences (used one or more times)
Grades 7-12
Expressed as Percent of Students Surveyed

		1987	1982/83	Change
Marijuana	Juneau	53.3	51.7	+ 1.6
	Fairbanks	47.8	40.1	+ 7.7
Alcohol	Juneau	69.1	70.1	- 1.0
	Fairbanks	73.7	65.8	+ 7.9
Tobacco (smoking)	Juneau	65*	40*	+24.7
	Fairbanks	71.1	48.5	+22.6

*approximately--presented in graph form only

Dr. Segal notes that "What is evident is that the prevalence of marijuana has been high, and that both experimental and regular use has occurred. Experimental use (1-2 times) was highest during the past month, suggesting ongoing infrequent or experimental use. In contrast to this pattern, a large number of students have used marijuana extensively. Over 30% of those having used marijuana did so 40 or more times during their lifetime, over 20 percent did so during the past year, and slightly over 5 percent reported having used marijuana forty or more times during the past month. Overall, many students have apparently tried and continue to use marijuana, following a pattern that ranges from infrequent to what may be termed 'regular' use."¹²⁰

- 3) Marijuana use in the state within both the general population and among adolescents is significantly higher than in the nation as a whole.

Support. Dr. Segal said marijuana use in Alaska continues to exceed national standards; however, he said that he believes the national estimates of marijuana use are low. He explained that Alaskans may be more willing than others to acknowledge use.¹²¹

Other Considerations. Mr. Gettman of NORML notes that "anomalies in data on the supply and consumption of marijuana in the United States suggest

¹²⁰Segal, "Adolescent Drug-Taking Behavior Followup Study: Juneau," October 1987, p. 8.

¹²¹Bernard Segal, personal communication, March 16, 1988.

that far more people use marijuana than surveys have indicated in the past. It may be that in a non-criminal atmosphere such as Alaska's, people are more open with surveyors concerning personal marijuana use."¹²² He cites a National Narcotics Intelligence Consumers Committee Report which lists "marijuana consumption in the United States as being close to 10 million pounds per year....[and] supply as being approximately 30 million pounds a year."¹²³ Mr. Gettman notes the discrepancy between demand and supply as proof of underreporting of use.

Alcohol. "In 1985, the equivalent of 4.35 gallons of absolute alcohol was sold per person over age 21 in Alaska. The U.S. average rate is 2.52 gallons per person."¹²⁴

Tobacco. In 1985, the incidence of tobacco smoking among adults was 33.8 percent (40.3 percent males, 27.3 percent females) in Alaska. The U.S. average was 26.5 percent (29.5 percent males, 23.8 percent females). Of the 50 states, Alaska had the highest rate of tobacco smoking.¹²⁵

- 4) There is a direct relationship between the use of marijuana at home by adults and the percentage of secondary school students who experience disciplinary and academic problems in public schools; over the last three years in the Anchorage School District, of the 230 students who have been suspended from school for possession or use of marijuana, 29 percent have indicated that marijuana is used by adults in their living environment.

Senator Fischer's office advised me that this information came from Theresa Johnson, formerly with the Anchorage REACH program and currently principal at McLaughlin Youth Center. Ms. Johnson said that these figures were self disclosed by parents as part of the in-take process at REACH. She said the

¹²²Gettman, personal communication, March 28, 1988.

¹²³National Narcotics Intelligence Consumers Committee, The Supply of Illicit Drugs to the United States from Foreign and Domestic Sources in 1985 and 1986, 1987, as cited by Gettman, personal communication, March 25, 1988.

¹²⁴Annual Report to the Legislature 1986, Office of Alcoholism and Drug Abuse, Alaska Department of Health and Social Services, DHSS SOADA 87-1, p. 4.

¹²⁵Louise Wiseman, American Lung Association, Washington, D.C., personal communication, March 28, 1988.

figures cited in the above finding were a generalization and are unsubstantiated. Ms. Johnson indicated that they were prepared in response to an informal request--she was not aware they had been incorporated into SB 32.¹²⁶

Other Considerations. This finding is based on unscientifically gathered data. No baseline statistics exist on the use of marijuana by adults in the homes of the general student population. In addition, the collection of such data would be hampered by AS 14.03.110, which prohibits the administration of surveys or questionnaires, whether anonymous or not, which inquire into private family affairs unless written permission is obtained from the student's parent or guardian.

- 5) The changing patterns of marijuana use and the relationship between marijuana use by adults and adolescents have significantly compromised the state's legitimate efforts to prevent the spread of marijuana use to adolescents and protect the health of adolescents.

Support. Dr. Segal said that a modelling effect among young adults and youth is to some degree true.¹²⁷ "Marijuana users tend to turn others on to its use, 25 percent within two years of first use, and 29 percent within five or more years after first marijuana use."¹²⁸

"Marijuana use is a problem that frequently follows a habitual pattern within the family. ...there tended to be a correlation between the amount of marijuana used by high schoolers and the rate of tranquilizer, stimulant, and barbiturate use by the parents,....marijuana use by peers is a better predictor than drug use by parents. There appears to be an additive factor since all of those with the highest use were reported by subjects whose best friends and parents were drug users."¹²⁹

Other Considerations. I am unable to substantiate all aspects of this finding. "The changing patterns of marijuana use," "the relationship between marijuana use by adults and adolescents," "significantly compromise," "legitimate efforts," and "protect the health of adolescents" are ambiguous.

¹²⁶Theresa Johnson, personal communication, March 18, 1988.

¹²⁷Segal, personal communication, March 16, 1988.

- (c) The legislature further finds there is a legitimate and compelling governmental interest, based on testimonial and scientific evidence, that the public health and welfare will suffer if personal use of marijuana even in small amounts is allowed.

The information which I have gathered in responding to the findings presented in CSSB 32(HESS) is based on only a fraction of the material which has been published on marijuana, alcohol and tobacco. In response to finding (c), I am presenting a selection of comments relating to drug use and users.

A Social Problem. Dr. Segal said that an important aspect of drug use, particularly marijuana, is that use has become reasonably normative--nonusers are now the exception--and therefore, the problem should not be dealt with punitively. He added that among youth, trying marijuana one or two times may have become part of the "rites of passage." He is concerned that the stigma attached to penalties which may be imposed on a one or two time user would do greater harm than the experimental use of marijuana. He stated that marijuana use needs to be treated "as a social problem which interrelates with the justice system rather than as a criminal problem."¹³⁰

Dr. Segal's 1982-83 school survey asked students their reasons for not trying drugs or for stopping drugs. He found that "Of the reasons listed,...fear of damage to one's mind is the most frequently given reason for not trying a drug. Other important reasons are fear that drugs may hurt one's body, and fear that they may cause addiction. Just over a third responding also did not try drugs because they are illegal, and because it was not important for them to try....Reasons for cessation of taking any type of drugs parallel the pattern established for not trying drugs. Fear of damage to one's mind is primary, and friend's disapproval is the least cited reason for stopping. In all, it appears that focusing on students' concerns about the potential adverse psychological and physical consequences of taking drugs may be the most influential way to direct educational/preventional efforts."¹³¹

¹²⁸H. L. Voss and R. R. Clayton, "'Turning on' other persons to drugs," 1984, cited in Drug Abuse and Drug Abuse Research, 1987, p. 78.

¹²⁹National Institute on Drug Abuse, Marijuana and Youth: Clinical Observations on Motivation and Learning, Washington, D.C., U.S. Government Printing Office, DHHS(ADM) 82-1186, 1982, p. 75.

¹³⁰Segal, personal communication, March 16, 1988.

Marijuana Use. "By age 20, the major risk for initiation to use marijuana, tobacco, and alcohol is essentially completed. Marijuana use begins to decline by age 22.5. This pattern is similar for males and females. Marijuana use is associated with greater use of other substances, with membership in networks of marijuana users, with less participation in conventional activities, with histories of psychiatric hospitalizations, with lower self perceived psychological well being, and with participation in deviant activities."¹³²

Gateway Drugs. "An incredible 81% of tobacco smokers have tried marijuana, compared with 17% of non-smokers. Further, tobacco smokers are 14 times more likely to use cocaine, amphetamines, and heroin."¹³³

Drug Seeking Behavior. "The misery inflicted by some of these [alcohol-related neurological] diseases may induce people to seek relief by drinking alcohol and may, thereby, contribute to the perpetuation of alcohol consumption. A consequence becomes a cause, and a self-perpetuating circle is established. It has been stated simplistically that to prevent these diseases people should stop drinking alcohol. In analogy, one might suggest that marital problems can be solved by abolishing marriage or traffic accidents be prevented by abolishing cars. Drug-seeking behavior is a powerful psychological force. It is not eliminated by prohibition or the distant threat of a physical disease."¹³⁴

* * *

I hope this information is useful to you. If you have any questions, please contact this agency.

¹³¹Bernard Segal et al, Patterns of Drug Use: School Survey, Center for Alcohol and Addiction Studies, University of Alaska Anchorage, 1983, p. 138.

¹³²D. B. Kandel, 1984, cited in Drug Abuse and Drug Abuse Research, 1987, p. 78.

¹³³Marijuana: A Second Look at Health Hazards, The American Lung Association, No. 4836, August 1985.

¹³⁴Gerhard Freund, "Neurologic Diseases Associated with Chronic Alcohol Abuse," in Medical and Social Aspects of Alcohol Abuse, 1983, p. 182.

STATE OF ALASKA

DEPARTMENT OF LAW

CRIMINAL DIVISION

STEVE COWPER, GOVERNOR

REPLY TO

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April 8, 1988

Honorable Fran Ulmer
Alaska State House
P.O. Box V (Mail Stop 3100)
Juneau, Alaska 99811

Dear Representative Ulmer:

This is in response to your request for our comments on specific aspects of HB 55. If HB 55 is adopted in its present form, possession of any amount of marijuana will be a class B misdemeanor. A Class B misdemeanor is punishable by not more than 90 days in jail or a \$1,000 fine. See, AS 12.55.035(b)(4) and 12.55.135(b).

It has never been the policy of the Department of Law to obtain search warrants for people's homes to look for small amounts of marijuana and we do not expect to change this policy anytime in the future. Irrespective of that policy, there is a substantial question whether or not a search warrant may be obtained for a marijuana offense which is classified merely as a violation. A violation is punishable by a fine or no more than \$300. See, AS 12.55.035(b)(5). Since a jail term is not authorized, the penalty may be interpreted to be non-criminal. As a result, there is a question if it is technically a "crime". AS 11.81.900(b)(9) defines crime as a felony or misdemeanor punishable by jail time. AS 11.81.900(b)(56) defines violation as a "noncriminal" offense.

Although there is some question as to whether it could be overturned, Ravin v. State, 537 P.2d 494 (Alaska 1975) is still the law of Alaska. It would take good findings by the legislature, supported by factual material to reverse that decision. We offer you two suggestions if you wish to amend HB 55. One alternative is to reduce the amount of marijuana which one can possess legally for one's personal use from four ounces to one ounce. Since the THC content of commonly obtainable marijuana has been rapidly increasing, four ounces is now a substantial amount of marijuana. Another alternative is to leave the four ounce amount as is, but to "recriminalize" certain conduct and classify it as a B misdemeanor as opposed to its

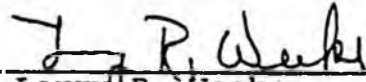
classification as a violation under present law. (See AS 11.71.070, misconduct involving a controlled substance in the seventh degree.)

Should you wish to implement either of these suggestions, I will be more than happy to assist your staff.

Very truly yours,

GRACE BERG SCHAIBLE
ATTORNEY GENERAL

By: _____


Larry R. Weeks
Director of
Criminal Prosecution

LRW:jf-91

cc: Art Peterson, Assistant Attorney General
Department of Law

Robert Evans, Legislative Liaison
Office of the Governor

Irwin RAVIN, Petitioner,
v.
STATE of Alaska, Respondent.
No. 2135.

Supreme Court of Alaska.
May 27, 1975.
As Amended May 28, 1975.

Proceeding was instituted on defendant's motion to dismiss charge of violation of statute proscribing possession of marijuana. The District Court, Third Judicial District, Anchorage, Dorothy D. Tyner, J., denied motion to dismiss and the superior court affirmed and petition for review from the superior court's affirmance was granted. The Supreme Court, Rabinowitz, C. J., held that need for control of drivers under influence of marijuana and existing doubts as to safety of marijuana demonstrate a sufficient justification for statutory proscription of possession of marijuana, and thus an individual's right to possess or ingest marijuana while driving is subject to statute proscribing possession of marijuana; and that no adequate justification exists for State's intrusion into citizen's right of privacy by its prohibition of possession of marijuana by an adult for personal consumption in home, and thus possession of marijuana by adults at home for personal use is constitutionally protected.

Remanded for further proceedings.

Boochever and Connor, JJ., filed specially concurring opinions.

1. Criminal Law ⚖️1030(2)

Issue of cruel and unusual punishment in application of statute proscribing possession of marijuana to possession of marijuana for personal use was not considered by Supreme Court, since issue was not raised below or in petition for review to Supreme Court. Rules of Appellate Procedure, rule 24(c); AS 17.12.010, 17.12.150.

2. Constitutional Law ⚖️82

Once a fundamental right under State Constitution has been shown to be involved and it has been further shown that this constitutionally protected right has been impaired by governmental action, government must come forward and meet its substantial burden of establishing that abridgment in question was justified by a compelling governmental interest.

3. Constitutional Law ⚖️82

When governmental action interferes with an individual's freedom in an area which is not characterized as fundamental, a less stringent test is ordinarily applied and, in such cases, court's task is to determine whether legislative enactment has a reasonable relationship to a legitimate government purpose, and under this "rational basis" test state need only demonstrate existence of facts which can serve as a rational basis for belief that measure would properly serve public interest.

4. Constitutional Law ⚖️82

If governmental restrictions interfere with individual's right to privacy, court will require that relationship between means and ends be not merely reasonable but close and substantial.

5. Constitutional Law ⚖️82

Federal right to privacy arises only in connection with other fundamental rights, such as the grouping of rights which involve the home, and even in connection with penumbra of home-related rights, right of privacy in sense of immunity from prosecution is absolute only when private activity will not endanger or harm the general public. Const. art. 1, § 22; U.S.C.A. Const. Amendments. 1, 3-5, 14.

6. Constitutional Law ⚖️82 Drugs and Narcotics ⚖️41

Right to privacy amendment to Alaska Constitution cannot be read so as to make the possession or ingestion of marijuana itself a fundamental right. Const. art. 1, § 22.

7. Constitutional Law
Privacy amendment was intended protection to the home.

8. Constitutional Law
Privacy in the home is a right. Const. art. 1, § 22; Amend. 4.

9. Constitutional Law
Right of privacy is not absolute; it yields when it interferes with the health, safety, or morals of the community. Const. art. 1, § 22; Amend. 4.

10. Constitutional Law
No one has a right to be left alone. Things in the privacy of one's home which will affect the privacy of others. Const. art. 1, § 22; Amend. 4.

11. Constitutional Law
Right of privacy is not absolute; it yields when it interferes with the health, safety, or morals of the community. Const. art. 1, § 22; Amend. 4.

12. Constitutional Law
In determining whether a proscription of possession is not a function of the government's interest in the community.

13. Constitutional Law
State cannot interfere with the right of privacy in the home when the public interest in the affairs of the community is not affected.

14. Constitutional Law
The right of privacy is not absolute; it yields when it interferes with the health, safety, or morals of the community.

15. Constitutional Law
Authority of the state to regulate the conduct of its citizens is not absolute; it yields when it interferes with the health, safety, or morals of the community.

1. Constitutional Law ⇨82

Privacy amendment to Alaska Constitution was intended to give recognition and protection to the home. Const. art. 1, § 22.

2. Constitutional Law ⇨82

Privacy in the home is a fundamental right. Const. art. 1, § 22; U.S.C.A.Const. Amend. 4.

3. Constitutional Law ⇨82

Right of privacy in the home must yield when it interferes in a serious manner with the health, safety, rights and privileges of others or with the public welfare. Const. art. 1, § 22; U.S.C.A.Const. Amend.

4. Constitutional Law ⇨82

No one has an absolute right to do things in the privacy of his own home which will affect himself or others adversely. Const. art. 1, § 22; U.S.C.A.Const. Amend. 4.

5. Constitutional Law ⇨82

Right of privacy in home is limited in that possession of substances is guaranteed only for purely private, noncommercial use in home. Const. art. 1, § 22; U.S.C.A.Const. Amend. 4.

6. Constitutional Law ⇨70.1(10)

In determining validity of legislative proscription of possession of marijuana, it is not function of court to reassess scientific evidence in the manner of a legislature.

7. Constitutional Law ⇨82

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.

8. Constitutional Law ⇨82

The right of an individual to do as he pleases is not absolute and it can be made to yield when it begins to infringe on the rights and welfare of others.

9. Constitutional Law ⇨81

Authority of state to control activities of its citizens is not limited to activities

which have a present and immediate impact on public health or welfare.

16. Constitutional Law ⇨82

State is under no obligation to allow otherwise "private" activity which will result in numbers of people becoming public charges or otherwise burdening the public welfare.

17. Health and Environment ⇨20

Statutes designed to protect the public health will receive a liberal construction.

18. Health and Environment ⇨20

There is a presumption in favor of public health measures.

19. Health and Environment ⇨20

When there is substantial doubt as to safety of a given substance or situation of public health, controls intended to obviate the danger will usually be upheld.

20. Automobiles ⇨332

Need for control of drivers under influence of marijuana and existing doubts as to safety of marijuana demonstrate a sufficient justification for statutory proscription of possession of marijuana; and thus an individual's right to possess or ingest marijuana while driving is subject to statute proscribing possession of marijuana. AS 05.25.060, 17.12.010, 17.12.150, 26.35.030; Const. art. 1, § 22; U.S.C.A.Const. Amends. 1, 14.

21. Drugs and Narcotics ⇨43

No adequate justification exists for State's intrusion into citizen's right of privacy by its prohibition of possession of marijuana by an adult for personal consumption in home, and thus possession of marijuana by adults at home for personal use is constitutionally protected. AS 17.12.010, 17.12.150; Const. art. 1, § 22; U.S.C.A.Const. Amends. 1, 4, 14.

22. Constitutional Law ⇨82

Privacy of individual's home cannot be breached absent a persuasive showing of a close and substantial relationship of the intrusion to a legitimate governmental interest.

23. Drugs and Narcotics ⇨62, 68

Neither federal nor Alaska Constitution affords protection for the buying or selling of marijuana, nor absolute protection for its use or possession in public. AS 17.12.010, 17.12.150; Const. art. 1, § 22; U.S.C.A.Const. Amendments. 1, 4, 14.

24. Drugs and Narcotics ⇨66

Possession at home of amounts of marijuana indicative of intent to sell rather than possession for personal use is unprotected. AS 17.12.010, 17.12.150; Const. art. 1, § 22; U.S.C.A.Const. Amendments. 1, 4, 14.

25. Constitutional Law ⇨250.1(2)**Drugs and Narcotics** ⇨43

Statute proscribing possession of marijuana is not violative of equal protection on ground that other commonly used recreational drugs, such as alcohol and tobacco, are not proscribed, even though they may inflict more damage on user than does marijuana. AS 17.12.010, 17.12.150; Const. art. 1, § 22; U.S.C.A.Const. Amend. 1, 14.

26. Health and Environment ⇨20

It is not irrational for legislature to regulate those public health areas where it can do so, when other areas exist where controls are less feasible.

27. Drugs and Narcotics ⇨43

Fact that marijuana may be the least harmful of drugs covered by statute proscribing possession is not alone sufficient to make classification of marijuana with other drugs covered irrational. AS 17.10.010 et seq., 17.12.010, 17.12.150(3); U.S.C.A.Const. Amendments. 1, 14.

28. Constitutional Law ⇨70.3(12)

Wisdom of statute proscribing possession of marijuana was for legislature, rather than judiciary. AS 17.10.010 et seq., 17.12.010, 17.12.150(3).

1. AS 17.12.010 provides:

Except as otherwise provided in this chapter, it is unlawful for a person to manufacture, compound, counterfeit, possess, have under his control, sell, prescribe, administer, dispense, give, barter, supply or distribute

R. Collin Middleton and Robert H. Wagstaff, Anchorage, for petitioner.

Stephen G. Dunning, Asst. Dist. Atty., Joseph D. Balfe, Dist. Atty., Anchorage, Norman C. Gorsuch, Atty. Gen., Juneau, for respondent.

OPINION

Before RABINOWITZ, C. J., and CONNOR, ERWIN, BOOCHEVER and FITZGERALD, JJ.

RABINOWITZ, Chief Justice.

The constitutionality of Alaska's statute prohibiting possession of marijuana is put in issue in this case. Petitioner Ravin was arrested on December 11, 1972 and charged with violating AS 17.12.010.¹ Before trial Ravin attacked the constitutionality of AS 17.12.010 by a motion to dismiss in which he asserted that the State had violated his right of privacy under both the federal and Alaska constitutions, and further violated the equal protection provisions of the state and federal constitutions. Lengthy hearings on the questions were held before District Court Judge Dorothy D. Tyner, at which testimony from several expert witnesses was received. Ravin's motion to dismiss was denied by Judge Tyner. The superior court then granted review and after affirmance by the superior court, we, in turn, granted Ravin's petition for review from the superior court's affirmance.

[1] Here Ravin raises two basic claims: first, that there is no legitimate state interest in prohibiting possession of marijuana by adults for personal use, in view of the right to privacy; and secondly, that the statutory classification of marijuana as a dangerous drug, while use of alcohol and tobacco is not prohibited, denies

in any manner, a depressant, hallucinogenic or stimulant drug.

AS 17.12.150 defines "depressant, hallucinogenic, or stimulant drug" to include all parts of the plant *Cannabis Sativa L.*

due process and equal protection of law.²

We first address petitioner's contentions that his constitutionally protected right to privacy compels the conclusion that the State of Alaska is prohibited from penalizing the private possession and use of marijuana. Ravin's basic thesis is that there exists under the federal and Alaska constitutions a fundamental right to privacy, the scope of which is sufficiently broad to encompass and protect the possession of marijuana for personal use. Given this fundamental constitutional right, the State would then have the burden of demonstrating a compelling state interest in prohibiting possession of marijuana. In light of these controlling principles, petitioner argues that the evidence submitted below by both sides demonstrates that marijuana is a relatively innocuous substance, at least as compared with other less-restricted substances, and that nothing even approaching a compelling state interest was proven by the State.

Ravin's arguments necessitate a close examination of the contours of the asserted right to privacy and the scope of this court's review of the legislature's determination to criminalize possession of marijuana.

[2] We have previously stated the tests to be applied when a claim is made that state action encroaches upon an individual's constitutional rights. In *Breese v. Smith*, 501 P.2d 159 (Alaska 1972), we had

before us a school hairlength regulation which encroached on what we determined to be the individual's fundamental right to determine his own personal appearance. There we stated:

Once a fundamental right under the constitution of Alaska has been shown to be involved and it has been further shown that this constitutionally protected right has been impaired by governmental action, then the government must come forward and meet its substantial burden of establishing that the abridgement in question was justified by a compelling governmental interest.³

This standard is familiar federal law as well. As stated by the United States Supreme Court:

Where there is a significant encroachment upon personal liberty, the State may prevail only upon showing a subordinating interest which is compelling.⁴

The law must be shown "necessary, and not merely rationally related, to the accomplishment of a permissible state policy."⁵

[3] When, on the other hand, governmental action interferes with an individual's freedom in an area which is not characterized as fundamental, a less stringent test is ordinarily applied. In such cases our task is to determine whether the legislative enactment has a reasonable relationship to a legitimate governmental purpose.⁶ Under this latter test, which is sometimes referred to as the "rational basis" test, the State

² In his briefs before this court, Ravin also attempts to raise the issue of cruel and unusual punishment in the application of AS 17.12.010 to possession of marijuana for personal use. Because this issue was not raised below or in the petition for review to this court, we decline to consider the issue in this proceeding. See Appellate Rule 21(c). Cf. *Moran v. Holman*, 501 P.2d 769, 770 n. 1 (Alaska 1972).

³ 501 P.2d at 171. See *State v. Wylie*, 516 P.2d 112 (Alaska 1973); *State v. Van Dort*, 502 P.2d 453 (Alaska 1972); *Gray v. State*, 525 P.2d 521, 527 (Alaska 1974); *Gilbert v. State*, 526 P.2d 1131, 1133 (Alaska 1974); *State v. Adams*, 522 P.2d 1125 (Alaska 1974).

⁴ *Bates v. Little Rock*, 361 U.S. 516, 524, 80 S.Ct. 412, 417, 4 L.Ed.2d 480, 486 (1960). See *Roe v. Wade*, 410 U.S. 113, 155, 93 S.Ct. 705, 35 L.Ed.2d 147, 178 (1973).

⁵ *McLaughlin v. Florida*, 379 U.S. 184, 190, 85 S.Ct. 283, 290, 13 L.Ed.2d 222, 231 (1964), quoted in the concurrence of Mr. Justice Goldberg in *Griswold v. Connecticut*, 381 U.S. 479, 497, 85 S.Ct. 1678, 14 L.Ed.2d 510, 523 (1965).

⁶ See *Concerned Citizens v. Kani Peninsula Borough*, 527 P.2d 447, 452 (Alaska 1974); *Mobil Oil Corp. v. Local Boundary Comm'n*, 518 P.2d 92, 101 (Alaska 1974); *Meyer v. Nebraska*, 262 U.S. 390, 43 S.Ct. 625, 67 L.Ed. 1042 (1923).

need only demonstrate the existence of facts which can serve as a rational basis for belief that the measure would properly serve the public interest.

In our recent opinion in *Lynden Transport, Inc. v. State*, 532 P.2d 700 (Alaska 1975), we recognized the existence of considerable dissatisfaction with the fundamental right-compelling state interest test. There we said:

It has been suggested that there is mounting discontent with the rigid two-tier formulation of the equal protection doctrine, and that the United States Supreme Court is prepared to use the clause more rigorously to invalidate legislation without expansion of "fundamental rights" or "suspect" categories and the concomitant resort to the "strict scrutiny" tests. We are in agreement with the view that the Supreme Court's recent equal protection decisions have shown a tendency towards less speculative, less deferential, more intensified means-to-end inquiry when it is applying the traditional rational basis test and we approve of this development. See Gunther, *Forward: In Search of Evolving Doctrine on a Changing Court: A Model for Newer Equal Protection*, 86 Harv.L.Rev. 1 (1972). See, e.g., *James v. Strange*, 407 U.S. 128, 92 S.Ct. 2027, 32 L.Ed.2d 600 (1972); *Jackson v. Indiana*, 406 U.S. 715, 92 S.Ct. 1845, 32 L.Ed.2d 435 (1972); *Humphrey v. Cady*, 405 U.S. 504, 92 S.Ct. 1048, 31 L.Ed.2d 394 (1972); *Eisenstadt v. Baird*, 405 U.S. 438, 92 S.Ct. 1029, 31 L.Ed.2d 349 (1972); *Reed v. Reed*, 404 U.S. 71, 92 S.Ct. 251, 30 L.Ed.2d 225 (1971).

[4] This court has previously applied a test different from the rigid two-tier formulation to state regulations. In *State v. Wylie*,⁷ we tested durational residency requirements for state employment by both

the compelling state interest test and a test which examined whether the means chosen suitably furthered an appropriate governmental interest.⁸ It is appropriate in this case to resolve Ravin's privacy claims by determining whether there is a proper governmental interest in imposing restrictions on marijuana use and whether the means chosen bear a substantial relationship to the legislative purpose. If governmental restrictions interfere with the individual's right to privacy, we will require that the relationship between means and ends be not merely reasonable but close and substantial.

Thus, our undertaking is two-fold: we must first determine the nature of Ravin's rights, if any, abridged by AS 17.12.01 and, if any rights have been infringed upon, then resolve the further question as to whether the statutory impingement is justified.

As we have mentioned, Ravin's argument that he has a fundamental right to possess marijuana for personal use rests on both federal and state law, and centers on what may broadly be called the right to privacy. This "right" is increasingly the subject of litigation and commentary and is still a developing legal concept.⁹

In Ravin's view, the right to privacy involved here is an autonomous right which gains special significance when its situs is found in a specially protected area, such as the home. Ravin begins his privacy argument by citation of and reliance upon *Griswold v. Connecticut*,¹⁰ in which the Supreme Court of the United States struck down as unconstitutional a state statute effectively barring the dispensation of birth control information to married persons. Writing for five members of the Court, Mr. Justice Douglas noted that rights protected by the Constitution are not limited to those specifically enumerated in the

7. 516 P.2d 142 (Alaska 1973).

8. *Id.* at n. 10.

9. The right to privacy was recently made explicit in Alaska by an amendment to the

state constitution. Alaska Const. Art. I, § 22.

10. 381 U.S. 479, 85 S.Ct. 1678, 14 L.Ed. 2d 510 (1965).

Constitution. In order to secure the enumerated rights, certain peripheral rights must be recognized. In other words, the "specific guarantees in the Bill of Rights have penumbras, formed by emanations from those guarantees that help give them life and substance."¹¹ Certain of these penumbral rights create "zones of privacy", for example, First Amendment rights of association, Third and Fourth Amendment rights pertaining to the security of the home, and the Fifth Amendment right against self-incrimination. The Supreme Court of the United States then proceeded to find a right to privacy in marriage which antedates the Bill of Rights and yet lies within the zone of privacy created by several fundamental constitutional guarantees. It was left unclear whether this particular right to privacy exists independently, or comes into being only because of its connection with fundamental enumerated rights.

The next important Supreme Court opinion regarding privacy is *Stanley v. Georgia*,¹² in which a state conviction for possession of obscene matter was overturned as violative of the First and Fourteenth Amendments. The Supreme Court had previously held that obscenity is not protected by the First Amendment.¹³ But in *Stanley* the Court made a distinction between commercial distribution of obscene matter and the private enjoyment of it at home. The Constitution, it said, protects the fundamental right to receive information and ideas, regardless of their worth. Moreover, the Supreme Court said,

... in the context of this case - a prosecution for mere possession of printed or filmed matter in the privacy of a

person's own home—that right takes on an added dimension. For also fundamental is the right to be free, except in very limited circumstances, from unwanted governmental intrusions into one's privacy.¹⁴

The Supreme Court concluded that the First Amendment means a state has no business telling a man, sitting alone in his own home, what books he may read or what films he may watch. The Court took care to limit its holding to mere possession of obscene materials by the individual in his own home. It noted that it did not intend to restrict the power of the state or federal government to make illegal the possession of items such as narcotics, firearms, or stolen goods.

The *Stanley* holding was subsequently refined by a series of cases handed down in 1973. In *Paris Adult Theatre I v. Slaton*,¹⁵ the Supreme Court rejected the claim of a theater owner that his showing of allegedly obscene films was protected by *Stanley* because his films were shown only to consenting adults. The Court explicitly rejected the comparison of a theater to a home and found a legitimate state interest in regulating the use of obscene matter in local commerce and places of public accommodation. It apparently found no fundamental right involved in viewing obscene matter under these conditions, for it noted that the right to privacy guaranteed by the Fourteenth Amendment extends only to fundamental rights. The protection offered by *Stanley*, the Supreme Court stated, was restricted to the home, and it explicitly refused to say that all activities occurring between consenting adults were beyond the reach of the government.¹⁶

11. 381 U.S. at 481, 85 S.Ct. at 1681, 14 L. Ed.2d at 514.

12. 393 U.S. 557, 89 S.Ct. 1243, 22 L.Ed.2d 542 (1969).

13. See *Roth v. U. S.*, 354 U.S. 476, 77 S.Ct. 1301, 1 L.Ed.2d 1198 (1957).

14. 393 U.S. at 564, 89 S.Ct. at 1247, 22 L. Ed.2d at 519.

15. 413 U.S. 49, 93 S.Ct. 2628, 37 L.Ed.2d 416 (1973). See also *United States v. Orito*, 413 U.S. 139, 93 S.Ct. 2674, 37 L.Ed.2d 513 (1973); *United States v. 12 200-Ft. Reels*, 413 U.S. 123, 93 S.Ct. 2605, 37 L.Ed.2d 500 (1973).

16. In a companion case, *United States v. Orito*, 413 U.S. 139 93 S.Ct. 2674, 37 L.Ed.2d 513 (1973), the Supreme Court observed

[5] These Supreme Court cases indicate to us that the federal right to privacy arises only in connection with other fundamental rights, such as the grouping of rights which involve the home. And even in connection with the penumbra of home-related rights, the right of privacy in the sense of immunity from prosecution is absolute only when the private activity will not endanger or harm the general public.

The view is confirmed by the Supreme Court's abortion decision, *Roe v. Wade*.¹⁷ There appellant claimed that her right to decide for herself concerning abortion fell within the ambit of a right to privacy flowing from the federal Bill of Rights. The Court's decision in her favor makes clear that only personal rights which can be deemed "fundamental" or "implicit in the concept of ordered liberty" are protected by the right to privacy. The Supreme Court found this right "broad enough to encompass a woman's decision whether or not to terminate her pregnancy," but it rejected the idea that a woman's right to decide is absolute. At some point, the state's interest in safeguarding health, maintaining medical standards, and protecting potential life becomes sufficiently compelling to sustain regulations. One does not, the Supreme Court said, have an unlimited right to do with one's body as one pleases.

The right to privacy which the Court found in *Roe* is closely akin to that in *Griswold*; in both cases the zone of privacy involves the area of the family and procreation,¹⁸ more particularly, a right

that the *Stanley* right to possess obscene matter in the home is limited to the home and does not create a right to transport, receive, or distribute the matter. The Supreme Court further said that it is not true that a zone of constitutionally protected privacy follows such materials when they are moved outside the home. See *United States v. 12 200-Ft. Reels*, 413 U.S. 123, 93 S.Ct. 2665, 37 L.Ed. 2d 500 (1973).

17. 410 U.S. 113, 93 S.Ct. 705, 37 L.Ed.2d 147 (1973).

18. *Cf. Eisenstadt v. Baird*, 405 U.S. 438, 453, 92 S.Ct. 1029, 1038, 31 L.Ed.2d 349 (1972) where the Supreme Court said in part:

of personal autonomy in relation to choices affecting an individual's personal life.

In Alaska this court has dealt with the concept of privacy on only a few occasions. One of the most significant decisions in this area is *Breese v. Smith*,¹⁹ where we considered the applicability of the guarantee of "life, liberty, the pursuit of happiness" found in the Alaska Constitution,²⁰ to a school hairlength regulation. Noting that hairstyles are a highly personal matter in which the individual is traditionally autonomous, we concluded that governmental control of personal appearance would be antithetical to the concept of personal liberty under Alaska's constitution. Since the student would be forced to choose between controlling his own personal appearance and asserting his right to an education if the regulations were upheld, we concluded that the constitutional language quoted above embodied an affirmative grant of liberty to public school students to choose their own hairstyles, for "at the core of [the concept of liberty] is the notion of total personal immunity from government control: the right 'to be let alone.'"²¹ That right is not absolute, however; we also noted that this "liberty" must yield where it "intrude[s] upon the freedom of others."²²

Subsequent to our decision in *Breese*, a right to privacy amendment was added to the Alaska Constitution. Article I, section 22 reads:

The right of the people to privacy is recognized and shall not be infringed. The

If the right of privacy means anything, it is the right of the individual, married or single, to be free from unwarranted governmental intrusion into matters so fundamentally affecting a person as the decision whether to bear or beget a child.

19. 501 P.2d 159 (Alaska 1972).

20. Alaska Const. Art. I, § 1.

21. 501 P.2d at 168.

22. 501 P.2d at 170, quoting *Bishop v. Colaw*, 450 F.2d 1069, 1077 (8th Cir. 1971).

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legislature shall implement this section. The effect of this amendment is to place privacy among the specifically enumerated rights in Alaska's constitution. But this fact alone does not, in and of itself, yield answers concerning what scope should be accorded to this right of privacy.²³ We have suggested that the right to privacy may afford less than absolute protection to "the ingestion of food, beverages or other substances".²⁴ For any such protection must be limited by the legitimate needs of the State to protect the health and welfare of its citizens.²⁵

Although a number of other jurisdictions have considered the privacy issue as it applies to marijuana prosecutions, they provide little help in defining the scope of article I, section 22 of Alaska's constitution. In Hawaii, whose constitution also contains an express guarantee of the right to privacy,²⁶ the supreme court has faced a similar issue. In *State v. Kantner*,²⁷ the Supreme Court of Hawaii upheld a conviction for possession of marijuana by a 3-2 vote, with one member of the majority concurring only because he thought the constitutional issue had not been properly raised. A majority rejected the claim that application of the statute violated guarantees of equal protection and due process, and two members of the court rejected the

claim of violation of "fundamental liberty" based on *Griswold*. In dissent, Justice Levinson emphasized the guarantees of privacy and personal autonomy which he found in both the Hawaii Constitution and the due process clause of the Fourteenth Amendment to the United States Constitution. He found that the right to privacy "guarantees to the individual the full measure of control over his own personality consistent with the security of himself and others."²⁸ The experiences generated by use of marijuana are mental in nature, he wrote, and thus among the most personal and private experiences possible. So long as conduct does not produce detrimental results, the right of privacy protects the individual's conduct designed to affect these inner areas of the personality. The state failed to show, he found, any harm to the user or others from the private, personal use of marijuana, and so the statute infringed on the right to personal autonomy.

In a Michigan case the same year, a conviction for possession of marijuana was overturned by a unanimous court, though for a variety of reasons. One of the justices in *People v. Sinclair*,²⁹ Justice T. G. Kavanagh, rested his opinion squarely on the basic right of the individual to be free from government intrusions. He found the marijuana possession statute to be "an

23. For a discussion of the origins and scope of a similar constitutional guarantee of privacy, in the Hawaii Constitution, Art. I, § 5, see *State v. Kantner*, 53 Haw. 327, 493 P.2d 306 (1972), particularly n. 4 in the dissent of Justice Levinson at p. 314. This court has, in the area of searches and seizures, attempted to define the right of privacy. See, e.g., *Jackson v. State*, 507 P.2d 508 (Alaska 1973); *Mattern v. State*, 500 P.2d 228 (Alaska 1972); *Davis v. State*, 499 P.2d 1025 (Alaska 1972); *Ellison v. State*, 483 P.2d 716 (Alaska 1971); *Rubey v. City of Fairbanks*, 456 P.2d 470 (Alaska 1970); *Shelink v. State*, 451 P.2d 252 (Alaska 1969).

24. *Gray v. State*, 525 P.2d 524, 528 (Alaska 1974). In *Gray* we said:

There is no available recorded history of this amendment, but clearly it shields the ingestion of food, beverages or other substances. But the right of privacy is not

absolute. Where a compelling state interest is shown, the right may be held to be subordinate to express constitutional powers such as the authorization of the legislature to promote and protect public health and provide for the general welfare.

25. *Id.* If the State were required, for instance, to carry the extremely heavy burden of showing a compelling state interest before it could regulate the purity of foodstuffs and medicines, the result would be a practical inability to protect the public from health threats which consumers could neither know about nor protect themselves against.

26. Hawaii Const. Art. I, § 5.

27. 53 Haw. 327, 493 P.2d 306 (1972).

28. 493 P.2d at 315.

29. 387 Mich. 91, 194 N.W.2d 878 (1972).

impermissible intrusion on the fundamental rights to liberty and the pursuit of happiness, and is an unwarranted interference with the right to possess and use private property."³⁰ He noted the basic freedom of the individual to be free to do as he pleases so long as his actions do not interfere with the rights of his neighbor or of society. ". . . 'Big Brother' cannot, in the name of Public health, dictate to anyone what he can eat or drink or smoke in the privacy of his own home."³¹

Generally, however, privacy as a constitutional defense in marijuana cases has not met with much favor. It was rejected, for instance, by the Massachusetts Supreme Judicial Court in *Commonwealth v. Leis*,³² where the court held that there was no constitutional right to smoke marijuana, that smoking marijuana was not fundamental to the American scheme of justice or necessary to a regime of ordered liberty, and that smoking marijuana was not locatable in any "zone of privacy". Furthermore, the court said, there is no constitutional right to become intoxicated.³³

[6] Assuming this court were to continue to utilize the fundamental right-compelling state interest test in resolving privacy issues under article I, section 22 of Alaska's constitution, we would conclude that there is not a fundamental constitutional right to possess or ingest marijuana in Alaska. For in our view, the right to privacy amendment to the Alaska Constitution cannot be read so as to make the possession or ingestion of marijuana itself a fundamental right. Nor can we conclude that such a fundamental right is shown by virtue of the analysis we employed in *Breece*. In that case, the student's tradi-

tional liberty pertaining to autonomy in personal appearance was threatened in such a way that his constitutionally guaranteed right to an education was jeopardized. Hairstyle, as emphasized in *Breece*, is a highly personal matter involving the individual and his body. In this sense this aspect of liberty-privacy is akin to the significantly personal areas at stake in *Griswold* and *Eisenstadt v. Baird*. Few would believe they have been deprived of something of critical importance if deprived of marijuana, though they would if stripped of control over their personal appearance. And, as mentioned previously, a discrete federal right of privacy separate from the penumbras of specifically enumerated constitutional rights has not as yet been articulated by the Supreme Court of the United States. Therefore, if we were employing our former test, we would hold that there is no fundamental right, either under the Alaska or federal constitutions, either to possess or ingest marijuana.

The foregoing does not complete our analysis of the right to privacy issues. For in *Gray* we stated that the right of privacy amendment of the Alaska Constitution "clearly it shields the ingestion of food, beverages or other substances", but that this right may be held to be subordinate to public health and welfare measures. Thus, Ravin's right to privacy contentions are not susceptible to disposition solely in terms of answering the question whether there is a general fundamental constitutional right to possess or smoke marijuana. This leads us to a more detailed examination of the right to privacy and the relevancy of where the right is exercised. At one end of the scale of the scope of the right to privacy is possession or ingestion:

30. 194 N.W.2d at 896.

31. *Id.*

32. 243 N.E.2d 898 (Mass.1969).

33. The privacy argument has been rejected in several other cases. *Miller v. State*, 458 S.W.2d 680 (Tex.Crim.App.1970); *In re Klor*, 64 Cal.2d 816, 51 Cal.Rptr. 903, 415 P.2d 791 (1966); *People v. Aguilar*, 257 Cal.

App.2d 597, 65 Cal.Rptr. 171 (1968); *United States v. Drorac*, 416 F.2d 914 (5th Cir. 1969), vacated on other grounds, 402 U.S. 939, 91 S.Ct. 1628, 29 L.Ed.2d 107 (1971); *Borras v. State*, 229 So.2d 244 (Fla.1969); *Raines v. State*, 225 So.2d 330 (Fla.1969). See *Scott v. United States*, 129 U.S.App.D.C. 296, 295 F.2d 619 (1968).

in the individual's home. If there is any area of human activity to which a right to privacy pertains more than any other, it is the home. The importance of the home has been amply demonstrated in constitutional law. Among the enumerated rights in the federal Bill of Rights are the guarantee against quartering of troops in a private house in peacetime (Third Amendment) and the right to be "secure in their . . . houses . . . against unreasonable searches and seizures . . ." (Fourth Amendment). The First Amendment has been held to protect the right to privacy and freedom of association in the home.³⁴ The Fifth Amendment has been described as providing protection against all governmental invasions "of the sanctity of a man's home and the privacies of life."³⁵ The protection of the right to receive birth control information in *Griswold* was predicated on the sanctity of the marriage relationship and the harm to this fundamental area of privacy if police were allowed to "search the sacred precincts of marital bedrooms."³⁶ And in *Stanley v. Georgia*,³⁷ the Court emphasized the home as the situs of protected "private activities". The right to receive information and ideas was found in *Stanley* to take on an added dimension precisely because it was a prosecution for possession in the home:

"For also fundamental is the right to be free, except in very limited circumstances, from unwanted governmental intrusions into one's privacy."³⁸ In a later case, the Supreme Court noted that *Stanley* was not based on the notion that the obscene matter was itself protected by a constitutional penumbra of privacy, but rather was a "reaffirmation that 'a man's home is his castle.'"³⁹ At the same time the Court noted, "the Constitution extends special safeguards to the privacy of the home, just as it protects other special privacy rights such as those of marriage, procreation, motherhood, child rearing, and education."⁴⁰ And as the Supreme Court pointed out, there exists a "myriad" of activities which may be lawfully conducted within the privacy and confines of the home, but may be prohibited in public.⁴¹

[7] In Alaska we have also recognized the distinctive nature of the home as a place where the individual's privacy receives special protection. This court has consistently recognized that the home is constitutionally protected from unreasonable searches and seizures, reasoning that the home itself retains a protected status under the Fourth Amendment and Alaska's constitution distinct from that of the occupant's person.⁴² The privacy amendment to the Alaska Constitution was intended to give recognition and protection to the

34. *Moreno v. United States Dep't of Agriculture*, 345 F.Supp. 310, 314 (D.D.C.1972), *aff'd*, 413 U.S. 528, 93 S.Ct. 2821, 37 L.Ed. 2d 782 (1973).

35. *Boyd v. U. S.*, 116 U.S. 616, 630, 6 S.Ct. 321, 29 L.Ed. 746, 751 (1886).

36. 381 U.S. at 486, 85 S.Ct. at 1682, 14 L. Ed.2d at 516.

37. 394 U.S. 557, 89 S.Ct. 1243, 22 L.Ed.2d 342 (1969).

38. 391 U.S. at 564, 89 S.Ct. at 1247, 22 L. Ed.2d at 519.

39. *Paris Adult Theatre I v. Slaton*, 413 U.S. 49, 93 S.Ct. 2628, 2640, 37 L.Ed.2d 446, 462 (1973).

40. *U. S. v. Orito*, 413 U.S. 139, 142, 93 S.Ct. 2674, 2677, 37 L.Ed.2d 513, 517 (1973). See

U. S. v. 12 200-Ft. Reels, 413 U.S. 123, 93 S.Ct. 2665, 37 L.Ed.2d 500 (1973).

41. *U. S. v. Orito*, 413 U.S. 139, 142-143, 93 S.Ct. 2674, 37 L.Ed.2d 513, 518 (1973).

42. *State v. Spietz*, 531 P.2d 521 (Alaska 1975); *Ferguson v. State*, 488 P.2d 1032 (Alaska 1971). See cases cited *supra* at n. 21. The home receives special attention in other areas of Alaska's laws, e. g., the homestead exemption in relation to execution sales, AS 09.35.080; the justifiable homicide defense pertaining to the prevention of a felony in the home, AS 11.15.100; and the distinction between burglary in a dwelling house and burglary in other structures, AS 11.20.080-.100.

home. Such a reading is consonant with the character of life in Alaska. Our territory and now state 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.

[8-11] The home, then, carries with it associations and meanings which make it particularly important as the situs of privacy. Privacy in the home is a fundamental right, under both the federal and Alaska constitutions. We do not mean by this that a person may do anything at anytime as long as the activity takes place within a person's home. There are two important limitations on this facet of the right to privacy. First, we agree with the Supreme Court of the United States, which has strictly limited the *Stanley* guarantee to possession for purely private, noncommercial use in the home. And secondly, 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. Indeed, one aspect of a private matter is that it is private, that is, that it does not adversely affect persons beyond the actor, and hence is none of

their business. When a matter does affect the public, directly or indirectly, it loses its wholly private character, and can be made to yield when an appropriate public need is demonstrated.

Thus, we conclude that citizens of the State of Alaska have a basic right to privacy in their homes under Alaska's constitution. This right to privacy would encompass the possession and ingestion of substances such as marijuana in a purely personal, non-commercial context in the home unless the state can meet its substantial burden and show that proscription of possession of marijuana in the home is supportable by achievement of a legitimate state interest.

This leads us to the second facet of our inquiry, namely, whether the State has demonstrated sufficient justification for the prohibition of possession of marijuana in general in the interest of public welfare; and further, whether the State has met the greater burden of showing a close and substantial relationship between the public welfare and control of ingestion or possession of marijuana in the home for personal use.

[12] The evidence which was presented at the hearing before the district court consisted primarily of several expert witnesses familiar with various medical and social aspects of marijuana use.⁴³ Numer-

43. Among the works we have examined in addition to the testimony below are the following: Marijuana: A Signal of Misunderstanding, the First Report of the National Commission on Marijuana and Drug Abuse (March 1972); Drug Use in America: Problem in Perspective, the Second Report of the National Commission on Marijuana and Drug Abuse (March 1973); Drug Use in Anchorage, Alaska, 223 J.Am.Med. Ass'n 657 (1971); G. Nahas, Marijuana: Deceptive Weed (1973); Nahas *et al.* Inhibition of Cellular Mediated Immunity in Marijuana Smokers, 183 Science 419 (1974); L. Grinspoon, Marijuana Reconsidered (1971); Hearings before the U. S. Senate Subcommittee on Internal Security, May 1974; Nahas & Greenwood, The First Report of the National Commission on Marijuana (1972); Signal of

Misunderstanding or Exercise in Ambiguity: draft of article to be published in Bulletin of N. Y. Academy of Medicine; Marijuana and Health: Fourth Annual Report to the U. S. Congress from the Secretary of Health, Education, and Welfare (1974); Silverstein & Tassin, Normal Skin Test Responses in Chronic Marijuana Users, 186 Science 740 (1974); Marijuana: The Grass May No Longer Be Greener, 185 Science 683 (1974); Marijuana (II): Does it Damage the Brain?, 185 Science 775 (1974); Depression of Plasma Testosterone Levels After Chronic Intensive Marijuana Use, 290 N.Engl.J.Med. 87 (1974); Plasma Testosterone Levels Before During and After Chronic Marijuana Smoking, 291 N.Engl.J.Med. 1051 (1974); Marijuana Survey-State of Oregon, Drug Abuse Council (1971).

his written reports and books were also introduced into evidence.⁴⁴

Marijuana is the common term for dried leaves or stalk of the plant *Cannabis sativa*. The primary psychoactive ingredient in the plant is delta-9-tetrahydrocannabinol (THC). Most marijuana available in the United States has a THC content of less than one percent. Other cannabis derivatives with a higher THC content, such as hashish, are available in the United States though much less common than is marijuana.

According to figures published by the National Commission on Marihuana and Drug Abuse⁴⁵ in 1973, an estimated 26 million Americans have used marijuana at least once. The incidence generally cuts across social and economic classes, though use is greatest among young persons (55%

of 18-21 year-olds have used it). Only about 2% of the adults who have used it were classified by the National Commission as "heavy users" (more than once daily). The experience in Alaska seems to be similar. A report published in the Journal of the American Medical Association in 1971 indicated that 24% of Anchorage school children in grades six through twelve had used marijuana, as had 46% in grades eleven and twelve.⁴⁶

Scientific testimony on the physiological and psychological effects of marijuana on humans generally stresses the variability of effects upon different individuals and on any one individual at different times. The setting and psychological state of the user can affect his responses. Responses also vary with the amount of marijuana one has used in the past. A new user, for instance, often feels no effects at all.

44. It is not the function of this court to reassess the scientific evidence in the manner of a legislature. See *U. S. v. Thorne*, 325 A. 2d 704 (D.C.App.1974), where an attack on the constitutionality of the District of Columbia marijuana statutes was made. There the court said:

In our opinion the court below misconceived its function in its approach to the constitutionality of the statutory proscription of the possession and use of marijuana. In deciding that this drug has virtually no harmful effects upon the human system, the court had occasion to consider the testimony of four expert witnesses and a voluminous mass of documentary studies. The court weighed this evidence and resolved the conflict to its own satisfaction. If this were a hearing or a trial turning upon the determination of facts upon which there was conflicting testimony, such procedure was, of course, correct.

But a holding that a legislative enactment is invalid cannot rest upon a judicial determination of a debatable medical issue. Any party assailing the constitutionality of a statute has the heavy burden of demonstrating that it has no rational basis.

It is apparent from the record in this case that the question decided by the court below after the hearing on the pretrial motions was "at least debatable." Hence, under the tests set forth in *Carolene Products*, the court should have deferred to congressional judgment.

Similarly the Supreme Judicial Court of Massachusetts in *Commonwealth v. Leis*, 243 N.E.2d 898, 901-02 (1969), said:

We know of nothing that compels the Legislature to thoroughly investigate the available scientific and medical evidence when enacting a law. The test of whether an act of the Legislature is rational and reasonable is not whether the records of the Legislature contain a sufficient basis of fact to sustain that act. The Legislature is presumed to have acted rationally and reasonably. See *Commonwealth v. Finnigan*, 326 Mass. 378, 379, 96 N.E.2d 715; *Coffee-Rich, Inc. v. Commissioner of Pub. Health*, 348 Mass. 414, 422, 204 N.E.2d 231. "Unless the act of the Legislature cannot be supported upon any rational basis of fact that reasonably can be conceived to sustain it, the court has no power to strike it down as violative of the Constitution." *Sperry & Hutchinson Co. v. Director of the Div. on the Necessaries of Life of Commonwealth*, 307 Mass. 408, 418, 30 N.E.2d 209, 274, 131 A.L.R. 1254. See *United States v. Carolene Prod. Co.*, 304 U.S. 144, 151, 58 S.Ct. 778, 82 L.Ed. 1234.

Justice Kirk, in his concurring opinion in *Leis*, also explains the question of legislative judgment and the range of judicial cognizance.

45. *Drug Use in America: Problem in Perspective*, the Second Report of the National Commission on Marihuana and Drug Abuse (March 1973) at 64.

46. *Drug Use in Anchorage, Alaska*, 223 J. Am.Med.Ass'n 657 (1971).

The short-term physiological effects are relatively undisputed. An immediate slight increase in the pulse, decrease in salivation, and a slight reddening of the eyes are usually noted. There is also impairment of psychomotor control. These effects generally end within two to three hours of the end of smoking.

Long-term physiological effects raise more controversy among the experts. The National Commission on Marihuana and Drug Abuse reported that among users "no significant physical, biochemical, or mental abnormalities could be attributed solely to their marijuana smoking."⁴⁷ Certain researchers have pointed to possible deleterious effects on the body's immune defenses,⁴⁸ on the chromosomal structures of users,⁴⁹ and on testosterone levels in the body.⁵⁰ The methodology of certain of these studies has been extensively criticized by other qualified medical scientists, however. These studies cannot be ignored. It should be noted that most of the damage suggested by these studies comes in the context of intensive use of concentrated forms of THC. It appears that the use of marijuana, as it is presently used in the United States today, does not constitute a public health problem of any significant dimensions. It is, for instance, far more innocuous in terms of physiological and social damage than alcohol or tobacco. But the studies suggesting dangers in intensive

cannabis use do raise valid doubts which cannot be dismissed or discounted.

The immediate psychological effects of marijuana are typically a mild euphoria and a relaxed feeling of well-being. The user may feel a heightened sensitivity to taste and to visual and aural sensations, and his perception of time intervals may be distorted. A desire to become high can lead to a greater high; fear of becoming high or general nervousness can cause the user to fail to experience any high at all. In rare cases, excessive nervousness or fear of the drug can even precipitate a panic reaction. Occasionally a user will experience a negative reaction such as anxiety or depression, particularly when he takes in more of the substance than needed to achieve the desired high. However, in smoking marijuana, the usual method of taking it in this country, the user can self-titrate, or control the amount taken in, since the effect builds up gradually.

Additional short-term effects are an impairment of immediate-past-memory facility and impairment in performing psychomotor tasks. Experienced users seem less impaired in this regard than naive users.

In extremely rare instances, use of marijuana has been known to precipitate psychotic episodes; however, the consensus of the experts seems to be that the potential for precipitating psychotic episodes exists only for a limited number of prepsychotic

47. *Marihuana: A Signal of Misunderstanding*, First Report of the National Commission on Marihuana and Drug Abuse (March 1972), p. 61.

48. See Nahas, et al. *Inhibition of Cellular Mediated Immunity in Marihuana Smokers*, 183 *Science* 419 (1974). *But cf.* *Normal Skin Test Responses in Chronic Marihuana Users*, 186 *Science* 740 (1974).

49. See Stenchever, *Statement before the Senate Subcommittee on Internal Security*, May 16, 1974. The National Institute on Drug Abuse, in *Marihuana and Health*, Fourth Report to the United States Congress from the Secretary of Health, Education, and Welfare, states in part:

The preclinical findings of greatest interest and potential significance during the past two years have been a series of studies

indicating that delta-9-THC (and possibly other marihuana constituents) have an effect upon certain basic cellular mechanisms which involve the uptake of amino acids and the nucleotides into primary nuclear components such as DNA. Since this may interfere with basic biological processes, the preliminary data raises the possibility that the effects of marihuana, under some circumstances, may be more widespread on the organism than has been previously thought.

Id. at 6.

50. *Depression of Plasma Testosterone Levels After Chronic Intensive Marihuana Use*, 299 *N.Engl.J.Med.* 872 (1974). *But cf.* *Plasma Testosterone Levels Before, During and After Chronic Marihuana Smoking*, 291 *N.Engl.J.Med.* 1051 (1974).

persons who could be pushed into psychosis by any number of drug or nondrug-related influences.

There is considerable debate as to the long-term effects of marijuana on mental functioning. Certain researchers cite evidence of an "amotivational syndrome" among long-term heavy cannabis users. However, the main examples of this effect are users in societies where large segments of the population exhibit such traits as social withdrawal and passivity even without drug use. The National Commission concludes that long-time heavy users do not deviate significantly from their social peers in terms of mental functioning, at least to any extent attributable to marijuana use.⁵¹

The experts generally agree that the early widely-held belief that marijuana use directly causes criminal behavior, and particularly violent, aggressive behavior, has no validity. On the contrary, the National Commission found indications that marijuana inhibits "the expression of aggressive impulses by pacifying the user, interfering with muscle coordination, reducing psychomotor activities and generally producing states of drowsiness, lethargy, timidity and passivity."⁵² Moreover, the Commission and most other authorities agree that there is little validity to the the-

ory that marijuana use leads to use of more potent and dangerous drugs. Although it has been stated that the more heavily a user smokes marijuana, the greater the probability that he has used or will use other drugs, "it has been suggested that such use is related to 'drug use proneness' and involvement in drug subcultures rather than to the characteristics of cannabis, *per se*."⁵³

The most serious risk to the public health discerned by the National Commission is the possibility of an increase in the number of heavy users, who now constitute about 2% (500,000) of those who have used the drug. Within this group certain emotional changes have been observed among "predisposed individuals" as a result of prolonged heavy use. This group seems to carry the highest risk, particularly in view of the risk of retarding social adjustment among adolescents if heavy use should grow.

Most authorities have accepted the theory that marijuana users develop a "reverse tolerance", that is, that a moderate user needs less and less marijuana over time to achieve a high. Recent research indicates that this may be true only up to a point, and that beyond a certain intensity of use a true tolerance begins to develop.⁵⁴ If true, this may be relevant regarding only

51. Marijuana: A Signal of Misunderstanding, the First Report of the National Commission on Marijuana and Drug Abuse (March 1972), 63. See also Marijuana and Health, Fourth Report to the United States Congress from the Secretary of Health, Education and Welfare (1974), which reads at

"While chronic users in the United States have used for appreciably shorter periods of time than users overseas, studies of American chronic users are potentially of great importance in assessing possible limitations of marijuana use for the American population. In one large scale study of undergraduate student use comparisons were made between nonusers (including those who had done a limited amount of experimentation), occasional users and chronic users (those who had used three or more times a week for three years or more or for ten years if use was almost daily). No

statistical differences in academic performance were found nor was there any evidence of reduced motivation. . . . Another study of moderately using medical students who had used regularly for three or more years and who were matched with non-using medical students for intelligence, found no difference on an extensive battery of neuropsychological tests.

52. *Id.* at 70-71.

53. Marijuana and Health, Fourth Report to the United States Congress from the Secretary of Health, Education, and Welfare (1974) at 6.

54. "While tolerance to the effects of marijuana has not been generally observed among American users, there is increasingly convincing evidence that tolerance (i. e., larger dosages required to produce the same effects found with lower dosages) does develop under conditions of heavy, regular use. Given

heavy use of concentrated forms of cannabis, since marijuana use is self-limiting due to the forms in which it is taken.

The National Commission rejected the notion that marijuana is physically addicting. It also rejected the notion that marijuana as used in the United States today presents a significant risk of causing psychological dependency in the user. Rather, the experimental or intermittent user develops little or no psychological dependence. Lengthy use on a regular basis does present a risk of such dependence and of subsequent heavier use, and strong psychological dependence is characteristic of heavy users in other countries. This pattern of use is rare in the United States today, however.

While there is no confirmed report of a human ever having died from an overdose of cannabis, the toxic levels of THC have been determined from tests on animals. The lethal dose for marijuana is approximately 40,000 times the dose needed to achieve intoxication. The equivalent ratio of intoxicating to lethal doses for alcohol is 4/10 and for barbiturates is 3/50.

The number of persons arrested for marijuana possession has climbed steeply in recent years. In 1973, over 400,000 marijuana arrests occurred, a 43% rise over the previous year. It should also be noted that 81% of persons arrested for marijuana-related crimes have never been convicted of any crime in the past, and 91% have never been convicted of a drug-related crime.⁵⁵

The justifications offered by the State to uphold AS 17.12.010 are generally that marijuana is a psychoactive drug; that it is not a harmless substance; that heavy

use has concomitant risk; that it is capable of precipitating a psychotic reaction in at least individuals who are predisposed towards such reaction; and that its use adversely affects the user's ability to operate an automobile. The State relies upon a number of medical researchers who have raised questions as to the substance's effect on the body's immune system, on chromosomal structure, and on the functioning of the brain. On the other hand, in almost every instance of reports of potential danger arising from marijuana use, reports can be found reaching contradictory results. It appears that there is no firm evidence that marijuana, as presently used in this country, is generally a danger to the user or to others. But neither is there conclusive evidence to the effect that it is harmless.⁵⁶ The one significant risk in use of marijuana which we do find established to a reasonable degree of certainty is the effect of marijuana intoxication on driving. We shall return to this aspect of the problem later in this opinion.

Possibly implicit in the State's catalogue of possible dangers of marijuana use is the assumption that the State has the authority to protect the individual from his own folly, that is, that the State can control activities which present no harm to anyone except those enjoying them. Although some courts have found the "public interest" to be broad enough to justify protecting the individual against himself,⁵⁷ most have found inherent limitations on the police power of the state. An apposite example is the litigation regarding the constitutionality of laws requiring motorcyclists to wear helmets. Most of the courts addressing the issue, including this one, have resolved it by finding a connection between

the relatively low doses and infrequent use typical of present patterns of use in the United States it is not surprising that tolerance has not usually been observed.

While the amounts involved were usually large and quite atypical of current use patterns, the probability of a withdrawal syndrome in at least some American heavy users must be considered." *Marihuana and Health*, Fourth Report to the United States Congress

from the Secretary of Health, Education, and Welfare (1974) at 10, 75-81.

55. *Marihuana: A Signal of Misunderstanding*, Appendix II, at 622.

56. Petitioner's witnesses, Doctors Fort and Ungerleider, both testified that marijuana was not harmless.

57. *E. g.*, *Raines v. State*, 225 S.2d 330 (Fla. 1960).

helmet requirement and the safety of motorists,⁵⁸ but a significant number of courts have explicitly rejected such restrictive measures as beyond the police power of the state because they do not benefit the public.⁵⁹ Typical of the logic in these latter cases is the dissent of Justice Abe in *State v. Lee*,⁶⁰ in which the Hawaii Supreme Court upheld a motorcycle-helmet requirement despite finding no causal link between lack of the equipment and the motorcyclist and injury to others. The court reasoned that where a person's conduct is so reckless, and the resulting injury and death are so widespread as to be of concern to the public, then the conduct affects the public interest and is within the scope of the police power. Justice Abe commented, citing a general right to be left alone or liberty to do as you please. There is to be a genuine harm to others, he stated, to justify such controls; a state cannot simply decide what is in a person's interest and compel it.⁶¹

[13, 14] We glean from these cases the general proposition that the authority of the state to exert control over the individual extends only to activities of the individual which affect others or the public at large as it relates to matters of public health or safety, or to provide for the general welfare. 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. The right of the individual to do as he pleases is not absolute, of course: it can be made to yield when it begins to infringe on the rights and welfare of others.⁶²

[15, 16] Further, the authority of the state to control the activities of its citizens is not limited to activities which have a present and immediate impact on the public health or welfare. It is conceivable, for example, that a drug could so seriously develop in its user a withdrawal or amotivational syndrome, that widespread use of the drug could significantly debilitate the fabric of our society. Faced with a substantial possibility of such a result, the state could take measures to combat the possibility. The state is under no obligation to allow otherwise "private" activity which will result in numbers of people becoming public charges or otherwise burdening the public welfare. But we do not find that such a situation exists today regarding marijuana. It appears that effects of marijuana on the individual are not serious enough to justify widespread concern, at least as compared with the far more dangerous effects of alcohol, barbitu-

E.g., *Kingery v. Chappel*, 504 P.2d 831 (Alaska 1972); *People v. Dielmeyer*, 54 N.Y.S.2d 466, 282 N.Y.S.2d 797 (1967); *State v. Melo*, 103 N.J.Super. 353, 247 A.2d 176 (1968).

E.g., *American Motorcycle Ass'n v. Da-* 11 Mich.App. 351, 158 N.W.2d 72 (1968); *People v. Fries*, 42 Ill.2d 446, 250 N.E.2d 119 (1969). See *Everhardt v. New Orleans*, 208 So.2d 423 (La.App.1968), *rev'd*, 217 So.2d 400 (1969); *People v. Carmichael*, 73 N.Y.2d 581, 279 N.Y.S.2d 272 (1967), *rev'd*, 158 N.Y.S.2d 388, 288 N.Y.S.2d 931 (1968).

⁵¹ Haw. 516, 105 P.2d 573 (1970).

Similarly, in *State v. Kantner*, 53 Haw. 103 P.2d 306 (1972), which involved the constitutionality of Hawaii's marijuana statute, Justice Abe noted his belief that the statute went beyond the police power of the state because of the lack of evidence that use of

marijuana harms anyone other than the user. There is, he wrote, under the Hawaii Constitution a fundamental right of liberty to make a fool of oneself so long as one's act does not endanger others.

⁶² *Gf. Liggett Co. v. Baldridge*, 278 U.S. 105, 111-12, 49 S.Ct. 57, 59, 73 L.Ed. 204, 208 (1928).

The police power may be exerted in the form of state legislation where otherwise the effect may be to invade rights guaranteed by the Fourteenth Amendment only when such legislation bears a real and substantial relation to the public health, safety, morals, or some other phase of the general welfare.

⁶³ See *Roe v. Wade*, 410 U.S. 113, 151, 93 S.Ct. 705, 35 L.Ed.2d 117, 177 (1971); *Gruy v. State*, 525 P.2d 521, 528 (Alaska 1974); *Breen v. Smith*, 501 P.2d 159, 170 (Alaska 1973).

rates and amphetamines. Moreover, the current patterns of use in the United States are not such as would warrant concern that in the future consumption patterns are likely to change.⁶⁴

[17-19] Research is continuing extensively. Scientific doubts persist, however, and that fact has significance for our application of the law. It is a long-standing rule of law that statutes designed to protect the public health will receive a liberal construction.⁶⁵ We have seen repeated examples in recent years where scientific doubts as to the safety of various products, drugs, or environmental conditions have been held to justify controls. There is a presumption in favor of public health measures; when there is substantial doubt as to the safety of a given substance or situation for the public health, controls intended to obviate the danger will usually be upheld.

64. We recognize that more potent forms of cannabis than marijuana are commonly used in other countries and are available on a limited scale here. However, studies of use patterns here do not indicate any great likelihood of a significant shift in use here to the more potent substances. If such a shift were to occur, then marijuana use could be characterized as a serious health problem.

65. 3 Sutherland Statutory Construction § 71.02 (4th ed. 1974) and the cases cited in note 42 *supra*.

66. See Marijuana and Health, Fourth Report to the United States Congress from the Secretary of Health, Education, and Welfare 105 (1974). This report contains citations to the most recent studies.

67. Evidence that marijuana has a detrimental effect on driving performance, especially as the dose increases, continues to mount. It has been found to increase both braking and starting times, to adversely affect attention and concentration abilities, and to detract from performance on a divided attention task, all of which are presumably involved in driving. A recent Canadian study of driving ability while marijuana-intoxicated examined drivers' performance under both driving course and actual traffic conditions. A significant decline in performance as measured by several criteria was found in most drivers test-

ed. But one way in which use of marijuana most clearly does affect the general public is in regard to its effect on driving. All of which brings us to the opposite (from the home) end of the scale of the right to privacy in the context of ingestion or possession of marijuana, namely, when the individual is operating a motor vehicle. Recent research has produced increasing evidence of significant impairment of the driving ability of persons under the influence of cannabis.⁶⁶ Distortion of time perception, impairment of psychomotor function, and increased selectivity in attentiveness to surroundings apparently can combine to lower driver ability.⁶⁷ In this regard, Ravin points out that marijuana usually produces passivity and inactivity, in contrast to alcohol, which increases aggressiveness and is likely to result in overconfidence in one's driving ability. Although a person under the influence of marijuana may be less likely to attempt to drive than

ed. Based on the accumulated evidence, it seems clear that driving while under the influence of marijuana is ill-advised. Marijuana and Health, Fourth Report to the U. S. Congress from the Secretary of Health, Education, and Welfare 10-11 (1974).

Petitioner's own experts do not disagree with the Secretary's conclusions. Dr. Grinspoon testified that "... it stands to reason that anybody who is intoxicated or has a psychoactive drug in him should not drive, because there is no question ... his wherewithall is not with him, and I think that would be the case with marijuana." Dr. Fineglass stated that "... moderate or heavy use of marijuana can definitely interfere with some of the local skills that would be necessary for the operation of a motor vehicle, and therefore, in their recommendation did take note of driving while intoxicated as a potential danger to the public safety. Dr. Ungerleider testified that although the immediate effects of marijuana intoxication on the organs and bodily functions are transient and have little or no permanent effect "there is a definite loss of some psychomotor control, temporary impairment of time space perception. . . ." Later in the course of his testimony, Dr. Ungerleider concluded that recent studies had proven that drivers under the influence of marijuana present a serious risk resulting from impaired driving ability.

person under the influence of alcohol, there exists the potential for serious harm to the health and safety of the general public.⁶⁸

[20-24] In view of the foregoing, we believe that at present, the need for control of drivers under the influence of marijuana and the existing doubts as to the safety of marijuana, demonstrate a sufficient justification for the prohibition found in AS 17.12.010 as an exercise of the state's police power for the public welfare. Given the evidence of the effect of marijuana on driving an individual's right to possess or ingest marijuana while driving would be subject to the prohibition provided for in AS 17.12.010. However, given the relative insignificance of marijuana consumption as a health problem in our society at present, we do not believe that the potential harm generated by drivers under the influence of marijuana, standing alone, creates a close and substantial relationship between the public welfare and control of ingestion of marijuana or possession of it in the home for personal use. Thus we conclude that no adequate justification for the state's intrusion into the citizen's right to privacy by its prohibition of possession of marijuana by an adult for personal consumption in the home has been shown. The privacy of the individual's home cannot be breached absent a persuasive showing of a close and substantial relationship of the intrusion to a legitimate governmental interest. Here, mere scientific doubts will not suffice.

68. Current Alaska law enacted since the trial of this case prohibits driving under the influence of an hallucinogenic drug, AS 28.35.030. Alaska law also specifically prohibits operation of a boat while under the influence of marijuana, AS 05.25.000.

There does not now exist a means for detecting the presence of cannabis in the body which is available for practical use by law enforcement agencies. Such means are in use in laboratories, however, and research is progressing toward a device which could be used by police in the way that breathalyzer tests for alcohol are used now.

69. We do not intend to imply that the right of privacy in the home does not apply to

The state must demonstrate a need based on proof that the public health or welfare will in fact suffer if the controls are not applied.

The state has a legitimate concern with avoiding the spread of marijuana use to adolescents who may not be equipped with the maturity to handle the experience prudently, as well as a legitimate concern with the problem of driving under the influence of marijuana. Yet these interests are insufficient to justify intrusions into the rights of adults in the privacy of their own homes.⁶⁹ Further, neither the federal or Alaska constitution affords protection for the buying or selling of marijuana, nor absolute protection for its use or possession in public. Possession at home of amounts of marijuana indicative of intent to sell rather than possession for personal use is likewise unprotected.⁷⁰

In view of our holding that possession of marijuana by adults at home for personal use is constitutionally protected, we wish to make clear that we do not mean to condone the use of marijuana. The experts who testified below, including petitioner's witnesses, were unanimously opposed to the use of any psychoactive drugs. We agree completely. It is the responsibility of every individual to consider carefully the ramifications for himself and for those around him of using such substances. With the freedom which our society offers to each of us to order our lives as we see fit goes the duty to live responsibly, for

children. See *Breese v. Smith*, 501 P.2d 150, 167 (Alaska 1972). We note that distinct government interests with reference to children may justify legislation that could not properly be applied to adults.

70. Statistics indicate that few arrests for simple possession occur in the home except when other crimes are simultaneously being investigated. The trend in general in law enforcement seems to be toward minimal effort against simple users of marijuana, and concentration of efforts against dealers and users of more dangerous substances. Moreover, statistics indicate that most arrests for possession of marijuana in Alaska result in dismissals before trial.

our own sakes and for society's. This result can best be achieved, we believe, without the use of psychoactive substances.

[25,26] We briefly address Ravin's second assertion of error, namely that AS 17.12.010 denies him due process and equal protection of the law. The argument is two-fold. First, Ravin asserts, the proscription denies equal protection because the other commonly used "recreational" drugs, alcohol and tobacco, are not proscribed, though they inflict far more damage on the user than does marijuana. We reject, however, the assumption that the legislature must apply equal controls to equal threats to the public health. Assuming some degree of control of marijuana use is permissible, it does not follow that the political obstacles to placing controls on alcohol and tobacco should render the legislature unable to regulate other substances equally or less harmful.⁷¹ It is not irrational for the legislature to regulate those public health areas where it can do so, when there exists other areas where controls are less feasible.

[27] Ravin also attacks as irrational the classification of marijuana with the other drugs covered by AS 17.12.150(3) ("depressant, stimulant, or hallucinogenic"). He may be correct that marijuana is the least harmful of the drugs covered by AS 17.12.150(3), but that alone is not sufficient to make the classification irrational. In a number of cases the classification of marijuana either as or with narcotic drugs has been struck down as irrational in view

of the relative harmlessness of marijuana.⁷² In other cases, courts have deferred to the legislative finding of facts implicit in the classification.⁷³ However, in every case in which statutes have been struck down, the statutory scheme classified marijuana with, or subject to equal sanctions with, the most dangerous proscribed drugs. In Alaska, however, "hard" drugs are in a completely different category⁷⁴ from marijuana, with substantially greater penalties for misuse. The drugs with which marijuana is grouped in AS 17.12.150(3) are not so different from marijuana that yet another classification must be set up for marijuana alone. We find no merit to Ravin's contention on this point.

[28] One other facet of this petition remains for discussion. Ravin urges us to recognize that whatever harm results from marijuana use is far outweighed by the negative aspects of enforcement. Over 400,000 persons were arrested for marijuana-related crimes in 1973; 81% of them had no previous criminal records. Using these statistics, and asserting that marijuana use does not pose a substantial public health threat, Ravin questions the wisdom of AS 17.12.010. We note that the Alaska Bar Association, American Bar Association, National Conference of Commissioners on Uniform State Laws, National Advisory Commission on Criminal Justice Standards and Goals and the Governing Board of the American Medical Association have recommended decriminalization of possession of marijuana. The National Commission on Marihuana and Drug

71. See *U. S. v. Maiden*, 355 F.Supp. 743 (D. Conn.1973); *U. S. v. Kiffer*, 477 F.2d 349 (2d Cir. 1973). In attacking a complex problem, the state need not choose between attacking every aspect of that problem or not attacking that problem at all. *Dandridge v. Williams*, 397 U.S. 471, 90 S.Ct. 1153, 25 L.Ed.2d 491 (1970); *McDonald v. Board of Election Commissioners*, 394 U.S. 802, 80 S.Ct. 1404, 22 L.Ed.2d 739 (1969).

72. *E. g.*, *People v. McCabe*, 49 Ill.2d 338, 275 N.E.2d 407 (1971); *Attwood v. State*, 509 S.W.2d 342 (Tex.Crim.App.1974); see *People v. Sinclair*, 387 Mich. 91, 194 N.W.2d

878 (1972); *cf.* *State v. Zornes*, 475 P.2d 109 (Wash.1970).

73. *E. g.*, *Bettis v. United States*, 408 F.2d 563 (9th Cir. 1969); *Commonwealth v. Lers*, 243 N.E.2d 898 (Mass.1969); *Miller v. Texas*, 458 S.W.2d 680 (Tex.Crim.App.1970); *Raines v. State*, 225 So.2d 330 (Fla.1969); *People v. McKenzie*, 169 Colo. 521, 458 P.2d 232 (1969); *People v. Stark*, 157 Colo. 54, 400 P.2d 923 (1965). See *State v. Kantner*, 53 Haw. 327, 493 P.2d 306 (1972).

74. See AS 17.10.010 et seq. (The Uniform Narcotic Drug Act).

House has recommended that private possession for personal use no longer be an offense. A Canadian study has arrived at similar results. And at least one state, Oregon, has already decriminalized possession of small amounts of marijuana.⁷⁵

In opposition, the State argues that under Alaska's constitutional system of separate but equal branches of government the issue is a "political controversy over the state's fundamental policy toward the drug marijuana". Thus, the "issue should be properly determined by the people's elected representatives". We agree that determination of the wisdom of a particular legislative enactment is more properly the subject of investigation and resolution by the legislature rather than the judiciary.

The record does not disclose any facts as to the situs of Ravin's arrest and his alleged possession of marijuana. In view of these circumstances, we hold that the matter must be remanded to the district court for the purpose of developing the facts concerning Ravin's arrest and circumstances of his possession of marijuana. Once this is accomplished, the district court is to consider Ravin's motion to dismiss in conformity with this opinion.

Remanded for further proceedings consistent with this opinion.

BOOCHEVER, Justice (concurring, with whom CONNOR, Justice, joins).

Because of the importance of the issues discussed in this case and the possibility that portions of the opinion may be construed as substantially circumscribing the Alaska Constitutional right to privacy, I find it necessary to file this concurrence. By its reliance on certain United States Supreme Court cases¹ and the manner in

which some of the conclusions are set forth, the opinion may be read as limiting the right of privacy principally to protection of activities engaged in within the confines of the home.² The opinion relies chiefly on United States Supreme Court precedent, although there is no Federal Constitutional provision corresponding to art. 1, § 22 of the Alaska Constitution which specifies that "the right of the people to privacy is recognized and shall not be infringed". While Federal cases defining the right of privacy derived from other provisions of the United States Constitution are of assistance in determining the perimeters of our constitutional right to privacy, we are certainly not bound by those cases in construing the separate Alaska provision. Even when Alaska Constitutional provisions are closely akin to those of the Federal Constitution, we have stated:

While we must enforce the minimum constitutional standards imposed upon us by the United States Supreme Court's interpretation of the Fourteenth Amendment, we are free, and we are under a duty, to develop additional constitutional rights and privileges under our Alaska Constitution if we find such fundamental rights and privileges to be within the intention and spirit of our local constitutional language and to be necessary for the kind of civilized life and ordered liberty which is at the core of our constitutional heritage. We need not stand by idly and passively, waiting for constitutional direction from the highest court of the land. Instead, we should be moving concurrently to develop and expound the principles embedded in our constitutional law.³

Although the majority opinion emphasizes the right of privacy in the home, it rec-

75. O.R.S. 167.207. The Alaska legislature have also recently passed a bill which would decriminalize possession of marijuana in certain contexts.

¹ Stanley v. Georgia, 394 U.S. 557, 89 S.Ct. 1230, 22 L.Ed.2d 542 (1969); Griswold v. Connecticut, 381 U.S. 479, 85 S.Ct. 1678, 14 L.Ed.2d 510 (1965).

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2. The court writes that art. 1, § 22 of the Alaska Constitution " . . . was intended to give recognition and protection to the home".

3. Baker v. City of Fairbanks, 471 P.2d 386, 401-02 (Alaska 1970) (footnotes omitted).

ognizes that analysis of the Federal decisions does not indicate that the right of privacy is relegated to the home. It is true that *Griswold v. Connecticut*⁴ invalidated a Connecticut statute prohibiting the distribution of contraceptives and the dissemination of birth control information to married adults by finding a right of privacy, emanating from other constitutional provisions, within which the marital relationship, arguably home related, was protected. But the later case of *Eisenstadt v. Baird*⁵ held that a statute prohibiting the distribution of contraceptives to unmarried persons but allowing such distribution to married persons violated the equal protection clause of the fourteenth amendment. In so holding, the Court referred to *Griswold* and explained what the case stood for.

If under *Griswold* the distribution of contraceptives to married persons cannot be prohibited, a ban on distribution to unmarried persons would be equally impermissible. It is true that in *Griswold* the right of privacy in question inhered in the marital relationship. Yet the marital couple is not an independent entity with a mind and heart of its own, but an association of two individuals each with a separate intellectual and emotional makeup. If the right of privacy means anything, it is the right of the individual, married or single, to be free from unwarranted governmental intrusion into matters so fundamentally affecting a person as the decision whether to bear or beget a child.⁶

The Court held that the right of privacy involved being free to decide for oneself

whether to bear or beget a child, a right relating to the autonomy of the individual, not to a place.

Similarly, *Roe v. Wade*,⁷ in upholding the right of a woman to decide whether she should terminate her pregnancy, stated:

This right of privacy, whether it be founded in the Fourteenth Amendment's concept of personal liberty and restrictions upon state action, as we feel it is, or, as the District Court determined, in the Ninth Amendment's reservation of rights to the people, is broad enough to encompass a woman's decision whether or not to terminate her pregnancy.⁸

Again, the right of privacy pertained to the freedom of the individual to decide as to her course of action and was unrelated to any situs.

On the other hand, there are the *Stanley—Paris Adult Theatre I* group of cases⁹ holding that the "broad power to regulate obscenity does not extend to mere possession by the individual in the privacy of his own home" although obscenity is not otherwise constitutionally immune from state regulation.

Thus it appears that the United States Supreme Court has found a right of privacy to exist as to activities within the home or with reference to values associated with the home, and, additionally, as a right of personal autonomy, to make decisions that shape an individual's personal life.¹⁰

Since the citizens of Alaska, with their strong emphasis on individual liberty, enacted an amendment to the Alaska Constitution expressly providing for a right to

4. 381 U.S. 479, 85 S.Ct. 1678, 14 L.Ed.2d 510 (1965).

5. 405 U.S. 438, 92 S.Ct. 1029, 31 L.Ed.2d 349 (1972).

6. *Id.* 405 U.S. at 453, 92 S.Ct. at 1038, 31 L.Ed.2d at 362.

7. 410 U.S. 113, 93 S.Ct. 705, 35 L.Ed.2d 147 (1973).

8. *Id.* 410 U.S. at 153, 93 S.Ct. at 727, 35 L.Ed.2d at 177.

9. *Stanley v. Georgia*, 394 U.S. 557, 89 S.Ct. 1243, 22 L.Ed.2d 542 (1969); *Paris Adult Theatre I v. Slaton*, 413 U.S. 49, 93 S.Ct. 2628, 37 L.Ed.2d 446 (1973); *United States v. Orito*, 413 U.S. 139, 93 S.Ct. 2674, 37 L.Ed.2d 513 (1973); *United States v. 12 200 Ft. Reels*, 413 U.S. 123, 93 S.Ct. 2665, 37 L.Ed.2d 500 (1973).

10. On Privacy: Constitutional Protection of Personal Liberty, 48 N.Y.U.L.Rev. 670, (1973).

privacy not found in the United States Constitution, it can only be concluded that that right is broader in scope than that of the Federal Constitution. As such, it includes not only activities within the home and values associated with the home, but also the right to be left alone and to do as one pleases as long as the activity does not infringe on the rights of others. Thus, the decision whether to ingest food, beverages or other substances comes within the purview of that right to privacy.¹¹

The right to privacy, however, is not monolithic. For example, the right to decide whether to eat strawberry ice cream cannot be placed on the same level as that of deciding whether to bear a child. Moreover, the importance of the right may properly be related to the place where it is exercised, for example, at the home or in the market place. Other considerations could be the nature of relationships involved (marital, doctor-patient, attorney-client, etc.), the particular activity in question and the individual's interest in it.

Having discussed generally the contours of what I perceive to be the right to privacy under the Alaska Constitution, I shall turn briefly to the test utilized by the court in determining infringements of that right. Particularly in equal protection cases, but also as to cases alleging infringement of other constitutional rights, the United States Supreme Court,¹² and this court¹³ in the past, have followed a two-tiered test. If the right involved was deemed to be "fundamental", a statute infringing upon it is required to be "necessary" to further a

"compelling state interest". Whereas if the right infringed upon was classified as non-fundamental, any rational basis that might be conceived to justify the legislation was held to be sufficient.¹⁴ As a practical matter, the test was result oriented, since once a right was declared to be fundamental, the challenged regulation or legislative act would be stricken,¹⁵ whereas otherwise some reason could usually be found to sustain it.

I agree with the majority's departure from that test in areas where we have discretion to depart from standards established by the United States Supreme Court. With reference to laws challenged as invading the Alaskan right of privacy,¹⁶ I would apply a single flexible test dependent first upon the importance of the right involved. Based on the nature of that right, a greater or lesser burden would be placed on the state to show the relationship of the intrusion to a legitimate governmental interest. I agree with the majority opinion that interference with rights of privacy within one's home requires a very high level of justification. Similar considerations would apply to certain relationships, without reference to situs, i. e. attorney-client, doctor-patient, priest-parishioner, marital relationship, parent-child. In all cases involving a right of privacy, I believe that the relationship of the intrusion to a legitimate governmental interest must be carefully examined. The court should not abandon protection of the right of an individual to decide how to conduct his life because a rational basis may be "con-

¹¹ *Gray v. State*, 525 P.2d 524 (Alaska 1974).

¹² See *Bates v. Little Rock*, 361 U.S. 516, 80 S.Ct. 112, 4 L.Ed.2d 480 (1960); *Roe v. Wade*, 410 U.S. 113, 93 S.Ct. 705, 35 L.Ed. 2d 111 (1973).

¹³ *Lyden Transport, Inc. v. State*, 532 P.2d 700 (Alaska 1975); *Breese v. Smith*, 501 P.2d 159 (Alaska 1972).

¹⁴ *Lyden Transport, Inc. v. State*, 532 P.2d 700, 703 (Alaska 1975).

¹⁵ Where a fundamental right has required use of the compelling state interest test, only one law has been found valid by the Supreme

Court, *Korematsu v. United States*, 323 U.S. 214, 65 S.Ct. 493, 89 L.Ed. 194 (1944), but no state law has passed muster. *Dunn v. Blumstein*, 405 U.S. 330, 363-64, 92 S.Ct. 995, 31 L.Ed.2d 274, 296-97 (1972) (Burger, C.J., dissenting). See 48 N.Y.U.L.Rev. 670 at 702. See also *Gilbert v. State*, 526 P.2d 1131 (Alaska 1974).

¹⁶ Of course, in any event where Federal Constitutional rights are involved, we must at least apply the minimum standards prescribed by the United States Supreme Court. *Baker v. City of Fairbanks*, 471 P.2d 380, 401-02 (Alaska 1970).

ceived" for the legislation in question. The importance of the governmental interest and the means utilized to accomplish this goal must be balanced against the nature of the particular right of privacy.¹⁷

Applying this test to the facts in this case, assuming that the defendant was found in possession of marijuana in an automobile, I agree with the majority that a valid reason existed for the prohibition due to the proven effect of marijuana on driving, and the unavailability of practical tests for ascertaining whether one is under the influence of an hallucinogenic when balanced against the rather minor status of the right involved, to possess marijuana in public. Accordingly, I would affirm the order denying the motion to dismiss.

CONNOR, Justice (concurring).

I concur in the majority opinion and the separate concurring opinion of Justice BOOCHEVER, but wish to add some observations.

The decision today properly leaves unanswered the question of how far the right to privacy, in connection with the possession of marijuana, extends outside the home. Such a determination can be made only when we are presented with specific facts against which the individual's claim of privacy can be measured, as opposed to the state's assertion of power to control the possession of marijuana. Under the test we have employed in determining the scope of the right to privacy, it is necessary to balance these conflicting claims and determine whether the state's prohibition bears a direct and substantial relationship to effectuating a legitimate state interest.

The record in the case before us does not contain facts about the particular circumstances in which appellant possessed marijuana. Accordingly, we must remand

the case for further elucidation of the facts.

It is certain that the right to privacy does not vanish when one leaves the home.¹ There are certain aspects of personal autonomy which one carries with him even when he ventures out of the home, though the claim to privacy diminishes in proportion to the extent that one's person and one's activities impinge upon other persons. But, in order to trace the contours of the right to privacy, it will be necessary to engage in a critical analysis of the facts of each case which presents itself for decision. Only in this fashion can the right to privacy, outside the home, be determined on a reasoned, coherent basis so as to furnish the courts and the public with reliable rules of action. Much definitional work, therefore, remains to be done in the cases yet to be determined.



In the Matter of the ALASKA BAR ASSOCIATION, Petitioner,

v.

Robert F. MARTIN, Respondent.

No. 2495.

Supreme Court of Alaska.

July 14, 1975.

The Bar Association brought disciplinary proceeding and recommended a suspension. The Supreme Court held that the respondent's misconduct warrants suspension from practice for a period of 6 months.

Suspension ordered.

17. 48 N.Y.U.L.Rev. 670 at 705.

1. The right to privacy which received protection in *Roe v. Wade*, 410 U.S. 113, 93

S.Ct. 705, 35 L.Ed.2d 147 (1973), has nothing to do with the locus of the home and, for the most part, is concerned with matters occurring outside the home.

Article I - State Constitution

Imprisonment
for Debt

SECTION 17. There shall be no imprisonment for debt. This section does not prohibit civil arrest of absconding debtors.

Eminent
Domain

SECTION 18. Private property shall not be taken or damaged for public use without just compensation.

Right to
Bear Arms

SECTION 19. A well-regulated militia being necessary to the security of a free state, the right of the people to keep and bear arms shall not be infringed.

Quartering
Soldiers

SECTION 20. No member of the armed forces shall in time of peace be quartered in any house without the consent of the owner or occupant, or in time of war except as prescribed by law. The military shall be in strict subordination to the civil power.

Construction

SECTION 21. The enumeration of rights in this constitution shall not impair or deny others retained by the people.

* {
Right of
Privacy

SECTION 22. The right of the people to privacy is recognized and shall not be infringed. The legislature shall implement this section.

(The addition of this section, as an amendment to Article I, was approved by the voters of the state August 22, 1972 and became effective October 14, 1972.)

ARTICLE II

THE LEGISLATURE

Legislative
Power;
Membership

SECTION 1. The legislative power of the State is vested in a legislature consisting of a senate with a membership of twenty and a house of representatives with a membership of forty.

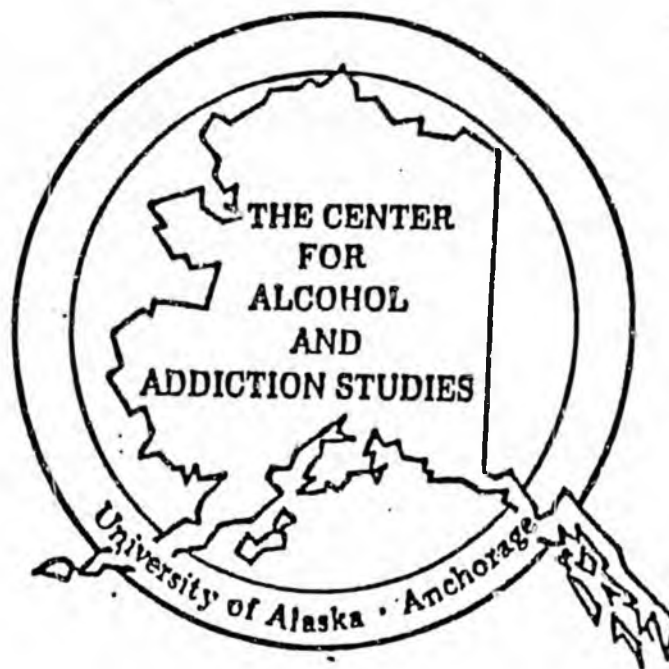
Members;
Qualifications

SECTION 2. A member of the legislature shall be a qualified voter who has been a resident of Alaska for at least three years and of the district

Confidential

Adolescent Drug-Taking Behavior Followup Study

Juneau: Grade 7 thru 12



**Bernard Segal, Ph.D.
The Center for Alcohol and Addiction Studies
University of Alaska Anchorage
October, 1987**

**Funded by a grant from the State Office of Alcoholism and Drugs Abuse,
Department of Health and Social Services**

This document became public on December 15, 1987.

Preface

Adolescent Drug-Taking Behavior Followup Study (Preliminary Findings)

During 1981 and 1982 an extensive statewide study, sponsored by the State Office of Alcoholism and Drug abuse (SOADA), was undertaken by the Center for Alcohol and Addiction Studies (CAAS) to estimate the prevalence of drug-taking behavior among Alaskan youth. A comprehensive report of the findings was released in 1983 (Segal et al., 1983). That research involved eight widely separated urban and rural school districts representative of the different regions of Alaska, except for the Aleutian chain. The locations were Anchorage, Juneau, Bethel, Fairbanks, Juneau, Kotzebue, Nome, and Sitka. These sites were selected in order to obtain a representative sample of the state's junior and senior high school students. This research also served to establish baseline information about drug-taking behavior among Alaskan youth so that comparisons could be made with subsequent studies.

The present research, also under the auspices of a grant from SOADA, is a follow-up study of the initial study undertaken during 1981-1982. The overall aims of the current study are: (1) to assess the nature and extent of current drug-taking behavior among Alaskan youth, (2) to compare the current findings with the initial study of drug-taking behavior, (3) to examine psychosocial characteristics associated with use and nonuse of chemical substances, and (4) to explore some of the implications that the findings have for prevention of substance abuse. Some of the specific objectives are:

- (1) To obtain demographic and socialization information about adolescents in grades 7 - 12 relative to use or nonuse of chemical substances.
- (2) To obtain information on the prevalence of specific chemical substances, including alcohol and tobacco.
- (3) To obtain data relating to the patterns of drug-taking behavior, including alcoholic beverages and tobacco products.
- (4) To obtain data relating to actual or perceived peer group use of specific drugs, including alcohol and tobacco.
- (5) To obtain information on the consequences of drug-taking behavior
- (6) To obtain information about which factors serve to contribute to or mitigate against drug-taking behavior.

Introduction

The apparent ongoing use of mind-altering substances in the United States, particularly by youth, has continued to challenge the efforts of educators, health professionals, law enforcement agencies, and governmental authorities, to deal with the problem. Despite significant efforts at prevention of drug abuse, it is patently clear that some youth will try drugs, and that a few will continue to use them to the point where they become substance abusers. From large surveys conducted in the United States, we have seen that there was an upward trend in the use of illicit drugs that began during the 1970s, which reached its peak in the 1980s. There is still considerable concern that while the use of many illicit psychoactive substances is beginning to decline, others such as cocaine are just beginning to stabilize, or even show modest increases in use.

This study provides an opportunity to review what is happening within Alaska with respect to the use of illicit psychoactive substances and about drinking and use of tobacco products among the state's adolescent population. It is envisioned that these findings will be useful to both the state and school districts in their efforts to address the continuing problem of drug use among adolescents.

It is important to note that the findings reported herein are based on self-report questionnaires. Although the research literature continues to indicate that such data are valid, a note of caution should be introduced. The findings can only reflect what the adolescent respondents say they think they have taken, and not what was actually used. It is well known that counterfeit and lookalike drugs exist, and that youngsters may have taken such substances thinking that they were the "real thing." In this instance what is important is that drug-taking behavior occurred, and that it was reported as having had occurred. Furthermore, it is always possible that some adolescents who may have tried a chemical substance may not have reported such use, or that some students may have either over- or under-reported their use. Each questionnaire was reviewed for consistency of responses to attempt to obtain reliable and valid data.

Confidentiality and Anonymity

The purpose of this research was to gain an understanding of drug-taking behavior among Alaskan Adolescents, and not to identify those who use or have tried a drug. Considerable effort was undertaken to obtain the most reliable and valid responses from the students choosing to participate in the study by ensuring their anonymity and confidentiality. The student's names were not asked for in any phase of the research, nor were any identifying measures used except to identify the community in which surveying was undertaken. The only

number of students in grades 7-12 is not known, it is not possible to report what percentage of the total population of students in grades 7-12 is represented in the sample. A description of the samples follows.

Characteristics of the Juneau Student Sample

<u>Gender</u>	<u>N</u>	<u>%</u>	<u>Ethnicity</u>	<u>N</u>	<u>%</u>	<u>Grade</u>	<u>N</u>	<u>%</u>
Males	199	47.6	Alaska Native	41	10.0	7	86	20.6
Females	218	52.2	White	317	75.8	8	88	21.1
Unreported	1	.2	Am. Indian	11	2.6	9	70	16.7
Total	146		Asian-Pacific	21	5.0	10	66	15.8
	418?		Black	10	2.4	11	78	18.7
			Hispanic	6	1.4	12	29	6.9
			Other	6	1.4	NR*	1	.2
			Not reported	6	1.4			

*Not reported

Participation by School, Gender*, and Grade*

	<u>Grade</u>	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>	<u>11</u>	<u>12</u>	<u>Total</u>
<u>School</u>								
Drake								
Males		21	22					43
Females		22	27					49
Dryden								
Males		20	17					37
Females		23	21					44
J. Alternative								
Males			1	19	1			21
Females				15	0			15
Juneau-Douglas H.S.								
Males				11	37	37	13	98
Females				25	28	41	16	110
Total:		86	88	70	66	78	29	417
Males								199
Females								218

*One student did not report gender, and one did not indicate grade.

The extent to which this sample is representative of the school district's student population cannot be estimated because the actual class sizes and

Table 1
Opportunity to Try and Trying Drugs:
Comparison of 1982 and 1987 Findings
Juneau Schools
Grades 7-12

<u>Drug</u>	<u>1987</u>	<u>1982</u>
	(n=418)	(n=298)
	Percent of Sample	Percent of Sample
	<u>Having a Chance to Try</u>	<u>Having a chance to Try</u>
Marijuana	69.4	68.7
Hallucinogens	25.1	26.5
Cocaine	30.1	34.6
Heroin	8.6	9.1
Inhalants	47.4	28.5
Stimulants	46.2	44.6
Depressants	22.7	18.1
Tranquilizers	24.2	13.4
Crack	1.4	--

10

Figure 2A
Juneau Schools
Lifetime Experience with One or More Chemical Substances
Grades 7-12

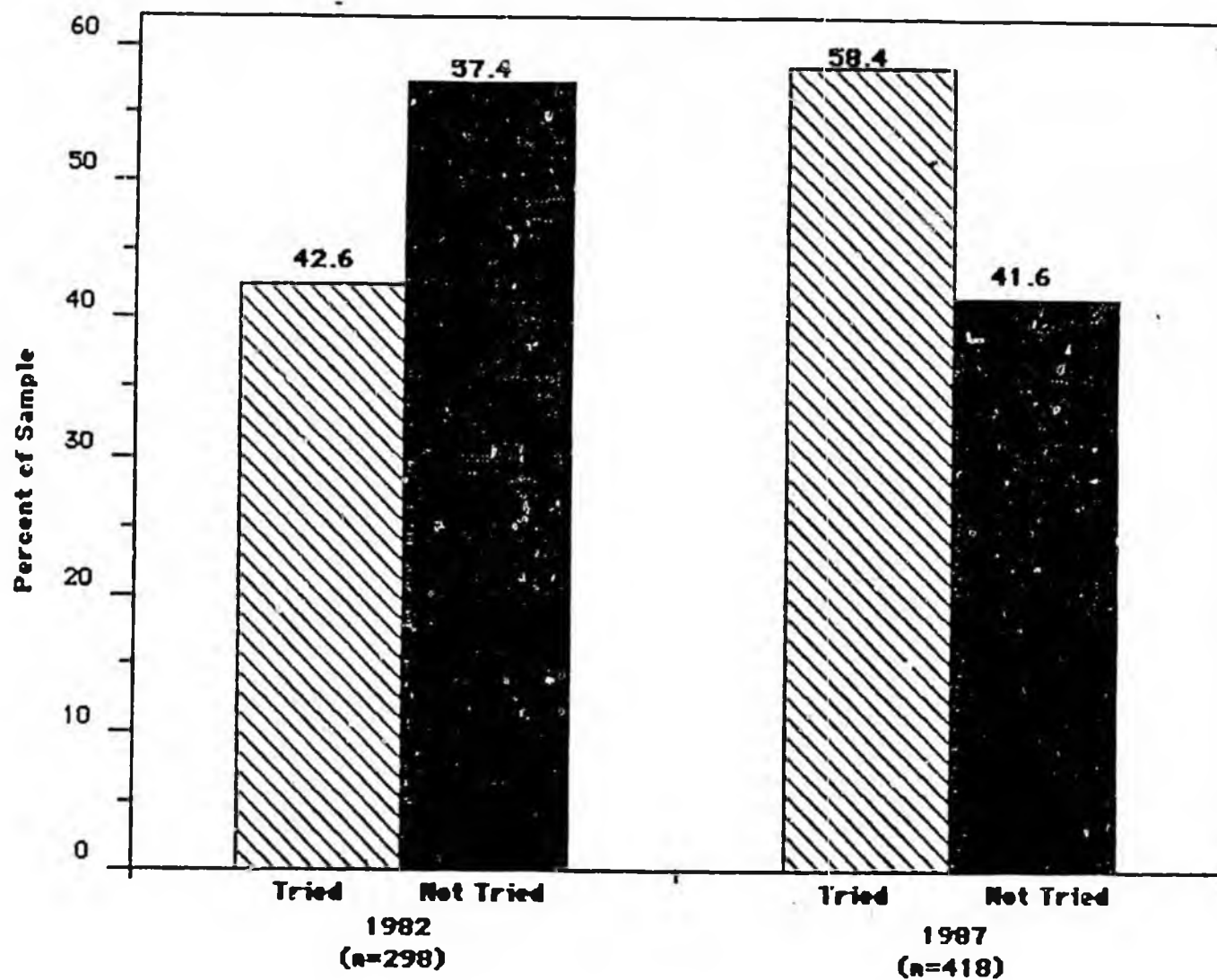


Table 2
Lifetime Experience with One or More
Chemical Substances
1982 and 1987
Juneau Schools
Grades 7-12

<u>Drug</u>	<u>Lower*</u> <u>Limit</u>	<u>1987</u> <u>(n=418)</u>	<u>Upper*</u> <u>Limit</u>	<u>1982</u> <u>(n=298)</u>	<u>Change</u>
Marijuana	48.5	53.3	58.1	51.7	+ 1.6%
Hallucinogens	10.6	13.9	17.2	8.1	+ 5.8%
Cocaine	9.5	12.7	15.9	18.8	- 6.1%
Heroin	0.8	2.2	3.6	2.7	- .5%
Inhalants	18.2	22.2	26.2	20.8	+ 1.4%
Stimulants	25.0	29.4	33.8	32.2	- 2.8%
Depressants	8.2	11.2	14.2	12.8	- 1.6%
Tranquilizers	9.5	12.7	15.9	9.4	- 3.3%
Crack	0.3	1.4	2.5	--	--

*95% Confidence Interval. These figures represent the lower and upper confidence intervals within which the true population value lies (95 out of 100 times).

Figure 3
Number of Drugs tried by Gender
Juneau Schools
Grades 7-12
1987

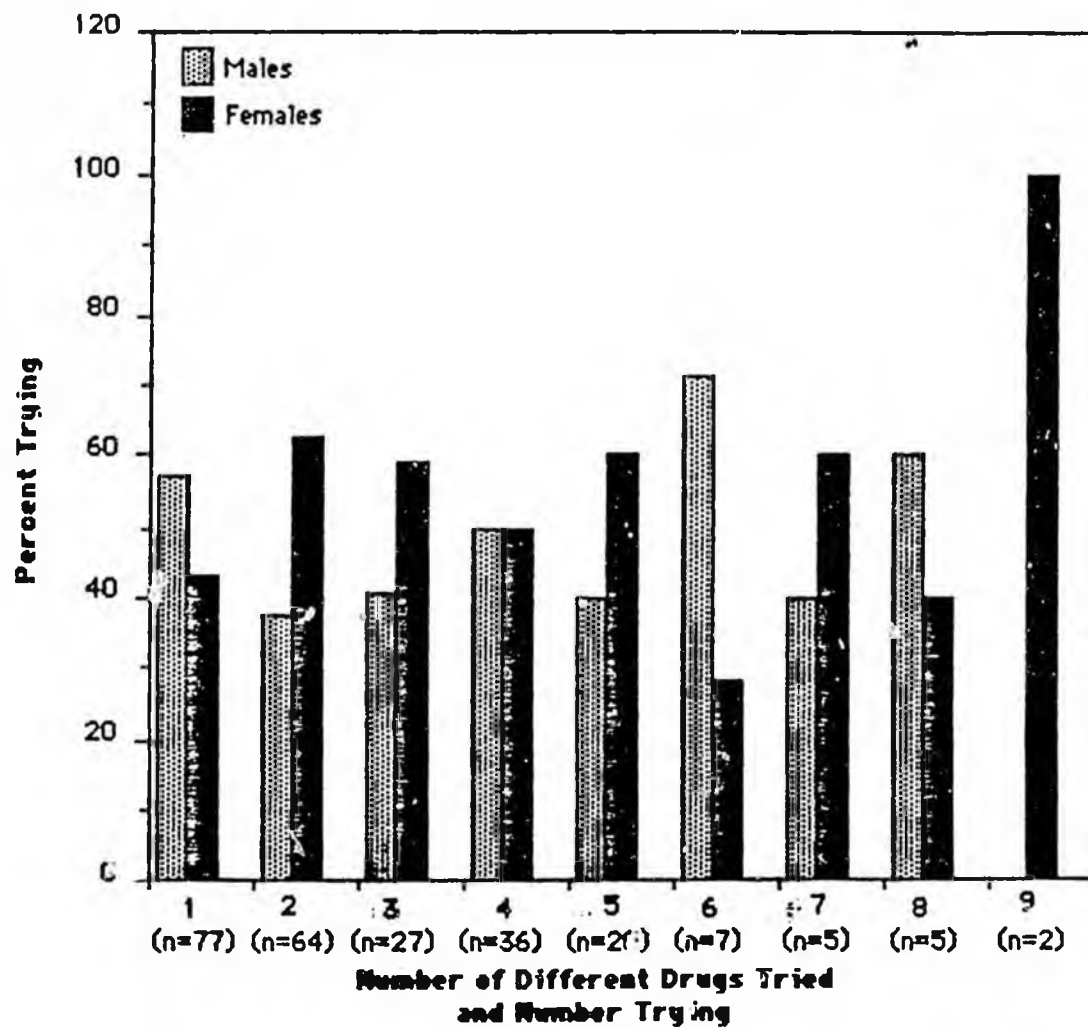


Figure 4B
Experience with Drugs by Gender and Grade
Juneau Schools
Grades 7-12
1987

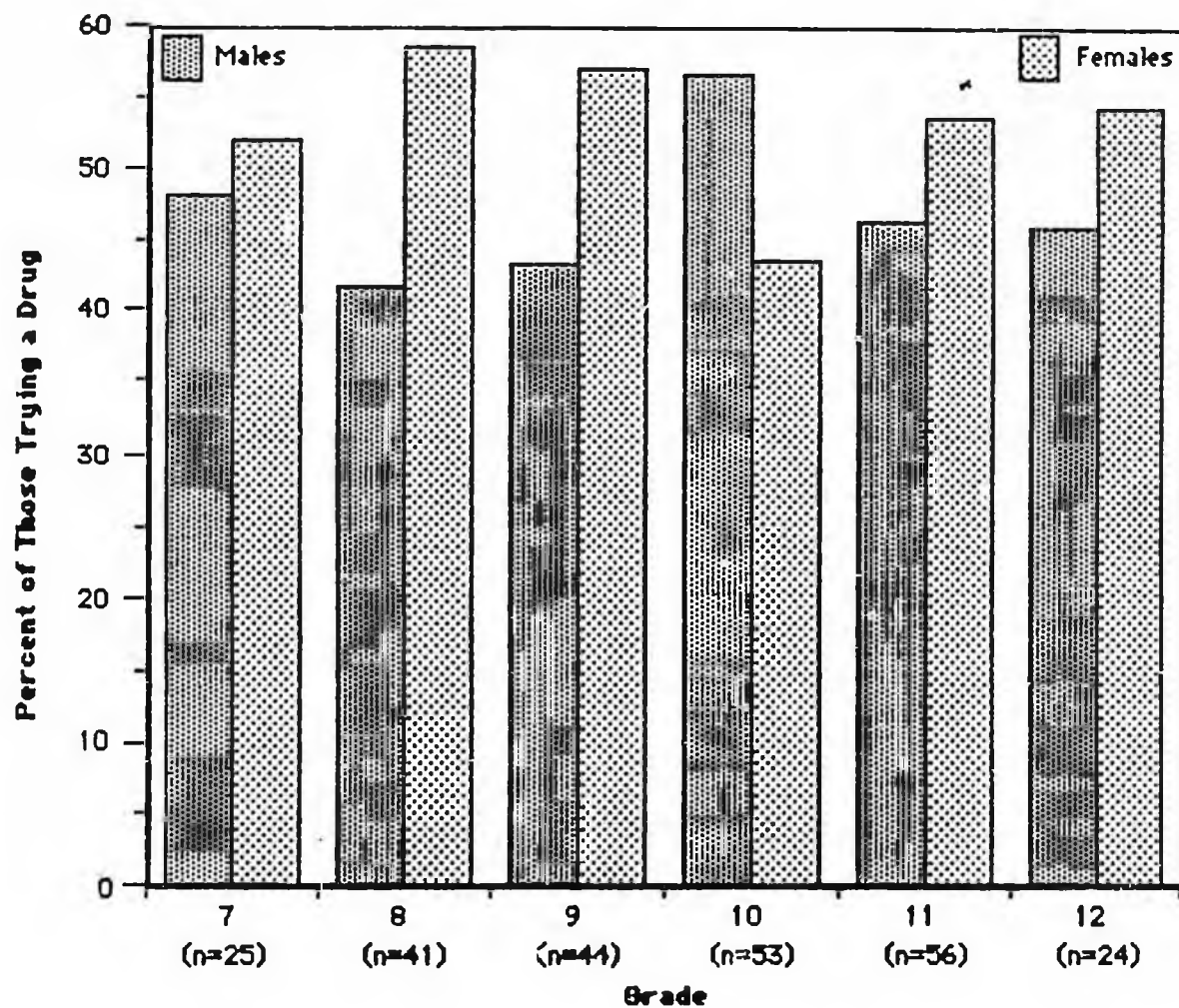
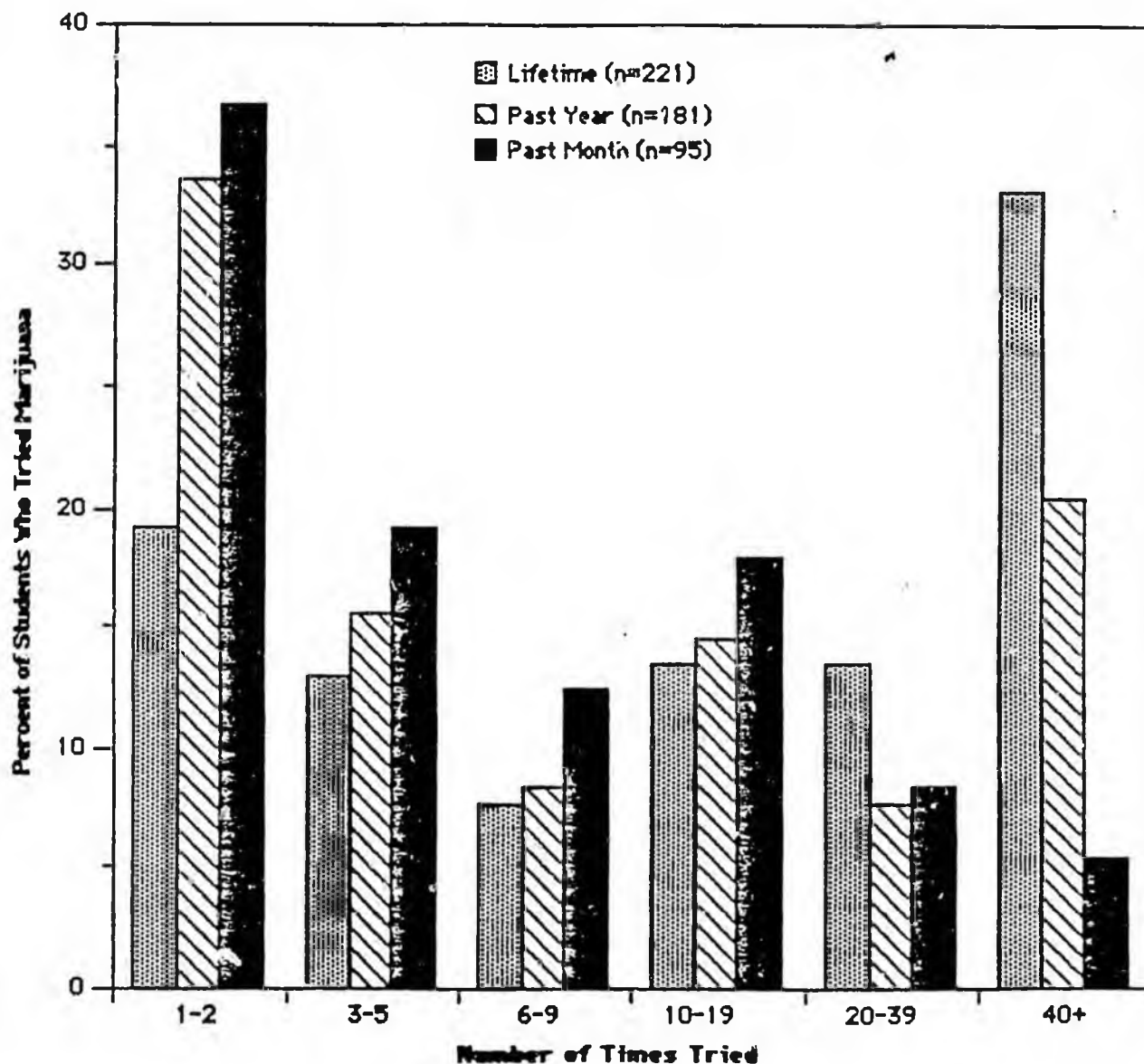


Figure 5A
Frequency and Recency of Marijuana Use
Juneau Schools
Grades 7-12
1987



Source: Adolescent Drug-Taking Behavior Followup Study/The Center for Alcohol and Addiction Studies/Bernard Segal, Ph.D., University of Alaska Anchorage, October, 1987. Same study done for the cities of Anchorage, Bethel, Fairbanks, Kotzebue, Nome, and Sitka.

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number of students (6.7%) have indicated that they used cocaine 6-9 times during the past month. More frequent use of cocaine has occurred among a small number of students one or more years ago.

3. Stimulants

Figure 5C reports on the pattern of stimulant use. As can be observed, among those who indicated having tried stimulants a large percentage of have done so experimentally (less than five times) during the past month and year. More recent and frequent is also reported by a small number of students, some of which occurred during the past month.

4. Hallucinogens

An active pattern of hallucinogen use is evident among the number of students who reported having tried a hallucinogenic substance. The results, shown in Figure 5D, indicate that the predominant level of use has been one or two times, but 75% of those who have tried it did so during the past month. More recent and frequent use is also reported, with 6.3 percent having used such substances 10-19 times during the past month. More extensive use has also occurred, but this has taken place a year or more ago.

5. Depressants

The predominate mode of experience with depressant substances, as shown in Table 5E, appears to be primarily experimental (1-2 or 3-5 times), but some students have used depressants more extensively.

6. Inhalants

Inhalant use, as revealed in Table 5F, shows a varying pattern of use, ranging from infrequent (1-2 times) during the past month to more frequent (40+ times) during the past month. The overall pattern suggests that an active involvement with inhalant substances is occurring.

7. Tranquilizers

Figure 5G shows that use of tranquilizer type drugs has been chiefly experimental, but that students have used it within the past month, and that a small number have also used such substances extensively.

In summarizing the findings pertaining to recency and frequency of drug-taking behavior, it appears that there is a mixed pattern of ongoing experimental and more sustained use of most substances. The substances used most recently and with greater frequency are marijuana, cocaine, stimulants, hallucinogens, and inhalants.

Age of First Experience With Marijuana, Stimulants, and Inhalants

Figure 6 shows the ages with which respondents indicated having first tried

Figure 5D
Frequency and Recency of Hallucinogen Use
Juneau Schools
Grades 7-12
1987

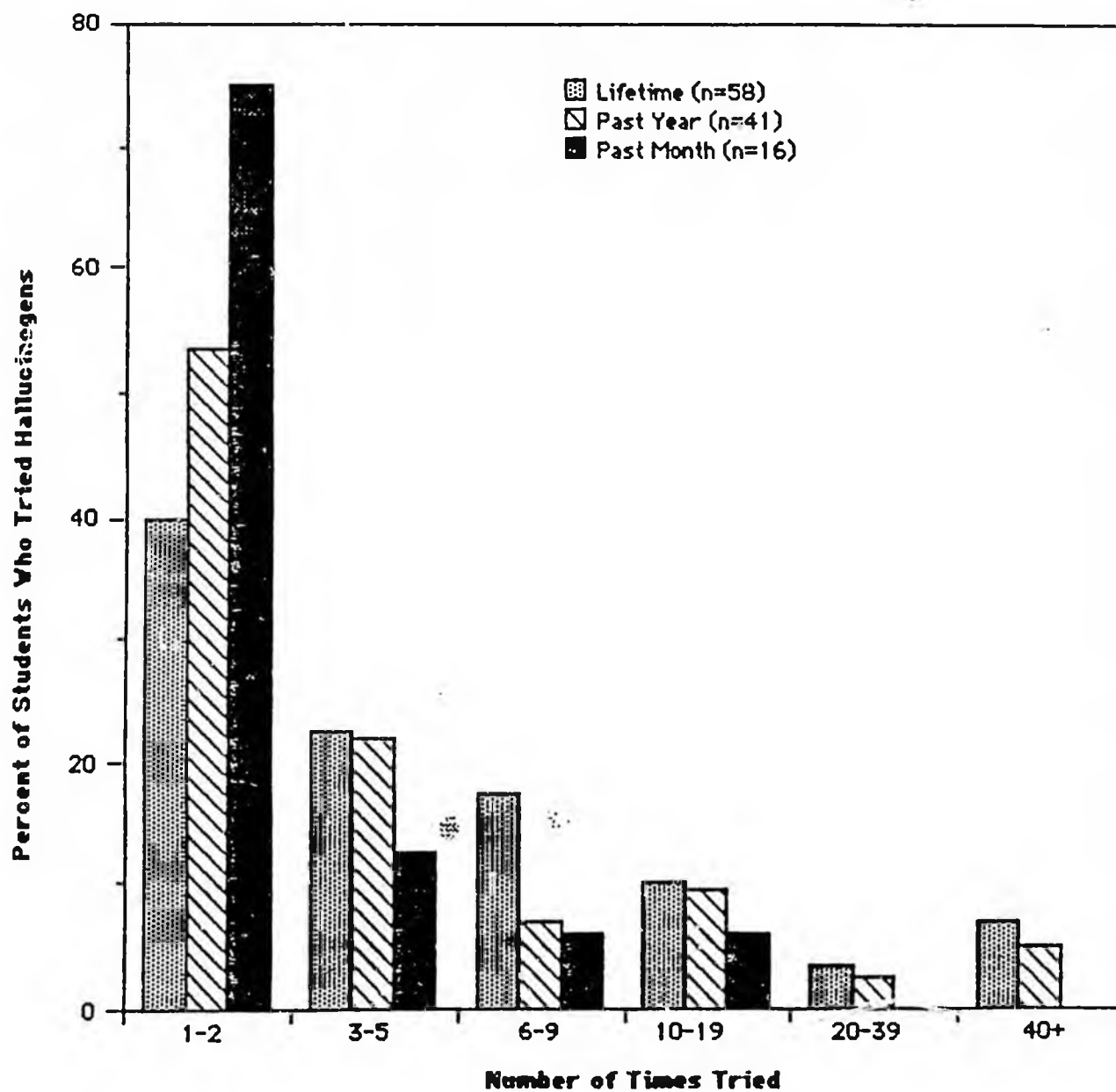
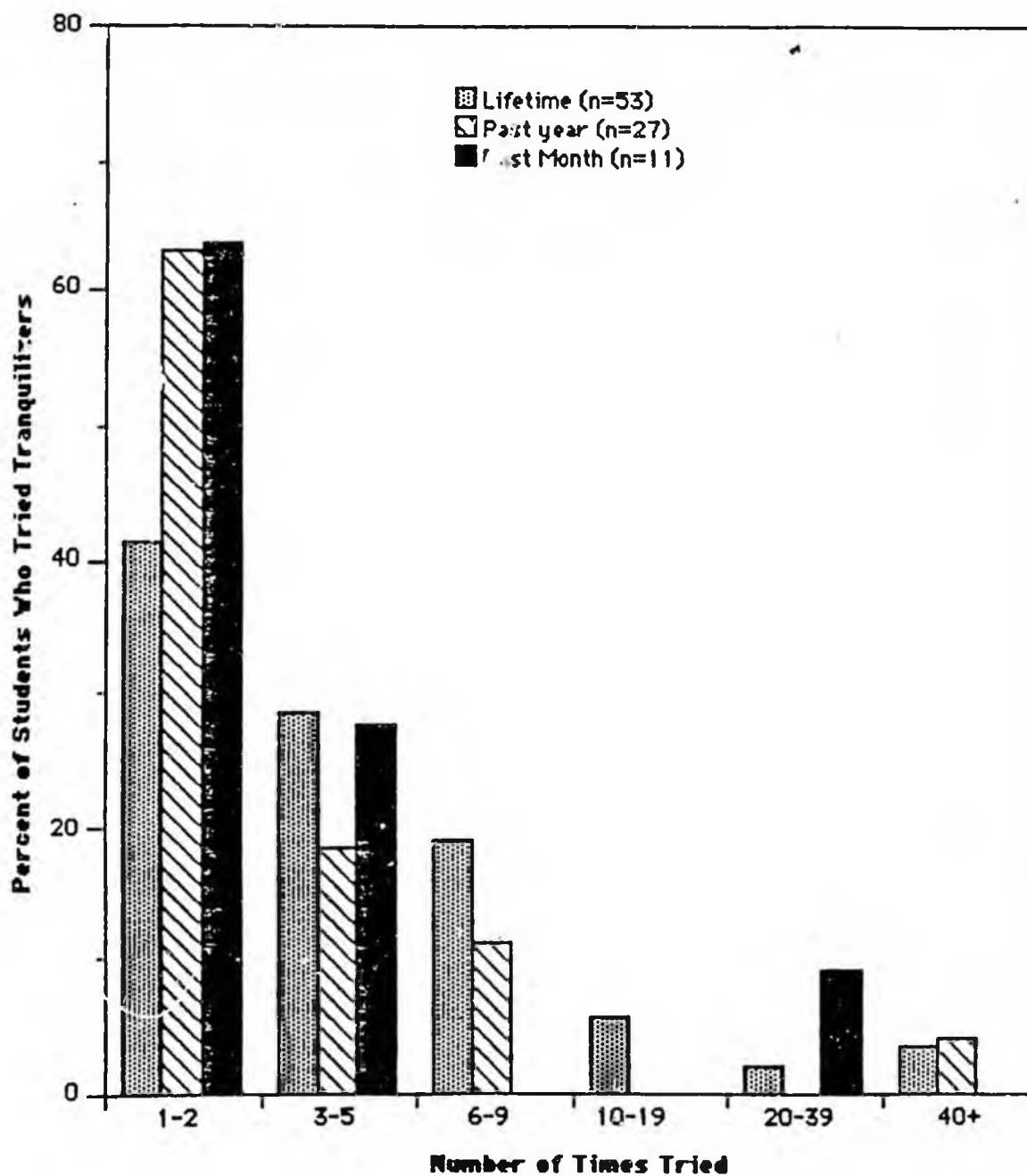


Figure 5G
Frequency and Recency of Tranquilizers Use
Juneau Schools
Grades 7-12
1987



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marijuana, stimulants, and inhalants, the three drugs tried most frequently by the sample. At nine years or less a small number of students have been initiated into substance use, with the highest number trying an inhalant type substance. Subsequent to nine years there is a decrease in initiation until age 12, where the first major peak occurs for all three substances. This high initiation level then drops sharply for inhalants, increases slightly for marijuana, and remains stable for stimulants at age 13. Subsequent to this point initiation into marijuana declines sharply. By age 14 initiation into stimulants peaks again at age 14, then drops sharply. Initiation into inhalants also increases, and then declines.

What the configuration of these three curves suggests is that inhalants tended to be used more than marijuana and stimulants at an early age, but that as age increases, interest shifts to experiencing marijuana and stimulants. Twelve years appears to correspond to a "critical period" of initiation into trying marijuana, inhalants, and stimulants. Subsequent to age 12 initiation to these substances declines, except for stimulants, which seems to attract the attention of 14 year olds. The data also suggests that if these substances were not tried by or before age 17, initiation into their use declines.

Part II. Alcohol

Lifetime Prevalence of Experience With Alcohol

Figure 7 shows the number of students who reported ever having tried alcohol in 1987 and 1982. (The lower confidence limit for the statistic pertaining to the number of students who drank is 64.7; the upper limit is 73.5.) As can be observed, the prevalence of lifetime experience with alcohol has decreased very slightly (1.4%) since 1982. The difference, however, is sufficiently small to conclude that the number of students who tried alcohol in 1982 and in 1987 remains at a consistent level.

Frequency of Drinking During the Past 30 Days

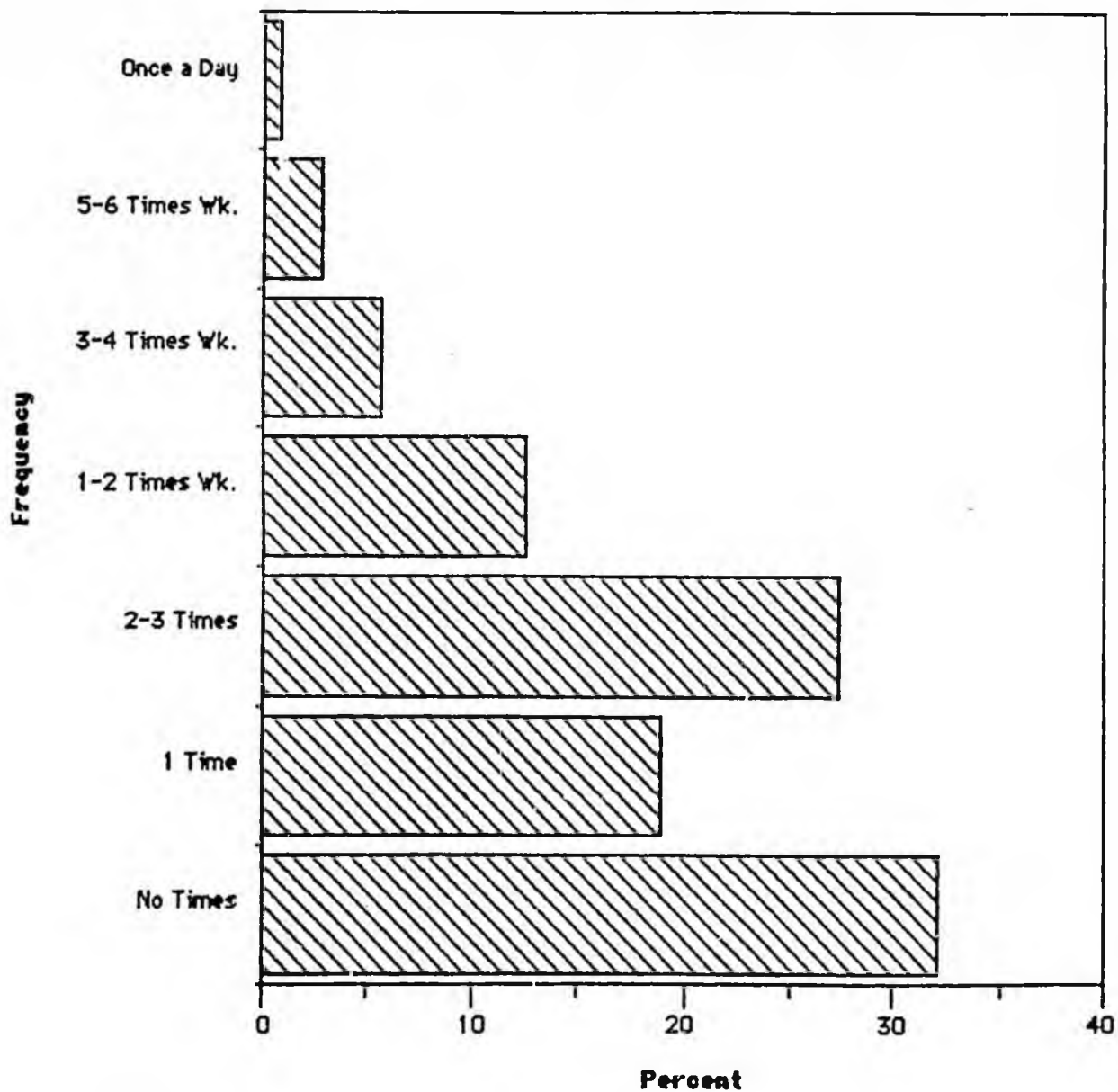
Figure 8 reports the frequency of alcohol consumption among students who indicated having consumed alcohol during the past 30 days. Of those, over 30% indicated that they did not drink during the past 30 days. Among those who did report that they consumed alcohol, the largest number reported drinking 2-3 times a week. What seems evident from the data is that alcohol is being consumed, and its use ranges from infrequent for a majority of respondents, to more frequently (more than 3-4 times a week) for a smaller number of students.

Drinking by Gender

Figure 9 reports on use of alcohol by gender, comparing lifetime and past year experience with alcohol. Interestingly, more females than males showed

27

Figure 8
Frequency of Drinking Past 30 Days
Juneau Schools Grades 7-12
1987
(n=289)



both higher rates of lifetime prevalence and use during the past year

Consequences of Drinking

Figure 10 shows how many respondents reported the frequency with which their drinking resulted in either feeling high, getting drunk or very high, or in having gotten sick during the past year. Inspection of the findings indicate that most of the students who drank did so to get high, but many of those who did drink experienced drunkenness or became sick one or more times. There are some students, however, who report more frequent incidents of adverse consequences associated with their drinking, and if these self-reports are accurate, these occurrences meet established criteria representative of "problem drinking" among adolescents (Rachel et al., 1980).

Part III. Tobacco

Smoking and Chewing/Smokeless Tobacco

Figure 11 provides a description of the prevalence rates for lifetime use of tobacco (ever tried), and a comparison of the present findings with those obtained in 1982. Data for comparing the prevalence rates from the 1982 sample for chewing/smokeless tobacco were unavailable. As can be noted, the prevalence of cigarette smoking has increased (by 24.7 percent) since 1982. Over a third of those sampled have also indicated having used smokeless or chewing tobacco.

Part IV. Students' Perception of Increase or Decrease in Drug Use

Figure 12 presents the summarized results of questions that asked students to report whether they thought use of any of the substances had increased or decreased in their school during the past year. The students' perception of the level of use, for the most part, appears to be consistent with the pattern of drug use observed with respect to the reports of recency and frequency of substance use. Marijuana, cocaine, hallucinogens, and stimulants, which showed a recent and frequent pattern of use, are all perceived by the students as having increased in use during the past year. Surprisingly inhalants, which showed a recent and frequent pattern of use, was perceived as having decreased in use by the students. The students also report that alcohol and tobacco use have increased during the past year, and this perception is almost universal.

Part V. Comparison with Other Alaska Communities

Figure 13 provides a comparison of the findings for reports of lifetime experience with chemical substances from Juneau with two other Alaskan communities surveyed in the spring of 1987. As can be observed Juneau, except for lifetime experiences with stimulants, either shows the lowest, or second lowest, prevalence rate among the three communities.

Figure 10
Consequences of Drinking During
the Past Year
Juneau Schools
Grades 7-12
1987

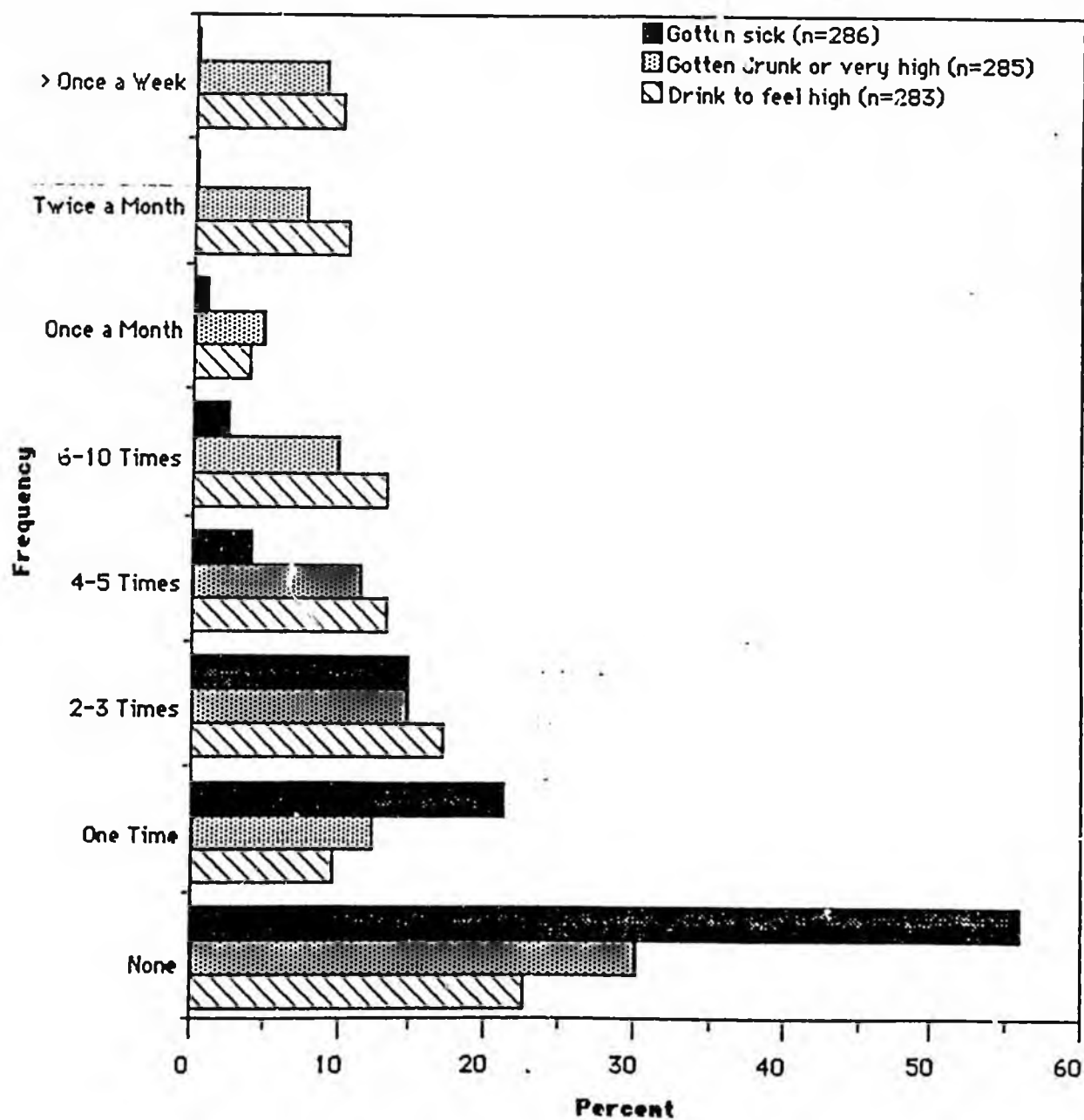


Figure 11
Use of Tobacco Products
Lifetime Experience
Juneau Schools

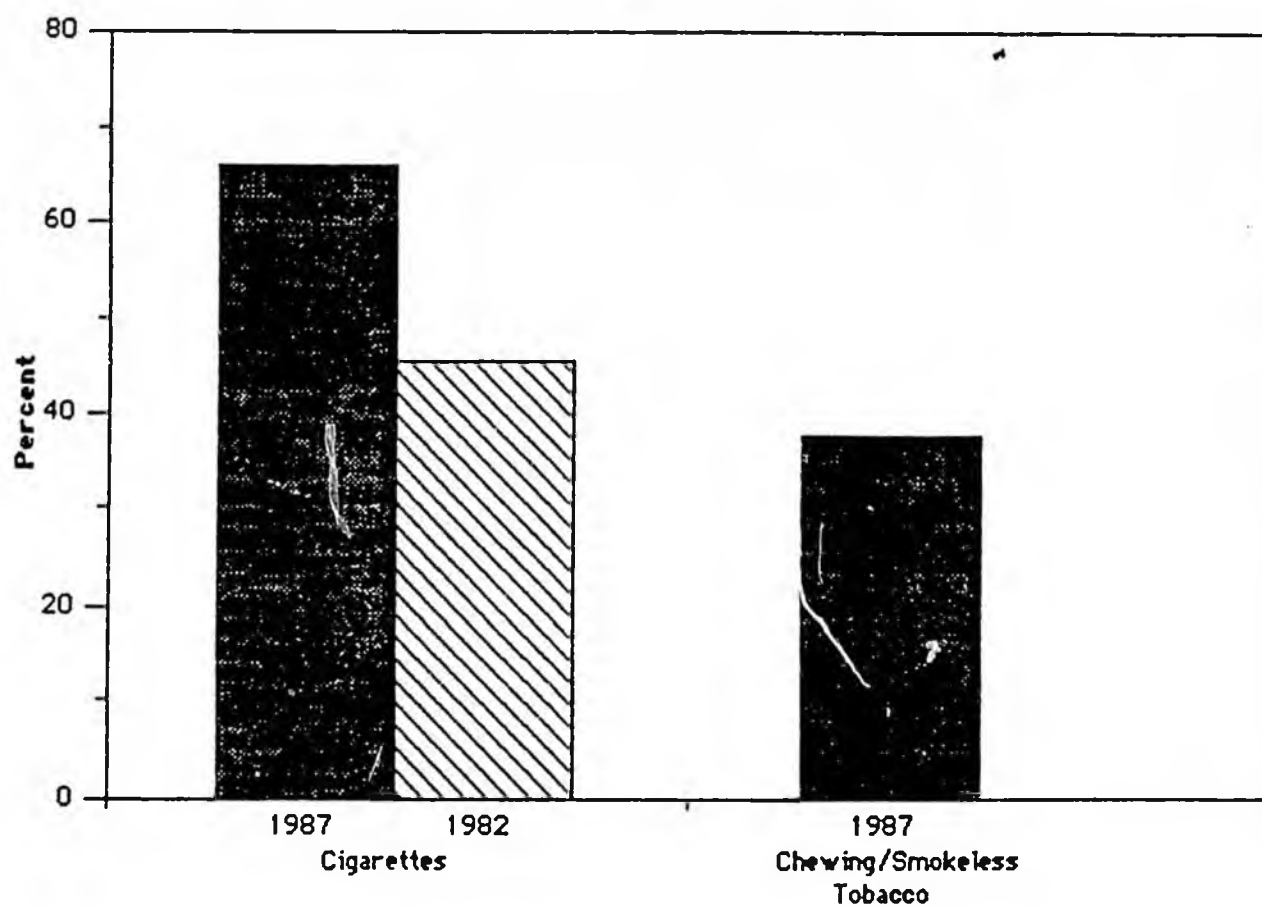
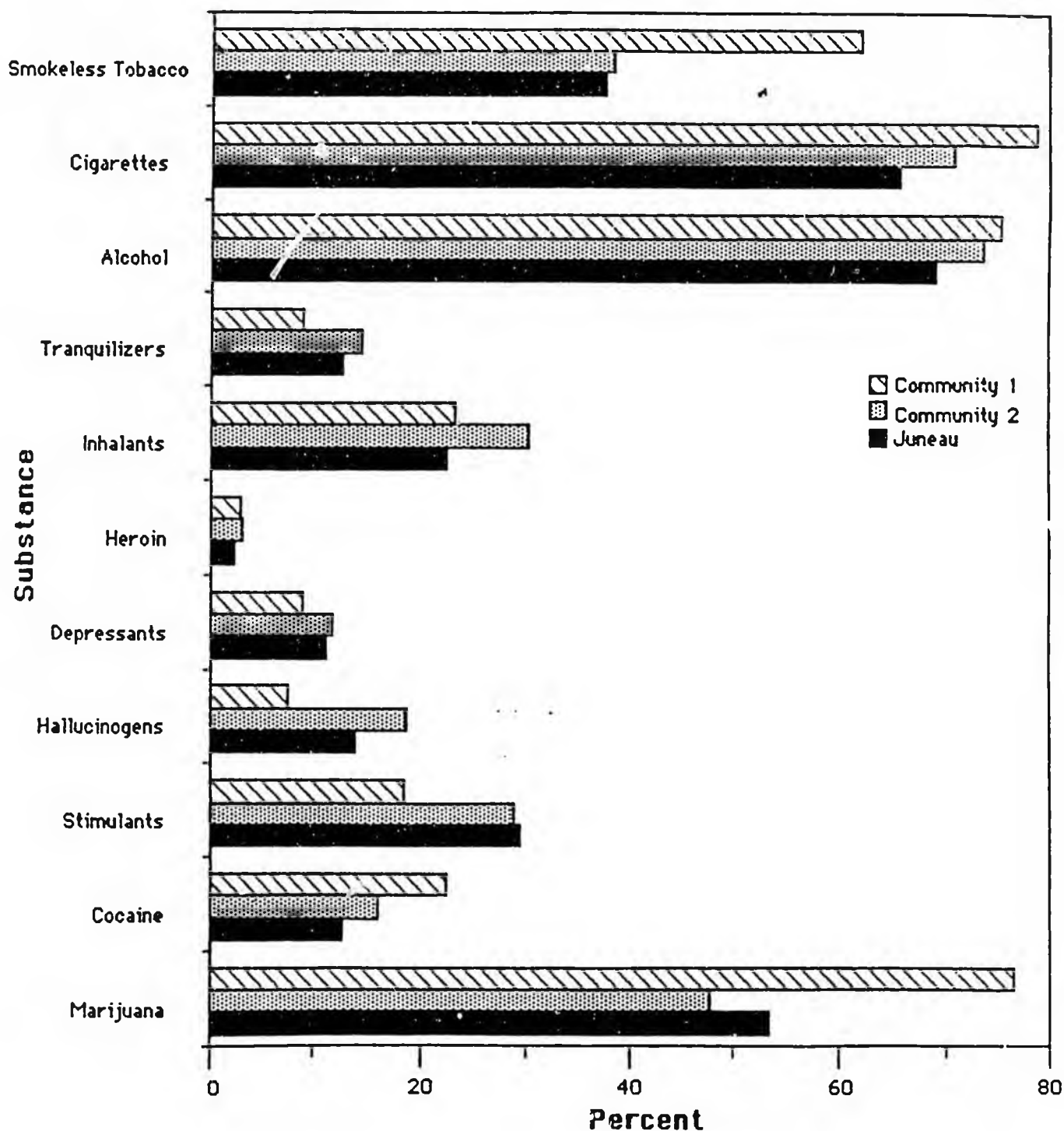


Figure 13
Lifetime Prevalence
Comparison of Experiences with Chemical
Substances Among Three Alaska Communities
1987



Discussion and Implications

In summarizing the findings, it is apparent that drug-taking behavior is prevalent in varying degrees among the students responding to the questionnaire, and that changes in the pattern of drug use has taken place since the previous survey was undertaken in 1982. Increases have occurred in the use of some substances, some have appeared to stabilize, while others have decreased. Although marijuana continues to show the highest overall prevalence, experience with hallucinogens and inhalants have increased slightly, while cocaine has decreased. While the findings do suggest that the drug-taking behavior reported by the students can largely be described as experimental or infrequent use, a pattern of more frequent use is also evident. Of special interest in this pattern of use is that more females than males are involved in drug-taking behavior. Additionally, the present findings indicate a downward trend in age of initiation into drug use. Previous research (Segal, 1986) suggested that age 13 was the peak year for initiation into drugs, but the present findings indicate that age 12 now appears to be the critical year for initiation into drug use.

The prevalence of alcohol use was also high, and encompassed a wide range of different types of consumption, one of which is consistent with criteria indicating problem drinking among a small number of students. The extent of smoking is also high, having increased by 25 Percent since 1982.

The findings suggest that efforts are needed to reduce or minimize teenage involvement with chemical substances, tobacco products, drinking, and its associated negative consequences. Both direct and indirect strategies can be utilized to modify the situation. Direct strategies encompass drug education or prevention programs within the school setting that deal directly with the problem. Indirect strategies focus on modifying conditions believed to influence adolescents' behavior with respect to use of drugs. An example of an indirect strategy is a program to help students develop decision making skills useful in dealing with high risk situations. Such a program, however, needs to correspond to the point at which students are at a high risk for initiation into drugs, alcohol, or tobacco products. Based on the results of this study, a critical point would be at the grade level corresponding to age 11, one year before the first peak initiation period occurs.

In approaching the problem of preventing/minimizing the use of mood-altering substances, smoking or use of chewing/smokeless tobacco, and use of alcohol, it is important to take note that illicit drug use, smoking, and drinking, have become incorporated into the American lifestyle. Adolescents are thus, to a large extent, reflecting the value system of the larger society, and their behavior with respect to alcohol, drugs, and tobacco, can be

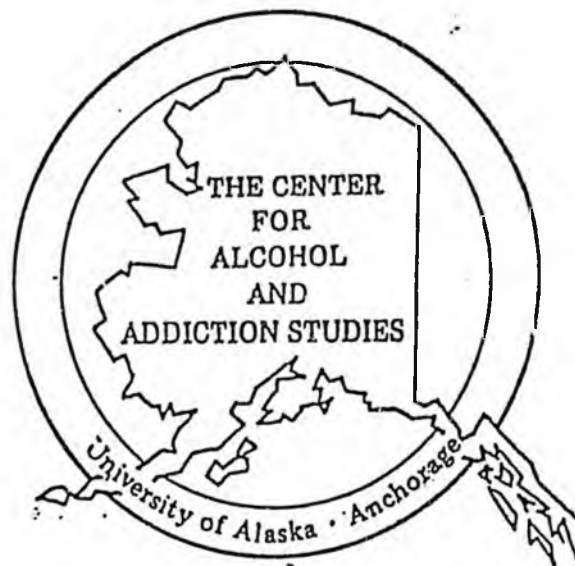
considered, to some extent, to be "normative" behavior. Many adolescents thus become involved with drugs in order to know what drug experience are like. Segal (1985-86) has shown that a major reason given by adolescents who try drugs is to experience the sensation that drugs provide. This does not diminish the need, however, to eliminate or reduce drug use among youth, particularly when other adolescents have reported that they used drugs to reduce stress (Segal, 1985-86), a motive that suggests that some adolescent drug users may be in need of help.

An effective way to combat the problem of drug use is a combination of both direct and indirect programs, in which the school and community cooperate on establishing an education/prevention program that is designed to meet common goals and objectives. A broadbased, community-wide approach, involving all elements of the community (parents, children, educators, police, governmental officials, counselors, etc.) is required to alleviate the problem of teenage smoking, drinking, and drug-taking behavior.

CONFIDENTIAL

Adolescent Drug-Taking Behavior Follow-Up Study
Preliminary Report

FAIRBANKS NORTH STAR BOROUGH SCHOOL DISTRICT



Bernard Segal, Ph.D.
The Center for Alcohol and Addiction Studies
The University of Alaska Anchorage
January, 1988

Released 3/2/93

Funded in part by a grant from from the State Office of Alcoholism and
Drug Abuse, Department of health and Social Services

Preface

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The present research, also under the auspices of a grant from SOADA, is a follow-up study of the initial project undertaken during 1981-1982. The overall aims of the current study are: (1) to assess the nature and extent of current drug-taking behavior among Alaskan youth, (2) to compare the current findings with the initial study of drug-taking behavior, (3) to examine psychosocial characteristics associated with use and nonuse of chemical substances; and (4) to explore some of the implications that the findings have for prevention of substance abuse. Some of the specific objectives are:

- (1) To obtain demographic and socialization information about adolescents in grades 7 - 12 relative to use or nonuse of chemical substances.
- (2) To obtain information on the prevalence of specific chemical substances, including alcohol and tobacco.
- (3) To obtain data relating to the patterns of drug-taking behavior, including alcoholic beverages and tobacco products.
- (4) To obtain data relating to actual or perceived peer group use of specific drugs, including alcohol and tobacco.
- (5) To obtain information on the consequences of drug-taking behavior.
- (6) To obtain information about which factors serve to contribute to or mitigate against drug-taking behavior.

The preliminary results of the study pertaining to Fairbanks are presented as a confidential report to the Fairbanks Borough School District. The findings will not be made public in any manner by CAAS, and will not be presented in any way that will allow Fairbanks to be identified in published documents. If the school district chooses to make the findings public, only then will the information be in the public domain.

This document presents a summary of the major findings, specifically focussing on substance use, alcohol, and tobacco. Comparisons may be made with previous findings and with findings from other Alaska communities. A complete report of the findings will be released by SOADA upon study's completion. Additional findings pertaining to Fairbanks will be forwarded after further analysis of the data is completed.

I would like to express my appreciation to the Fairbanks Borough Schools for enabling me to include Fairbanks in this follow-up study.

Bernard Segal, Ph.D.
Principal Researcher and,
Director, Center for Alcohol and Addiction Studies

Introduction

The apparent ongoing use of mind-altering substances in the United States, particularly by youth, has continued to challenge the efforts of educators, health professionals, law enforcement agencies, and government authorities, to deal with the problem. Despite significant efforts at prevention of drug abuse, it is patently clear that some youth will try drugs, and a few will continue to use them to the point where they become substance abusers. From large surveys conducted in the United States, we have seen that there was an upward trend in the use of illicit drugs that began during the 1960s, which reached its peak in the 1980s. There is still considerable concern that while the use of many illicit psychoactive substances is beginning to decline, others such as cocaine are just beginning to stabilize, or even show modest increases in use.

This study provides an opportunity to review what is happening within Alaska with respect to the use of illicit psychoactive substances, including drinking and use of tobacco products among the state's adolescent population. It is envisioned that these findings will be useful to both the state and school districts in their efforts to address the continuing problem of drug use among adolescents.

Discussion and Implications

In summarizing the findings, it is apparent that drug-taking behavior is prevalent in varying degrees among the students responding to the questionnaire, and that some changes in the pattern of drug use has taken place since the previous survey was undertaken in 1982 (and reported in 1983). Increases have occurred in the use of some substances, some have appeared to stabilize, while others have decreased. Although marijuana continues to show the highest overall prevalence, experience with hallucinogens, stimulants, inhalants, and tranquilizers have increased. While the findings do suggest that the drug-taking behavior reported by the students can largely be described as experimental or infrequent use, a pattern of more frequent use is also evident. Additionally, the present findings indicate a downward trend in age of initiation into drug use. Previous research (Segal, 1986) suggested that age 13 was the peak year for initiation into drugs, but the present finding indicate that age 12 now appears to be the critical year for initiation into drug use.

The prevalence of alcohol use was also high, and encompassed a wide range of different types of consumption, one of which is consistent with criteria indicating problem drinking among a small number of students. The extent of smoking and use of chewing and smokeless have also increased since 1982.

The findings suggest that efforts are needed to reduce or minimize teenage involvement with chemical substances, tobacco products, and with drinking and its associated negative consequences. Both direct and indirect strategies can be utilized to modify the situation. Direct strategies encompass drug education or prevention programs within the school setting that deal directly with the problem. Indirect strategies focus on modifying conditions believed to influence adolescents' behavior with respect to use of drugs. An example of an indirect strategy is a program to help students develop decision making skills useful in dealing with high risk situations. Such a program, however, needs to correspond to the point at which students are at a high risk for initiation into drugs, alcohol, or tobacco products. Based on the results of this study, a critical point would be at the grade level corresponding to age 12, one year before the first peak initiation period occurs.

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Table 3
Lifetime Experience with One or More
Chemical Substances
1983 and 1987
Fairbanks North Star Borough School District
Grades 7-12

<u>Drug</u>	<u>Lower*</u>	<u>1987</u>	<u>Upper*</u>	<u>1982</u>	<u>Change</u>
	<u>Limit</u>	<u>(n=836)</u>	<u>Limit</u>	<u>(n=421)</u>	
Marijuana	44.4	47.8	51.2	40.1	+ 7.7%
Cocaine	13.4	15.9	18.4	15.9	- 0.0%
Stimulants	25.7	28.8	31.9	27.8	- 1.0%
Hallucinogens	16.2	18.9	21.6	9.5	+ 9.4%
Depressants	9.4	11.6	13.8	14.7	-3.1%
Heroin	2.0	3.2	4.4	2.1	+1.1%
Inhalants	27.4	30.5	33.6	21.4	+ 9.1%
Tranquilizers	12.1	14.5	16.9	11.6	+ 2.9%
Crack	3.3	4.7	6.1	--	--

*95% Confidence Interval. These figures represent the lower and upper confidence intervals within which the true population value lies (95 out of 100 times).

Figure 1
Lifetime Experience with One or More Chemical Substances
Fairbanks North Star Borough School District
Grades 7-12

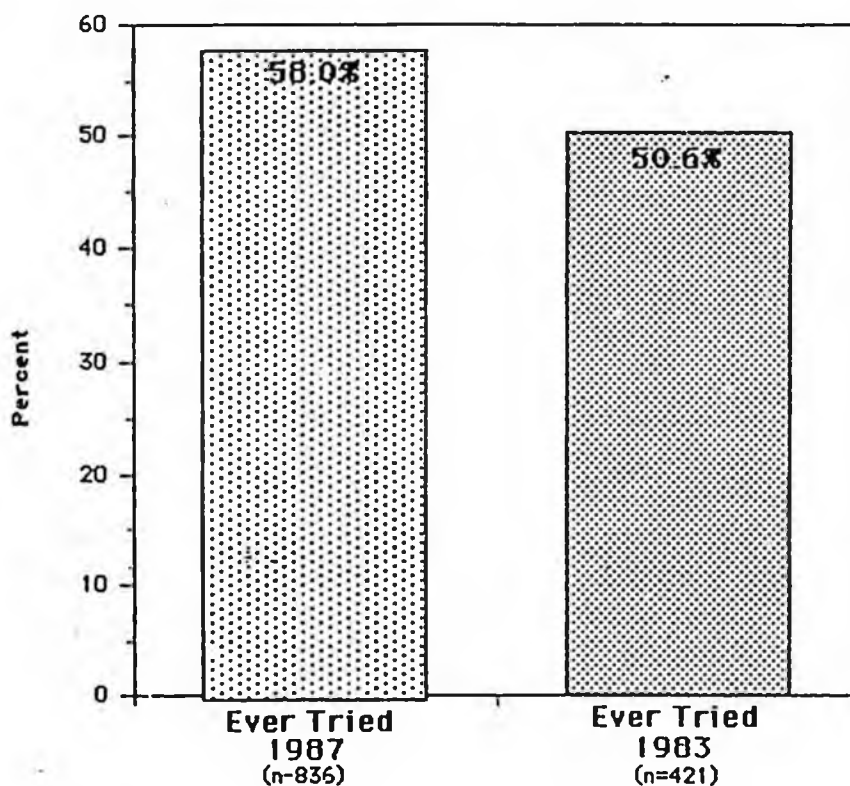


Figure 2
Experience with Drugs by Grade Level
Fairbanks North Star Borough School District

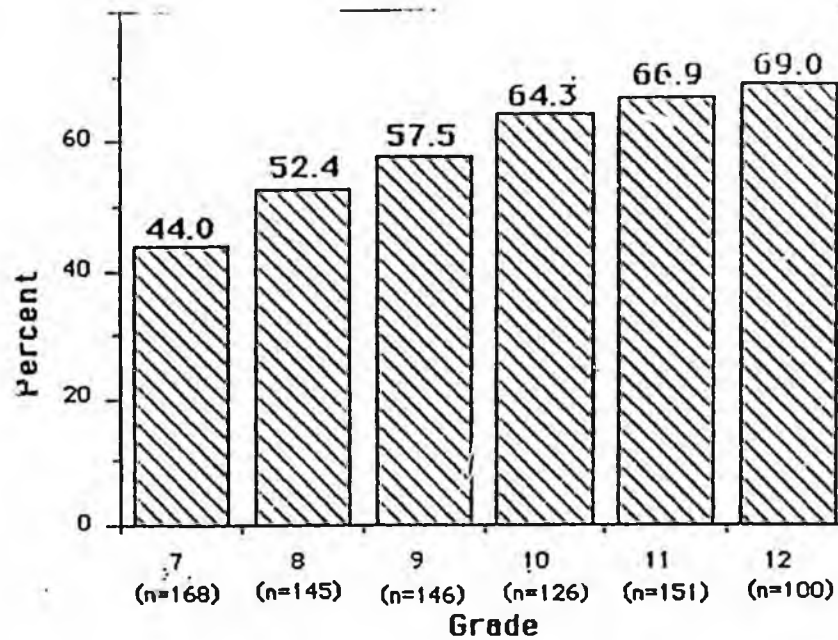


Figure 3A
Frequency and Recency of Marijuana Use
Fairbanks North Star Borough School District
Grades 7-12

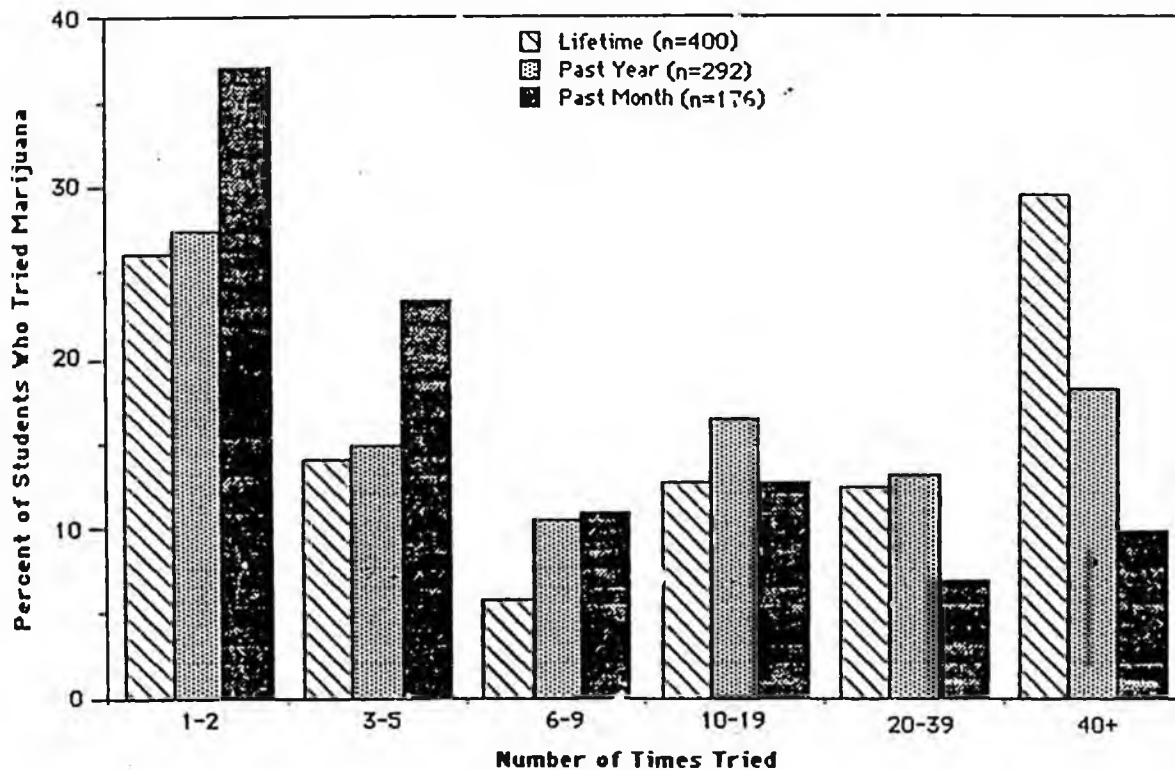


Figure 3B
Frequency and Recency of Cocaine Use
Fairbanks North Star Borough School District
Grades 7-12

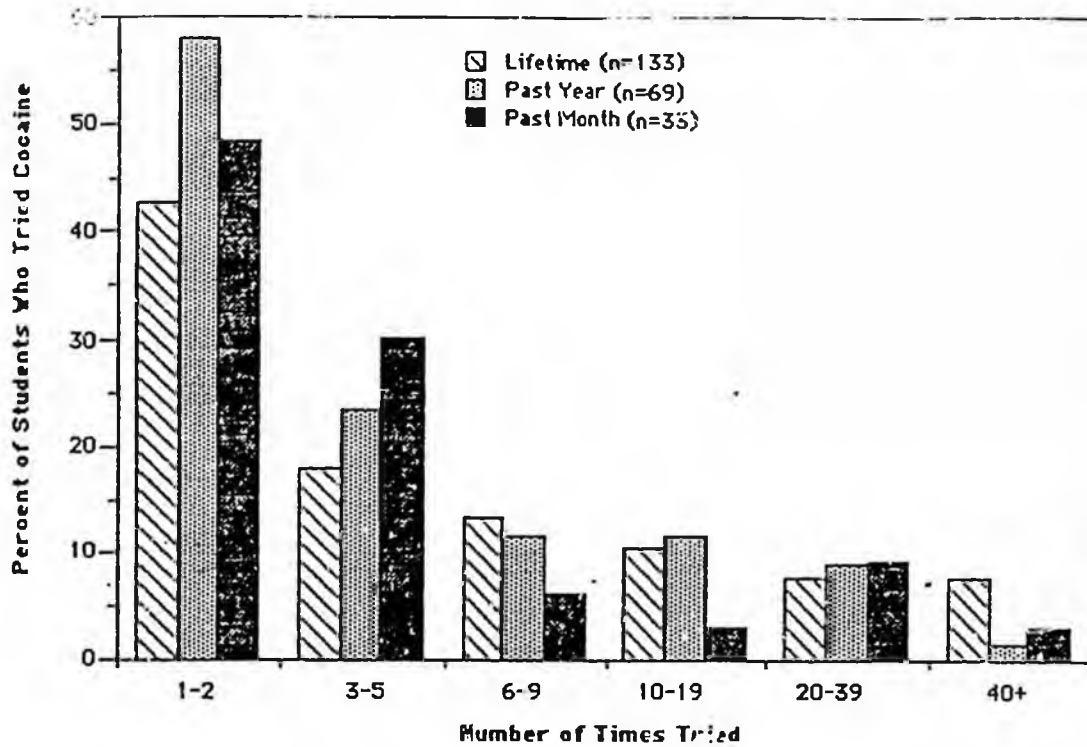


Figure 3C
Frequency and Recency of Stimulant Use
Fairbanks North Star Borough School District
Grades 7-12

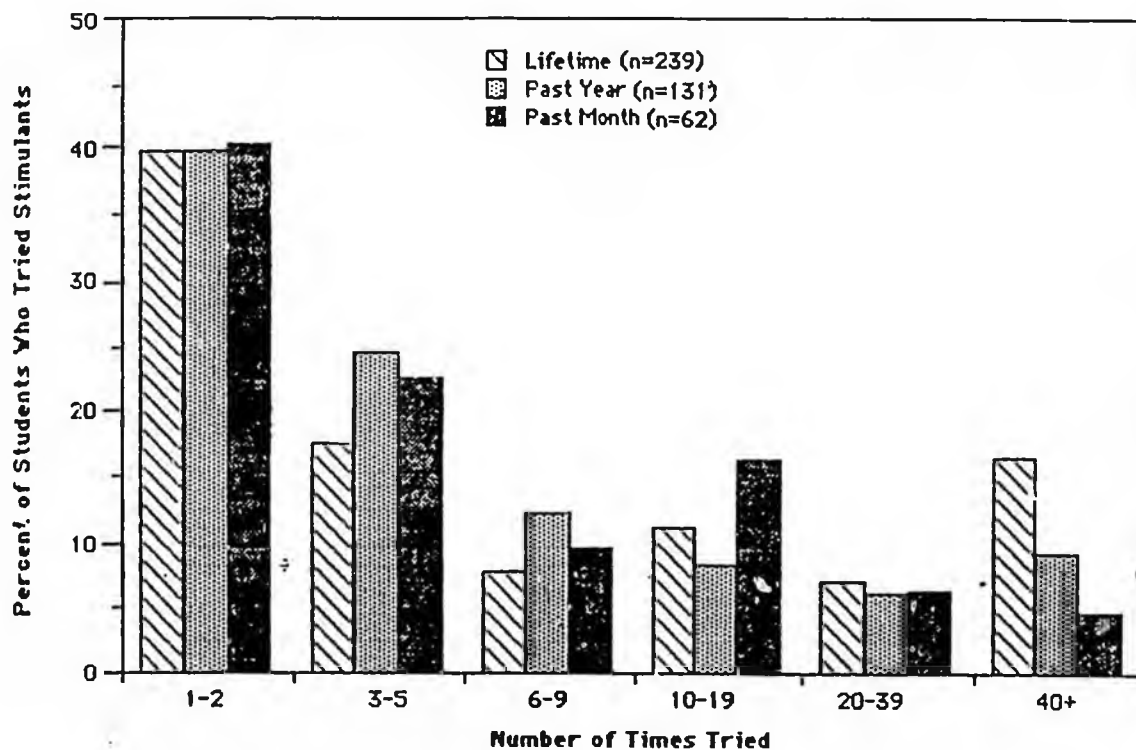


Figure 3D
Frequency and Recency of Hallucinogen Use
Fairbanks North Star Borough School District
Grades 7-12

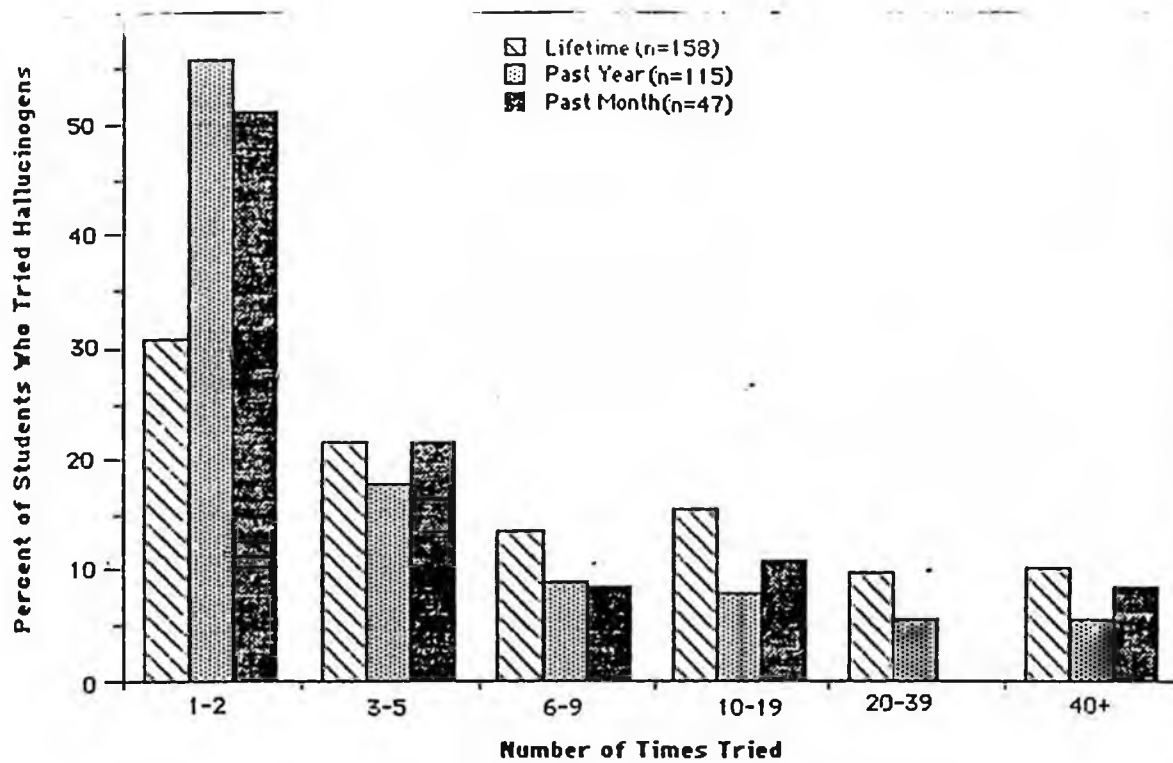


Figure 3E
Frequency and Recency of Depressant Use
Fairbanks North Star Borough School District
Grades 7-12

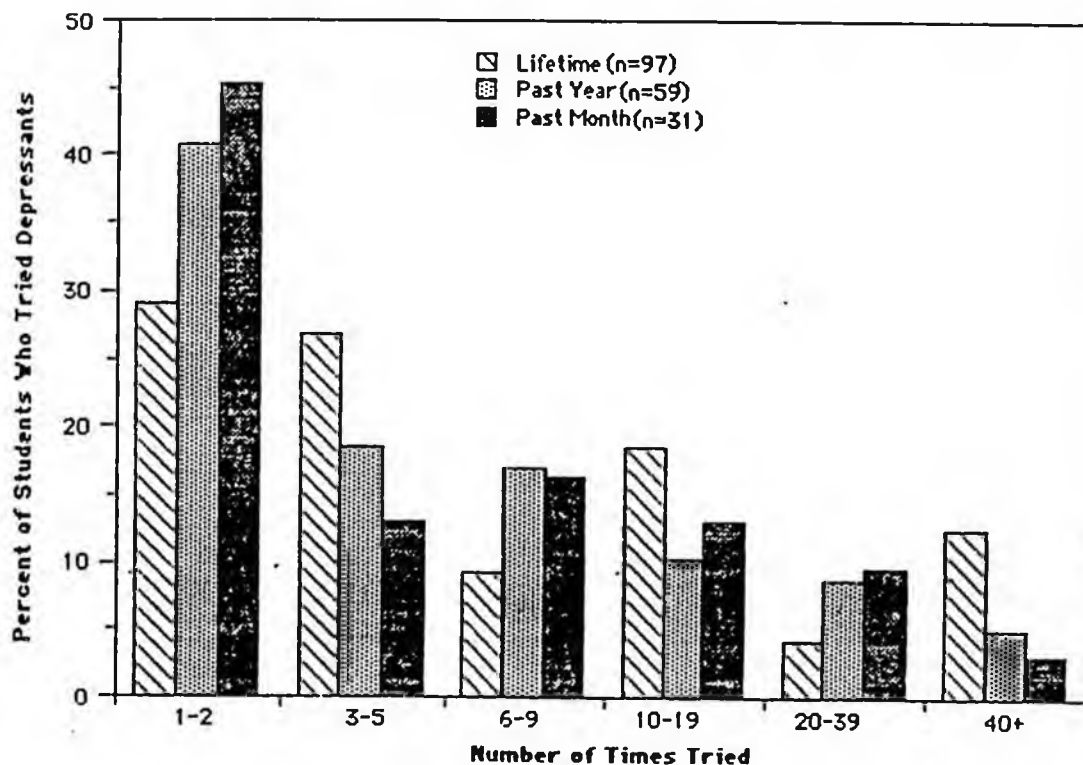


Figure 3F
Frequency and Recency of Inhalant Use
Fairbanks North Star Borough School District
Grades 7-12

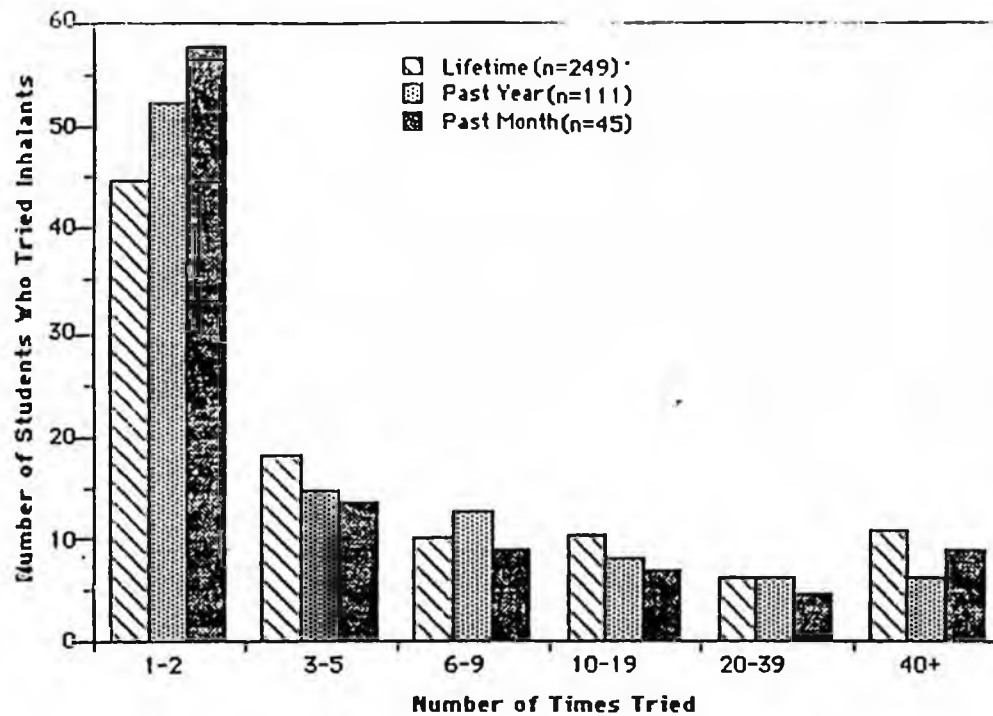


Figure 3G
Frequency and Recency of Tranquilizer Use
Fairbanks North Star Borough School District
Grades 7-12

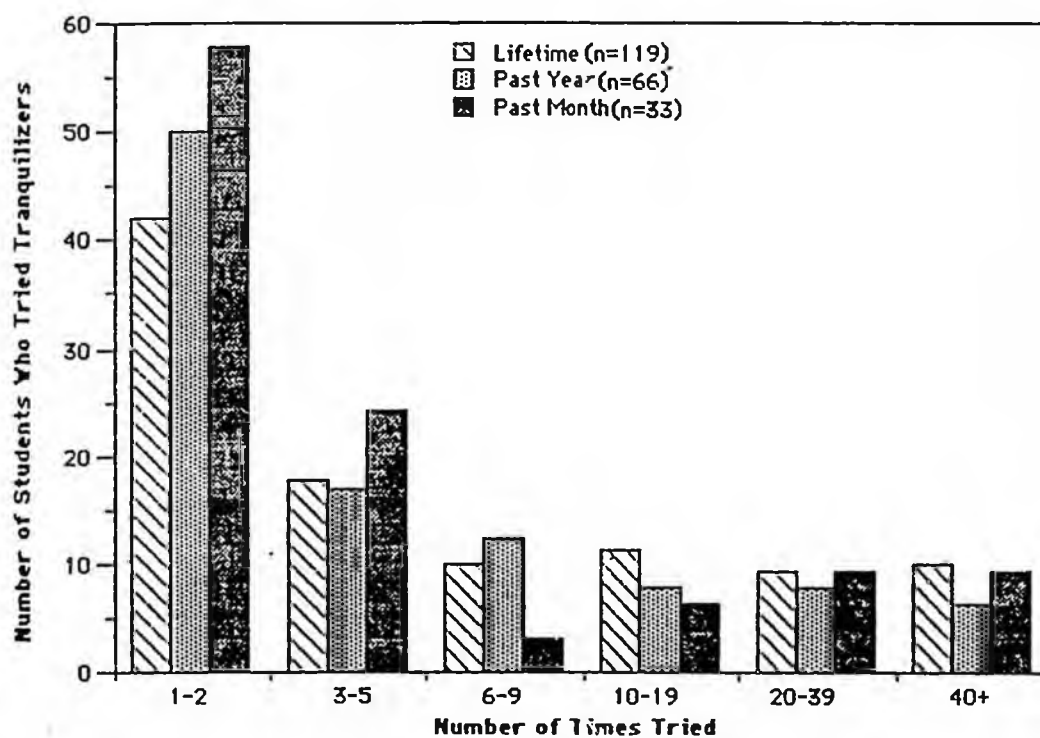


Figure 4
Age of Initiation Into
Marijuana, Stimulants, and Inhalants
Fairbanks North Star Borough School District
Grades 7-12

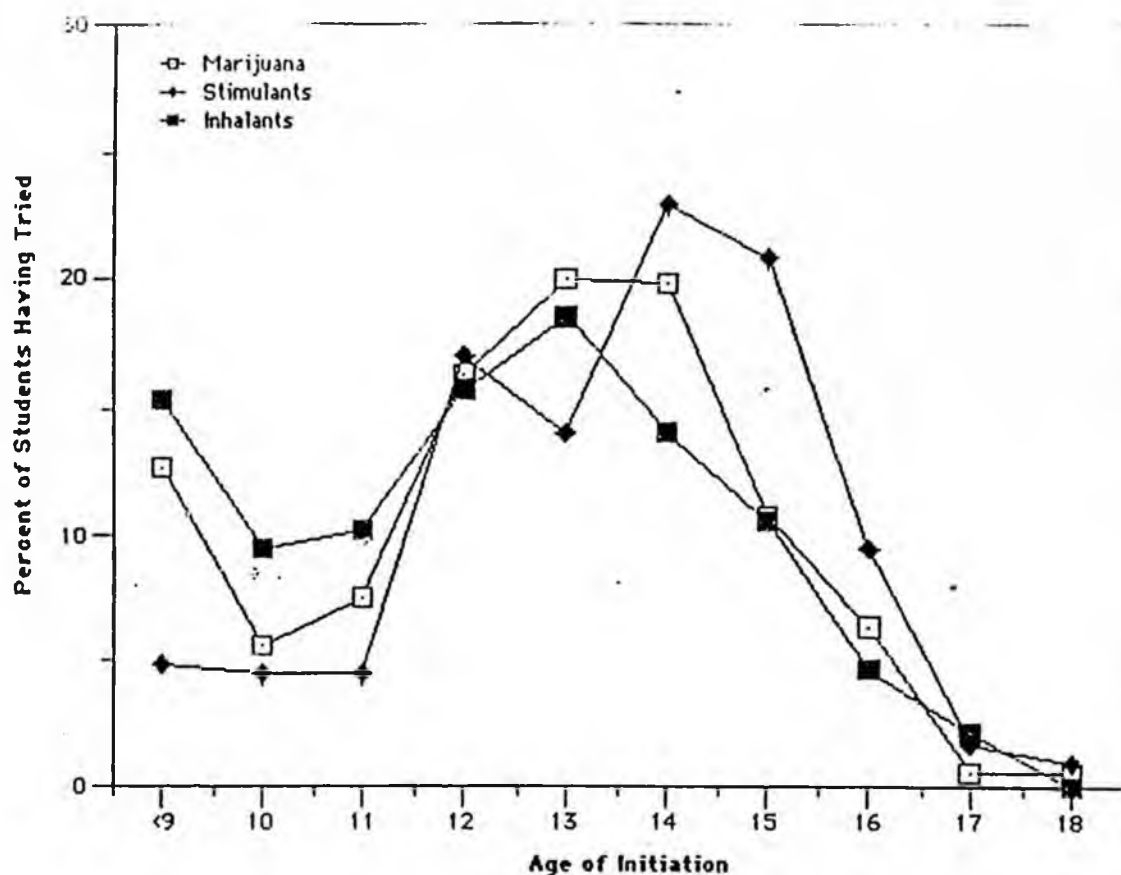


Figure 5
Lifetime Experience with Alcohol
Comparison of 1983 and 1987 Findings
Fairbanks North Star Borough School District
Grades 7-12

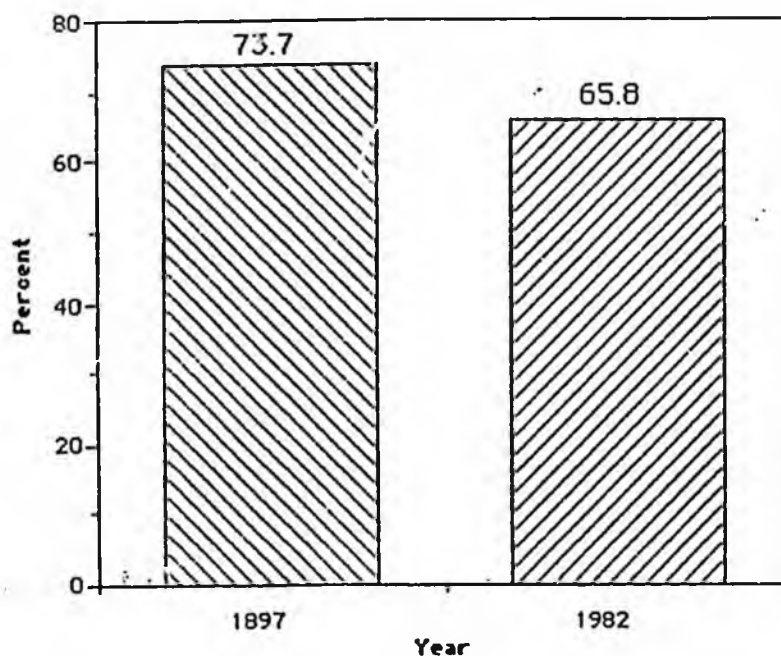


Figure 6
Frequency of Drinking Past 30 Days
Fairbanks North Star Borough School District
Grades 7-12

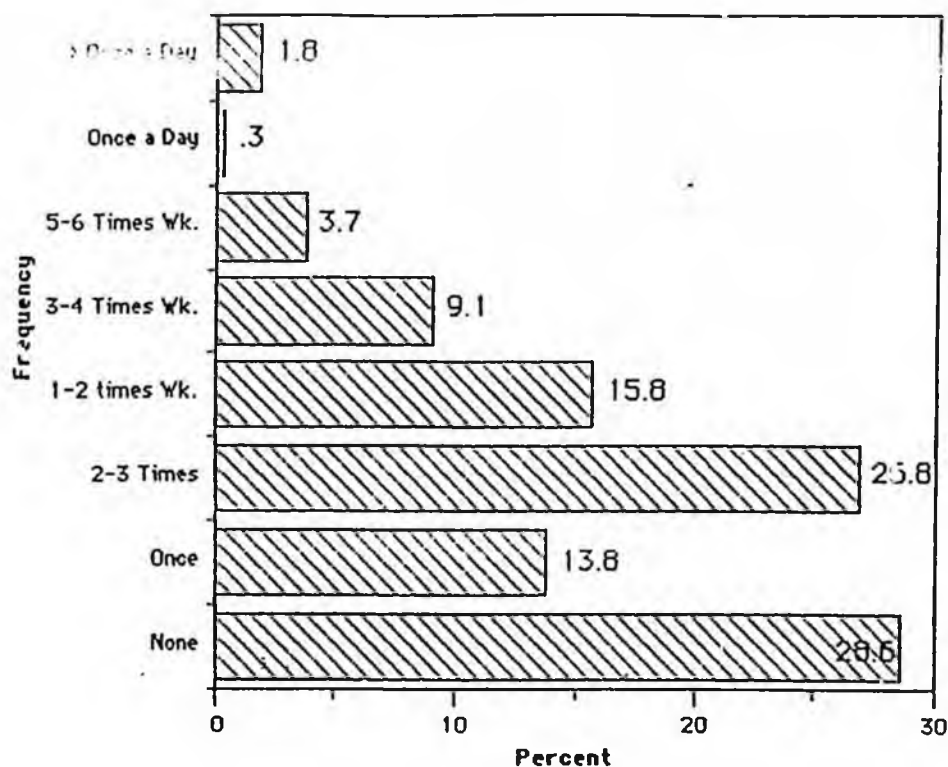


Figure 7
Consequences of Drinking During
the Past year
Fairbanks North Star Borough School District
Grades 7-12

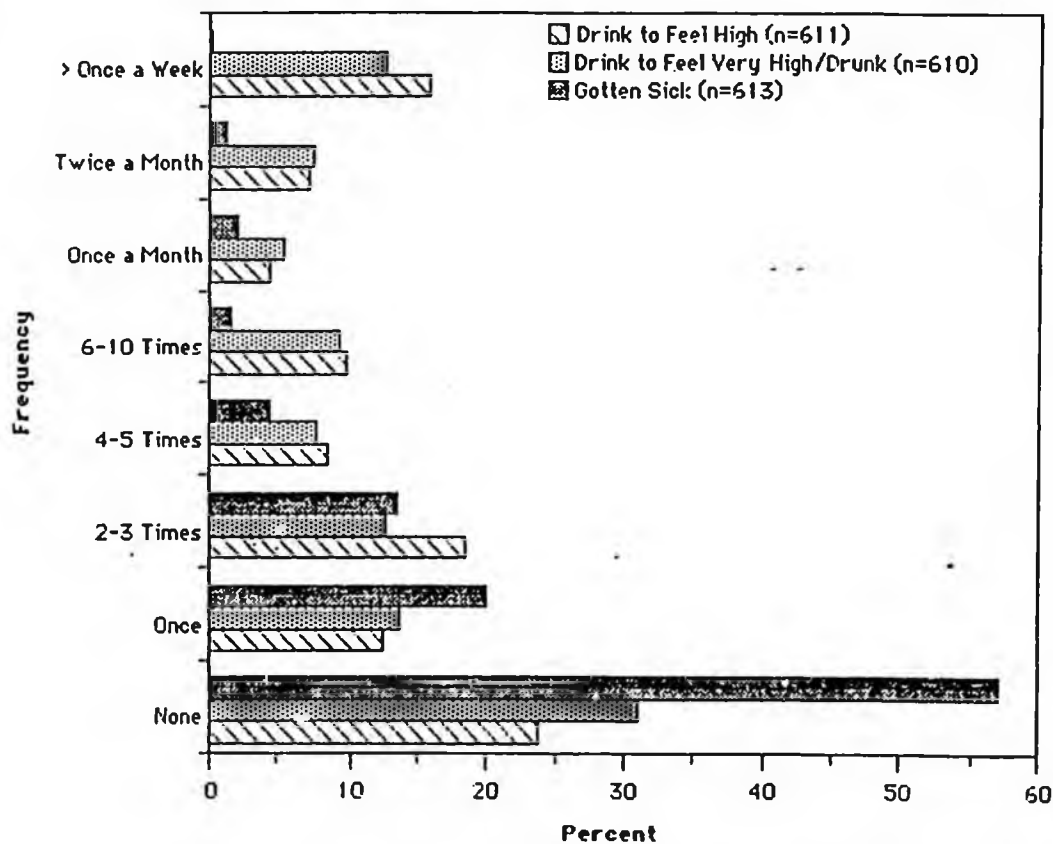


Figure 8
Experience With Cigarettes
and Chewing/Smokeless Tobacco
in North Star Borough Schools
Grades 7-12

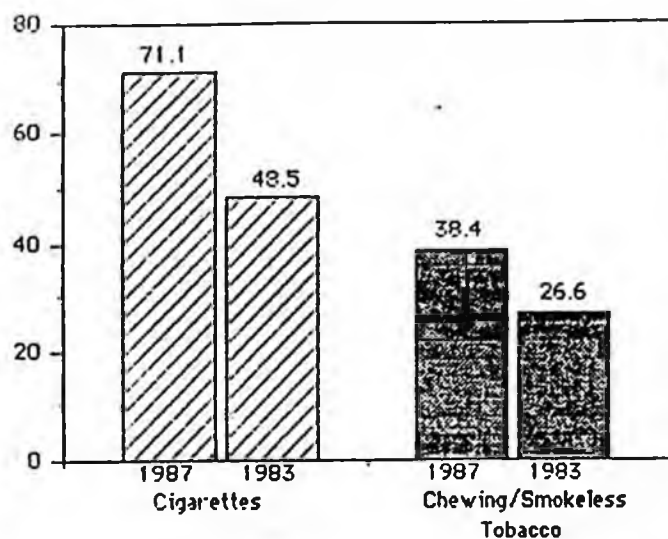
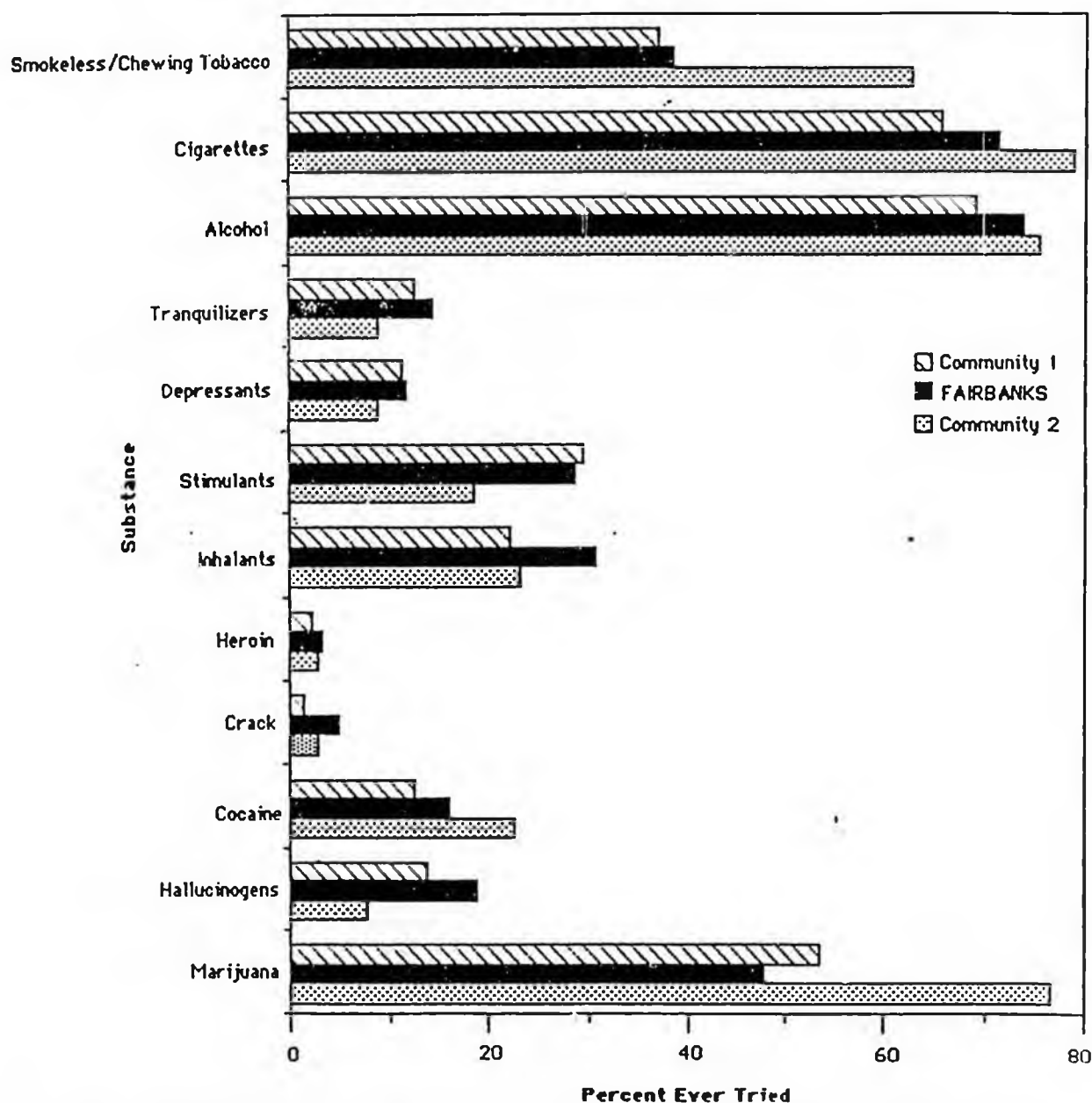


Figure 9
Comparisons of Lifetime Experience with
Chemical Substances
Three Alaska Communities
1987



It is important to note that the findings reported herein are based on self-report questionnaires. Although the research literature continues to indicate that such data are valid, a note of caution should be introduced. The findings can only reflect what the adolescent respondents say they think they have taken, and not what was actually used. It is well known that counterfeit and lookalike drugs exist, and that youngsters may have taken such substances thinking that they were the "real thing." In this instance what is important is that drug-taking behavior occurred, and that it was reported as having had occurred. Furthermore, it is always possible that some adolescents who may have tried a chemical substance may not have reported such use, or that some students may have either over- or under-reported their use. Each questionnaire was reviewed for consistency of responses to attempt to obtain reliable and valid data.

Confidentiality and Anonymity

The purpose of this research was to gain an understanding of drug-taking behavior among Alaskan Adolescents, and not to identify those who use or have experimented with a drug. Considerable effort was undertaken to obtain the most reliable and valid responses from the students choosing to participate in the study by ensuring their anonymity and confidentiality. The student's names were not asked for in any phase of the research, nor were any identifying measures used except to identify the community in which surveying was

undertaken. The only identifying information on the questionnaire was age, gender, grade, and ethnicity, none of which could be used to identify any single student.

Method

Questionnaire

The questionnaire used in the 1987 study was similar to the one used in the previous study, but with a different format. The questionnaire was designed to be self-administered and restricted to an administration time of one class period (about 50 minutes). The types of data items outlined below were collected through the questionnaire shown in Appendix A.

(1) Demographic

This section included question that inquired about: gender, ethnic background, age, participation in drug education programs, grades obtained, and length of time lived in community.

(2) Drug Usage

Information on drug usage included an extensive set of question on nonprescriptive or social/recreational use of marijuana, cocaine, crack, stimulants, hallucinogens, depressants, heroin, inhalants, and tranquilizers, with specific reference to recency and frequency of use, problems resulting from use, age of first use, and estimator of level of peer use.

(3) Alcohol

This section includes information about the quantity and frequency of consumption, and about some adverse consequences of drinking.

(4) Tobacco

Information on cigarette smoking and on use of smokeless tobacco products, including the quantity and frequency of use.

(5) Personality Items

The use or nonuse of drugs is in part influenced by personality characteristics. The incorporation of a measure of personality attributes facilitates an evaluation of what personality traits are related or unrelated to nonuse of drugs and to different patterns of drug use.

The Sample

Sampling within the Fairbanks schools was undertaken by the School District itself, utilizing the method of disproportional stratified random sampling to obtain a representative sample of students in grades 7-12. Stratification was based on school, grade, and gender. Individual students

were obtained by means of a simple random sample. Based on a computer generated list of all students in the district, who were classified into the appropriate strata, a total sample of 1450 students was then randomly selected for participation in the study. At the time of sampling, which occurred on May 12, 1987, each student selected was asked to report to a central location within their school at a given time. An explanation of how and why each student was selected was conveyed, and each student was then asked to volunteer to complete the questionnaire. A total of 836 completed questionnaires were obtained. Based on a target of 1450 students, a response rate of 57.7% was obtained, a level which is considered adequate based on an anticipated return of 50%. A description of the samples is provided in Table 1 and its component sections.

Table 1
Part I

<u>Gender</u>	<u>N</u>	<u>%</u>	<u>Ethnicity</u>	<u>N</u>	<u>%</u>	<u>Grade</u>	<u>N</u>	<u>%</u>
Males	468	56.0	Alaska Native	51	6.1	7	168	20.1
Females	366	43.8	White	661	79.1	8	145	17.3
Unreported	2	.2	Am. Indian	17	2.0	9	146	17.5
Total	836		Asian-Pacific	18	2.2	10	126	15.1
			Black	46	5.5	11	151	18.1
			Hispanic	22	2.6	12	100	12.0
			Other	15	1.8			
			Not reported	6	.7			

Table 2
Opportunity to Try and Trying Drugs:
Comparison of 1983 and 1987 Findings
Fairbanks North Star Borough School District
Grades 7-12

<u>Drug</u>	<u>1987</u> (n=836) Percent of Sample <u>Having a Chance to Try</u>	<u>1983</u> (n=421) Percent of Sample <u>Having a chance to Try</u>
Marijuana	66.9	58.2
Cocaine	30.1	33.5
Stimulants	41.4	37.8
Hallucinogens	28.6	24.9
Depressants	22.1	24.0
Heroin	9.3	12.4
Inhalants	49.6	32.8
Tranquillizers	23.7	17.8
Crack	11.5	--

EXECUTIVE SUMMARY

PATTERNS OF DRUG USE: SCHOOL SURVEY



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July 31, 1983

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EXECUTIVE SUMMARY:
Highlights of the Study

A. Introduction

This report presents the findings from a study conducted by the Center for Alcohol and Addiction Studies (CAAS) of the University of Alaska, Anchorage. The research, sponsored by the State Office of Alcoholism and Drug Abuse (SOADA), surveyed students in grades 7-12 in school districts in eight locations in the state: Anchorage, Barrow, Bethel, Kotzebue, Fairbanks, Juneau, Nome and Sitka. The project was designed to obtain information on the use or nonuse of a broad spectrum of chemical substances, ranging from legal socially-sanctioned drugs for those of legal age, such as alcohol and tobacco, to illegal and unsanctioned drugs taken for nonmedical purposes, such as marijuana, cocaine, hallucinogens and stimulants, among others.

In recent years American society has experienced an increase in the frequency and intensity of substance use and abuse, particularly among college and secondary school age youth. In particular, the nonmedical use of illicit mood-altering drugs by youth of elementary, junior and senior high school age has become a problem of major concern. Although legal and social sanctions exist to preclude nonmedical use of psychoactive drugs for recreational or social purposes, they continue to be taken, and youngsters who take them are placing themselves at risk for potential legal, social, and health problems.

Recent research (c.f., Richards, 1981) has shown that the prevalence of drug use is generally fairly low among elementary school youth, but that the prevalence increases dramatically among junior and senior high school students. The

use of drugs among school age youth began to emerge slowly in the early 1960's, and increased dramatically during the mid to late 1970's. Although the prevalence of drug use is believed to be moderating (Miller, 1983; Johnston, Bachman, & O'Malley, 1982), the overall level of drug use by youth remains a significant concern.

Interest in learning about the nature and extent of drug use by school age youth has prompted a number of national surveys sponsored by the National Institute of Drug Abuse (NIDA), as well as a myriad of research studies directed at investigating adolescent drug use (c.f., Richards, 1981). Alaska has been isolated from participation in these studies, thereby leaving a void with respect to reliable information on the use and nonuse of drugs by Alaska's school age youth. Without this information state and local agencies are hampered in their planning for drug related services, education, and prevention programs.

The present research is directed at achieving information concerning experiences with mood-altering drugs by school age youth. It is the specific aim of the study to identify current trends and patterns of use by these youthful Alaskan residents, and to also obtain knowledge about students' perceptions and consequences of using drugs. In order to achieve these objectives, surveys were conducted in eight school districts (listed above) in diverse locations within the state. The major topics to be addressed from the results of the survey in this report are the current prevalence of drug use among the students and an analysis of some of the characteristics of those who have had experiences with psychoactive drugs. Also reported are data on use by grade, age of first use, intensity of drug use, and perceptions about taking drugs. Emphasis is also given to addressing the non-using student, and to explore why they did not experiment with chemical substances.

The results to be presented have been summarized in a series of tables, charts and graphs; a discussion of results follows the presentation of the tables. In the following section a glossary has been provided to help define terms and to provide a key to the interpretation of the graphic figures. When appropriate, comparisons of the Alaskan data have been made with comparable school age youth included in some of the national survey research.

It is envisioned that the findings of the drug survey will be useful to schools in their efforts to develop education programs designed to address the issue of drug-taking behavior. Additionally, the study is designed to assist SOADA with respect to its planning and policy development, as well as to be of value to local and state governments and governmental agencies in their efforts to understand and deal with the health, social and legal consequences of drug-taking behavior by school age youth.

In summary, the five sets of results share several critical characteristics which contribute to the integration of findings, and which also contribute to their utility to estimate drug use among the general population of school age youth in Alaska:

- data collection from students in grades 7-12, which consistently includes those in age from 12 to 18;
- adequate and consistent sampling methodology;
- comparability of drugs investigated;
- comparability of question formats; and
- accessibility of detailed tabular data.

Each of the five data sets are found in Chapter III, the section on results. Chapter IV contains a discussion of the results, followed by conclusions and recommendations (Chapter V).

B. Glossary

This section is provided to acquaint the reader with precise definitions of the terms and concepts used in this report. Included in this glossary are definitions of substances and frequently used terms, as well as information on reading tables, and clarification of the statistical terms used in the report. Phrases are listed in alphabetical order.

<u>Adults</u>	This category includes persons age 26 years and older. For other age groups see: Youth and Young Adults.
<u>Alcohol</u>	Alcoholic beverages - beer, wine, and whiskey, such as gin, and other hard liquors.
<u>Barbiturates</u>	See depressants.
<u>Cocaine</u> (see stimulants)	A behavioral stimulant drug taken to induce a "rush" which involves a feeling of intense euphoria and a sense of well-being.
<u>Confidence Level</u> (Interval)	A range of values within which the true statistic or value may be found, or where there is a probability of locating the true population value.
<u>Current Use</u>	Has used within past month.
<u>Depressants</u>	Chemical substances which act to exert a nonselective general depressant action upon the central nervous system, and which are taken to induce a mild state of euphoria similar to alcohol intoxication. Sedatives are divided into four subgroups: intermediate/long acting barbiturates, nonbarbiturate/nonbenzodiazepine sedatives, short acting barbiturates and Dalmane.
<u>Drug</u>	For purposes of the study, a drug is defined as any chemical substance that alters mood, perception, or consciousness.
<u>Frequency</u>	How often a drug was taken, e.g., once a week, weekly, etc.
<u>Ever Used</u>	Taking/trying a drug one or more times during one's lifetime.
<u>Hallucinogens</u>	Drugs classified as hallucinogens and/or psychedelics have the capacity to induce visual, auditory, and other hallucinatory experiences, and to separate the individual from reality. Such drugs as LSD, phencyclidine (PCP), mescaline, psyote, psilocybin, and DMT, among others, are included within general data on hallucinogens.
<u>Heroin</u>	A semisynthetic opiate produced by a chemical modification of morphine, taken to induce a subjective experience characterized by an extremely pleasant, euphoric state, feelings of warmth, well-being, peacefulness and contentment.

Inhalants

For the purpose of this report, substances currently being inhaled to alter subjective states are being defined as inhalants. Inhalants may be classified into three basic classes: commercial and related volatile solvents, aerosols, and anesthetics. The following substances have been defined as inhalants:

- 1) Gasoline or lighter fluids; 2) Spray paints;
- 3) Other aerosol sprays (PAM or deodorants);
- 4) Shoe shine, glue, or toluene; 5) Lacquer thinner, or other paint solvents; 6) Amyl nitrite, "poppers";
- 7) Halothane, ether, or other anesthetics; 8) Nitrous oxide, whippets; 9) Locker room odorizer; 10) Other substances used as inhalants.

Lifetime
Prevalence
(Ever Used)

Percent who ever used; i.e., has used the drug one or more times in lifetime.

Marijuana

A mixture of the crushed leaves, flowers, and small branches obtained from the hemp plant, and taken to induce feelings of well-being, relaxation, tranquility, and a heightened state of awareness.

Nonuse

A "No" answer to any of the questions which inquire whether one had ever taken a chemical substance.

Opiates

Any natural or synthetic drug that acts in the same way as morphine to relieve pain, such as codeine, demerol and other such drugs.

Past Month,
Past Year Use

See: Use in Past Month, Use in Past Year.

Percents/
Percentage

A given part or amount in every hundred, e.g., a 20% rate means 20 in every 100. Percents are shown to the nearest tenth for the data in this study.

Prevalence

The incident of drug taking, represented by the percent of respondents who tried a drug, such as 40% tried a drug 6 or more times.

Recency of
Use

The categories of recency are: past 30 days, past year, and lifetime use.

Relative
Percent

The amount or number of persons among those within a specific group, e.g., taking or not taking a specific drug, who have responded to questions which pertain only to use or non-use of the drug.

Rounding

The tables sometimes add to 99% or 101% when they should add to 100%. Similarly, tables shown to one decimal place sometimes add to 99.9% or 100.1% instead of 100%. These discrepancies are due to the rounding of percents.

Sedatives

See depressants.

Significance
(level of)

The reliability of finding or the dependability one can place on an obtained statistic as an indicator of the true population

value. Significance always refers to probability, or how much an obtained value can be explained as a chance occurrence. The significance value used in this research is $p = .05$, which means that we anticipate that 95 times out of 100 chances we have obtained reliable statistics.

Stimulants

Any drug that increases behavioral activity is defined as a stimulant drug. Stimulants are divided into amphetamines, nonamphetamine anorectics, Ritalin, and Cylert. These drugs are generally taken to feel more alert, to achieve a "rush," or to enhance the effects of other drugs.

Tranquilizers

Psychoactive drugs which are used principally to reduce anxiety, stress or tension and to treat neurotic disorders. The tranquilizers concerned in this survey are Librium, Valium, Equanil and other such types.

Use in Past
30 Days

Reports given which indicate have taken a drug one or more times during the past 30-day period.

Use in Past
Year

Respondent reports use one or more times during year prior to interview date.

Young Adults

This category includes persons age 18 to 25 years. For other age groups see: Youth and Older Adults.

Youth

This category includes persons who participated in Junior and Senior High School samples. Age of respondents will vary but will generally range from 12 to 18. For other groups see Adults and Young Adults.

Key to Graphs and Figures

MJ - Marijuana	ST - Stimulants
HL - Hallucinogens	DP - Depressants
CK - Cocaine	TQ - Tranquilizers
HR - Heroin	OP - Opiates
IH - Inhalants	TB - Tobacco
AL - Alcohol	

C. Major Findings

The major findings of the study are summarized in the tables, graphs and figures which follow, and in the summary statements listed below:

- Half the students sampled have reported experiences with one or more illicit mood-altering drugs. A substantial proportion of these experiences involved marijuana. The percentages of students who tried different illicit drugs is illustrated in Figure 1. After marijuana, the other drugs experienced reflect the following order of lifetime prevalence: stimulants, cocaine, inhalants, depressants, tranquilizers, hallucinogens and heroin.
- The level of lifetime experiences with psychoactive drugs among students is high. The extent to which drugs have been tried/taken among Alaska's students is illustrated vividly when the present findings are compared to results of a national survey of drug use among a sample of 12-17 year olds. Although the ages of the two samples are not exactly comparable, the national data nevertheless provides a "baseline" which helps to achieve a perspective on drug use by Alaska's youth. The comparison in Figure 2 shows clearly that Alaskan students are having more experiences with psychoactive drugs than their counterparts in the "lower 48."
- Although many students have tried drugs, the majority of such use has been chiefly experimental. Only a small percent of students have taken drugs with any consistency or regularity. Marijuana, however, is the exception, with about 4% of the sample using it once or more a day.

FIGURE 1

LIFETIME EXPERIENCES WITH PSYCHOACTIVE DRUGS
TOTAL SCHOOLS

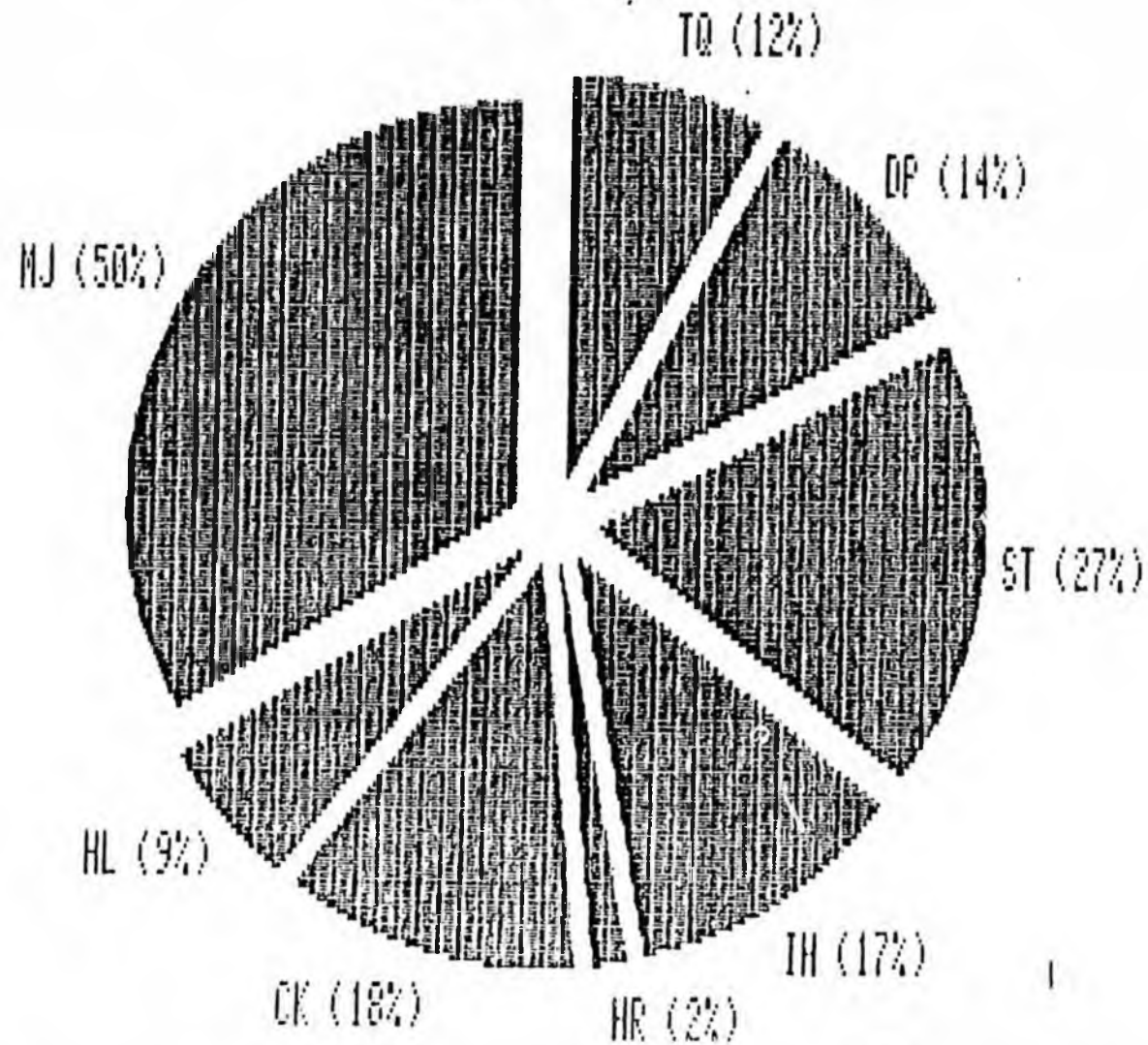
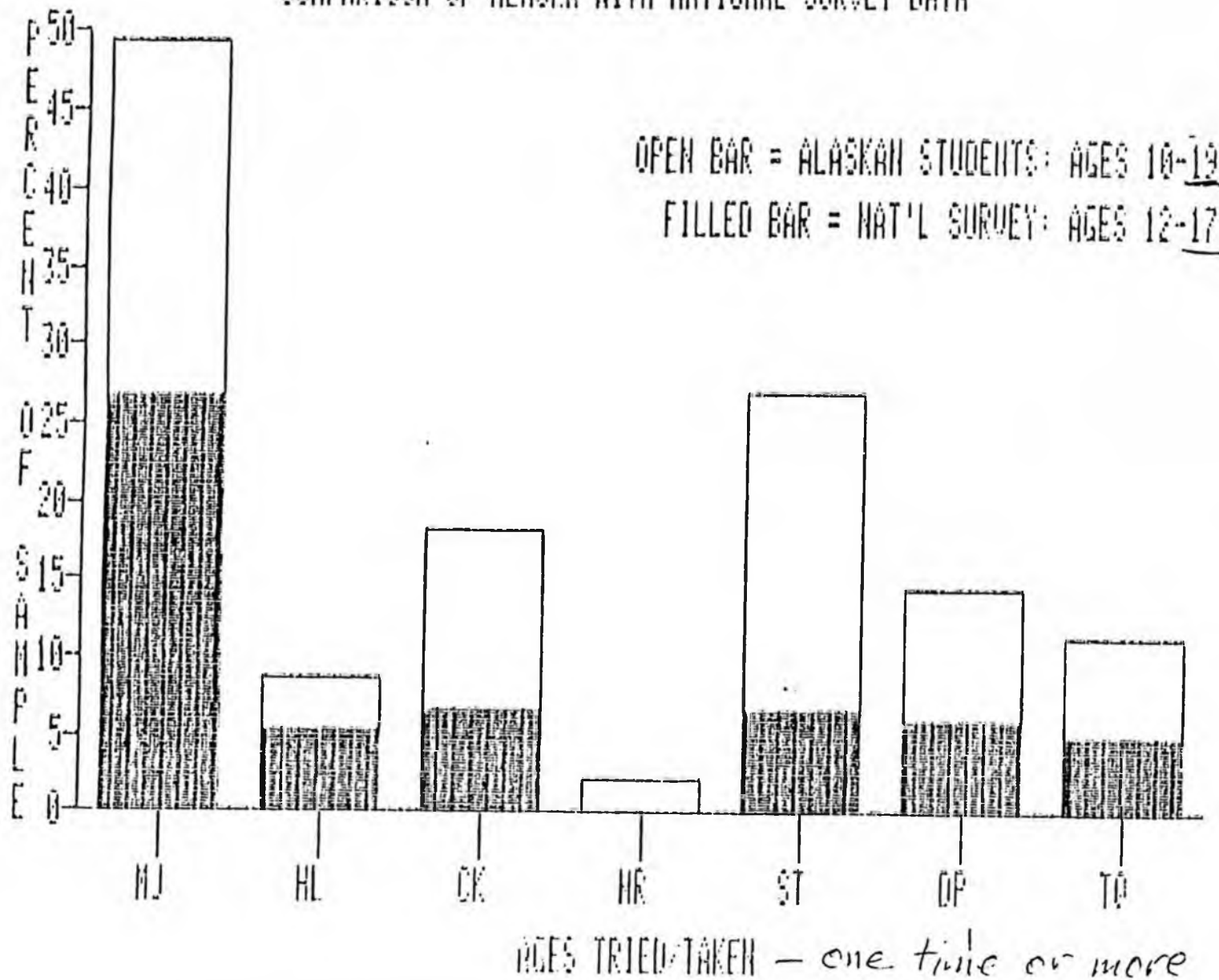


FIGURE 2

COMPARISON OF ALASKA WITH NATIONAL SURVEY DATA



- Slightly higher proportions of males than females are involved in taking/trying drugs.
- Distinct relationships exist between age, grade, and drug-taking behavior. These relationships are represented by the following results:

(1) Age and First Trying Psychoactive Drugs

As age increases, the proportion of students who try/take drugs increases correspondingly, but this relationship appears to be non-linear. That is, as age increases, the number of students who try different drugs varies at different age levels, thereby presenting distinct patterns for trying each drug. Figure 3 illustrates this process for the three most widely tried/taken drugs - marijuana, stimulants and cocaine - for all but the Anchorage school sample (where the question of age of first trying each drug was not asked).

(2) Grade and Drug-Taking Behavior

A direct, almost linear, relationship exists between grade level and the taking of drugs. As grade level increases, the percent of students who have tried/taken drugs increases correspondingly. The nature of this relationship is illustrated in Figure 4, for the three most tried drugs - marijuana, stimulants and cocaine.

(3) Junior-Senior High School Comparisons

The extent of drug-taking behavior differs significantly between junior high school (grades 7-9) and senior high school (grades 10-12) students. Senior high school students experiment with taking drugs more frequently than junior high school students.

- Most students who do not try drugs report that it is because of concern that drugs would "hurt" their minds, and because of fear that drugs would also cause physical harm.

FIGURE 3

AGE FIRST TRYING PSYCHOACTIVE DRUGS

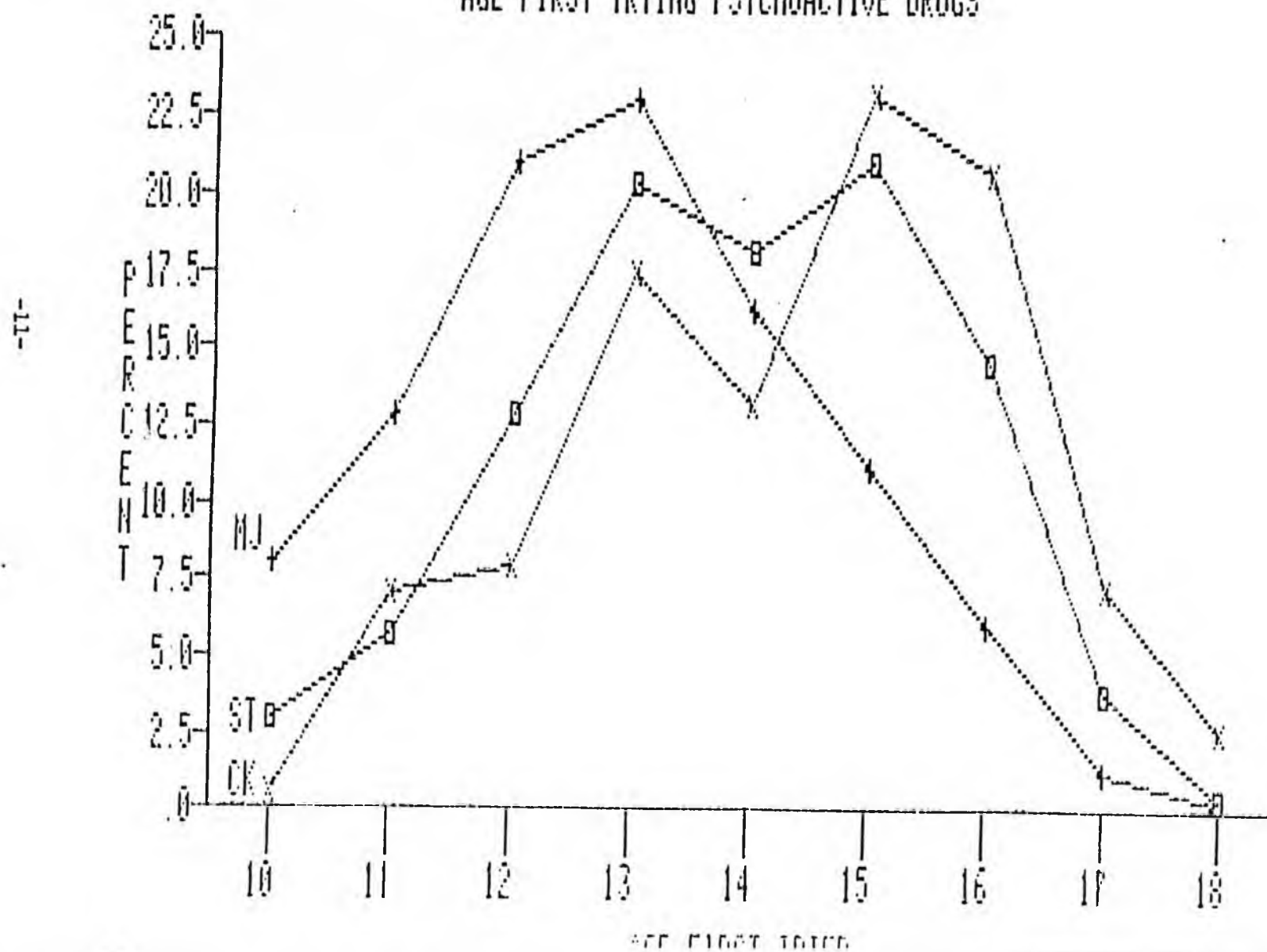
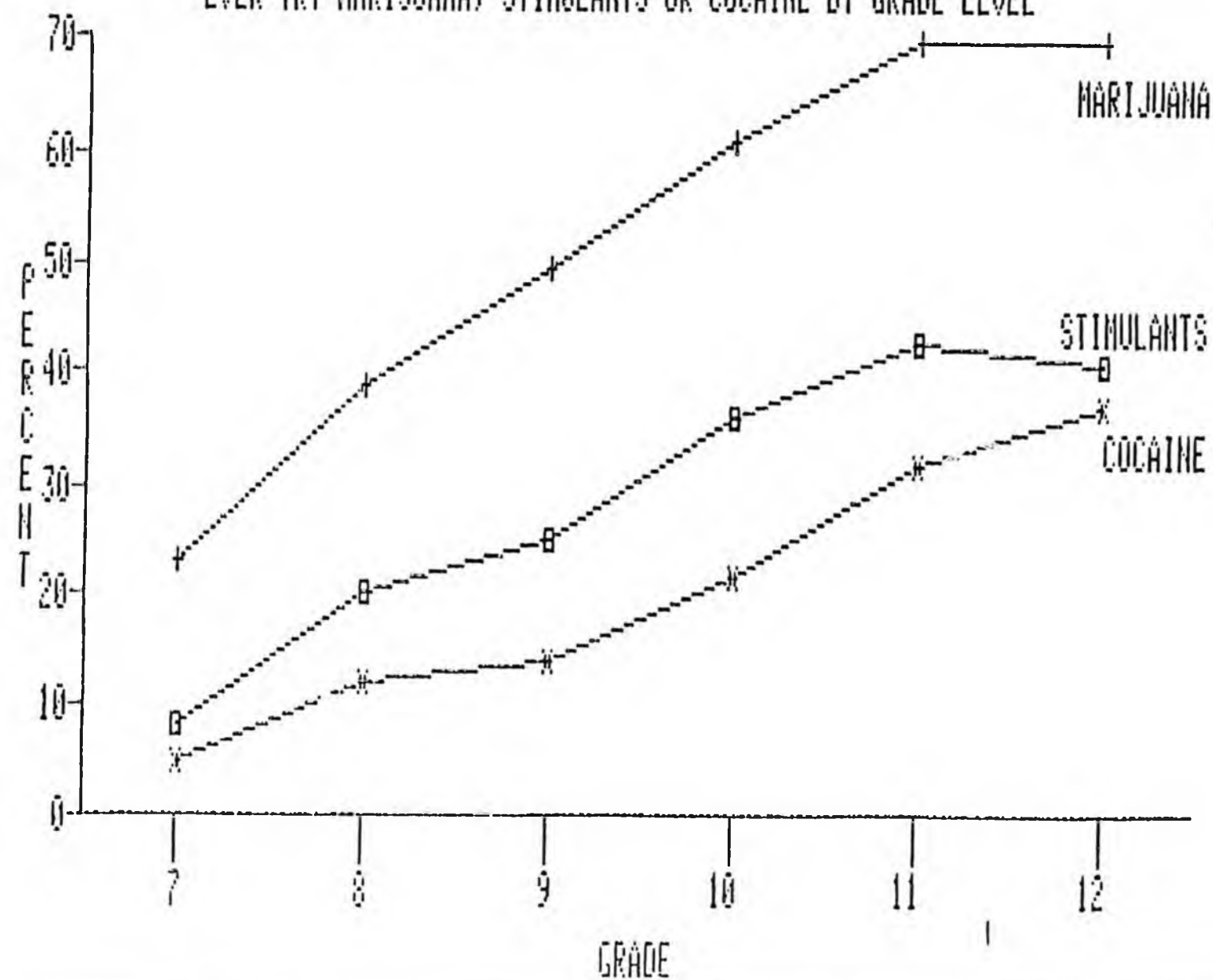


FIGURE 4

EVER TRY MARIJUANA, STIMULANTS OR COCAINE BY GRADE LEVEL



- Of those who have tried/taken drugs, the reasons for stopping are also mainly because of concern over psychological and physical harm.
- More students who have tried drugs express a need for drug education than those who did not try drugs.
- Corresponding to the relationship between grade level and drug-taking behavior, problems related to drug-use increase as grade level increases, but there is much variation within and between grade levels.

D. Abstraction of Summary and Conclusions

In reviewing the overall findings from the statewide study, it is readily apparent that the opportunities to try mood-altering drugs are very high, and that the rate of trying drugs is also correspondingly high. Although it is not known whether it is the "real thing" as opposed to a "look-a-like" or a substitute chemical that students are taking/trying, the important fact is that students report that they are involved in drug-taking behavior. A question which arises is, Why is the opportunity to try drugs so very high?

The most apparent answer is that the drugs are available for them to try. It is clear the these youth are reflecting what is alleged about drug use in general in Alaska, especially in the larger communities - that it is high. The drugs that are available - albeit illegally - find their way down to adolescents and early teenagers in the school system. Also, a large percent of students are willing to try certain illicit drugs such as marijuana, cocaine and stimulants among those available.

Another questions is, Why do so many students experiment with drugs? There are several possible answers to this question. One is that many of the illicit drugs such as marijuana, stimulants and cocaine have become incorporated into

the "lifestyle" of so many people that adolescents themselves experiment with them as part of their own "normative" behavior. That is, the wide scale prevalence of drug use in general makes it a phenomenon which adolescents may pursue in order to know what drug experiences are like. It thus appears that adolescent drug use may be related to the attitudes and behavior found in the larger adult society. Research by Segal (1983), which has shown that experimentation with drugs and even moderate drug taking by a significant percentage of youth is divorced from any particular pattern of deviant behavior or severe emotional distress, tends to support the above conclusion.

The implications from the study are clear. Efforts need to be directed toward reducing the high rate of experimentation with drugs by a large number of students, as well as reducing the on-going usage by the small percentage of students who are involved in such behavior. The data suggest that intervention strategies should be emphasized within grades 8 and 9, or at least prior to age 14, since experiences with drugs tend to peak by 14 years of age.

III

RESULTS

Overview

This section provides the report of the results of the school surveys with respect to nonmedical drug-taking behavior by students in eight different locations within the state in grades 7 through 12. Also included is data on alcohol consumption and cigarette smoking.

Information compiled from surveying over 3,000 students, utilizing a comprehensive questionnaire, can be very extensive. There are a multitude of different ways of reporting results, some may have either special or unique significance, and some may be too general to be of value. It was therefore necessary to place some limitations on the reporting of the survey findings with the aim of presenting data which would be best utilized by the schools, by the State Office of Alcoholism and Drug Abuse (SOADA), by health planners, and by governmental bodies. Thus, the primary emphasis of this section, in keeping with the study's research objectives, is to present information which describes the extent, type, patterns, frequency, and distribution of nonmedical drug use among a large sample of Alaska's junior and senior high school students. Additionally, the results also describe age and grade differences with respect to drug-taking behavior, as well as data on some of the motivations for trying or not trying drugs, and on some consequences of drug-taking.

The data to be reported are presented in tabular and graphic form. They illustrate the prevalence and frequency of drug use for eight major drug categories (marijuana, inhalants, hallucinogens, cocaine, heroin, stimulants, sedatives, and tranquilizers) listed by frequency of occurrence, by gender, and by

selected school-related characteristics such as grade and comparison of junior and senior high school. A table and graph illustrating the relationship between age and first experience with drugs is also included.

Contingency tables have been utilized to help describe the results. This procedure is a way of showing the relationship between two or more classificatory variables. The display of the distribution of cases by their positions on two or more variables is the chief component of contingency table analysis and is a commonly accepted and popular procedure used by social scientists. The joint frequency distributions can be systematically analyzed by certain tests of significance (e.g., the Chi Square statistic) to determine whether or not the variables are statistically independent; these distributions can also be summarized by a number of measures of association, such as the contingency coefficient, which describes the degree to which the values of one variable predict or vary with those of another.

Contingency tables or cross-tabulation tables also allow for a determination of whether the differences which occur with respect to selected variables (e.g., specific sample characteristics such as selected demographic variables) are significantly different.

Finally, the surveys from the eight school districts have been grouped together to form five sets of results. This procedure was followed for two basic reasons: (a) to account for the procedural differences which necessitated using revised forms of the school survey in different school districts, and (b) to facilitate regional comparisons. The classification of results is as follows:

1. Total Sample (Tables T-1 - T-14)

This section links together all similar items which were used in Anchorage, Barrow, Bethel, Fairbanks, Juneau, Kotzebue, Nome and Sitka. It provides a

comprehensive summary of the responses of 3,609 students, giving an extensive overview of the nature and pattern of drug use by students in grades 7-12. The remaining four sets of tables represent subsets of the total results and, except for items not in the total sample, they essentially mirror the total findings, with some minor fluctuations.

2. Total Less Anchorage (Tables A-1 - A-14)

This data set contains the aggregated results from all the communities less Anchorage. Thus, Barrow, Bethel, Fairbanks, Juneau, Kotzebue, Nome, and Sitka are represented. Since the Anchorage sample constitutes such a large percent of the total (44%), and since Anchorage is the state's largest school district it was decided to compare the aggregated data from all other locations with the Anchorage sample.

3. Anchorage, Barrow, Kotzebue, Nome, and Sitka (Tables A1-1 - A1-13)

The results were aggregated because they were obtained from a total school district or were obtained from a random survey of students representative of the district. These compiled results not only link the findings from different sections of the state, but they are also used to contrast with schools where nonrandom samples were obtained.

4. Bethel, Fairbanks, and Juneau (Tables A2-1 - A2-13)

This aggregation represents those school districts in which a nonrandom sample was obtained. These districts required parental permission and only students with such authorization were surveyed.

5. Barrow, Kotzebue, and Nome (Tables A3-1 - A3-13)

This aggregated unit links the three northern communities into a single data set, and also provides a means of maintaining the anonymity of each location.

In summary, the five sets of results share several critical characteristics which contribute to the integration of findings, and which also contribute to their utility to estimate drug use among the general population of school age youth in Alaska:

- Data collection from students in grades 7-12, which includes those in age from 12 to 18;
- Adequate and consistent sampling methodology;
- comparability of drugs investigated;
- comparability of question formats; and
- accessibility of detailed tabular data.

Each of the five data sets are found in the following pages. The next chapter contains a discussion of the results.

TABLE T-1

OPPORTUNITY TO TRY AND TRYING DRUGS
Lifetime Experiences

Total Schools
Students Grades 7-12
(N = 3609)

	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
<u>Drug</u>	Number of Students Having a Chance to Try a Drug	Percent of All Students Having a Chance to Try a Drug	Number of Students Reporting Having Tried a Drug	Percent of Students who Had a Chance to Try and Did Try a Drug	Percent of All Students Trying a Drug
Marijuana	2384	66.1	1784	74.8	49.5
Hallucinogens	653	18.1	314	48.1	8.7
Cocaine	1046	29.0	662	63.3	18.3
Heroin	261	7.2	78	29.9	2.2
Inhalants	968	26.8	595	61.5	16.5
Stimulants	1288	35.7	982	76.2	27.2
Depressants	725	20.1	516	71.2	14.3
Tranquillizers	573	15.9	416	72.6	11.5

FIGURE T-1

ALL SCHOOLS: OPPORTUNITY TO TRY AND TRYING DRUGS

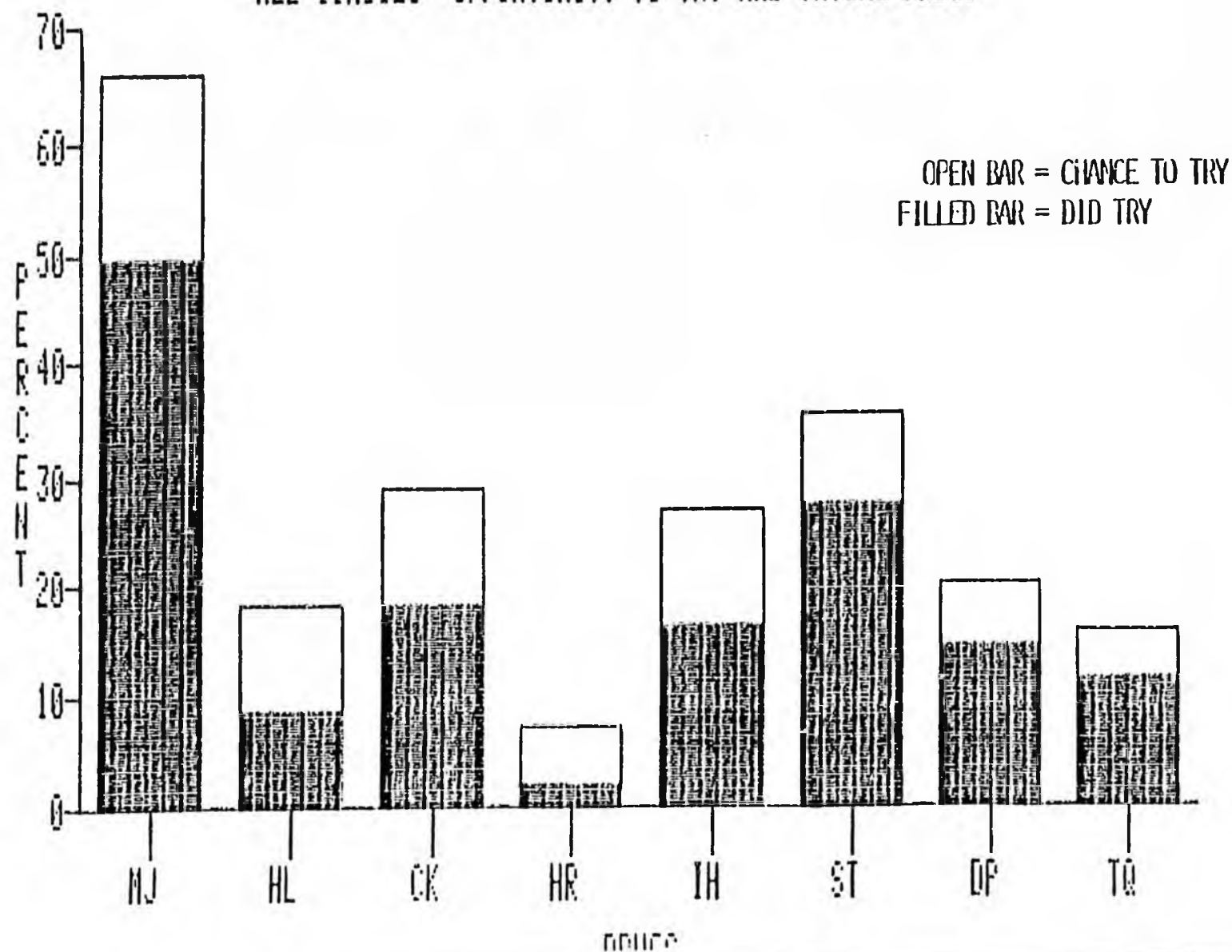


TABLE T-2

LIFETIME EXPERIENCES WITH PSYCHOACTIVE DRUGS

Total Schools
Students Grades 7-12
(N = 3609)

<u>Drug</u>	<u>Number of Students Reporting Trying</u>	<u>Lower* Limit</u>	<u>Percent of Sample who Ever Tried</u>	<u>Upper* Limit</u>	<u>Percent of Sample who Tried Within Past Year</u>
Marijuana	1784	47.2	<u>49.5</u>	51.6	42.6
Hallucinogens	314	7.5	<u>8.7</u>	10.0	7.1
Cocaine	662	18.3	<u>18.3</u>	16.6	15.6
Heroin	78	1.9	<u>2.2</u>	2.7	1.7
Inhalants	595	15.1	<u>16.5</u>	18.0	11.9
Stimulants	982	25.4	<u>27.2</u>	29.2	22.0
Depressants	516	12.5	<u>14.3</u>	16.2	11.8
Tranquilizers	416	10.2	<u>11.5</u>	11.6	11.4
Alcohol	2589	69.7	<u>71.7</u>	73.8	-
Tobacco	1986	3.3	<u>55.0</u>	57.2	56.9

*Confidence Limits

TABLE T-3

FREQUENCY OF DRUG-TAKING BEHAVIOR
Past Year Experiences

Percent of Students Who Have Tried/Taken a Drug

Total Schools
Students Grades 7-12
(N = 3609)

Drug	Percent of Sample Responding	Not Taken	Frequency*						Total Once or More
			Once a Month or Less	2-3 Times a Month	Once A Week	2-5 Times a Week	Daily	More Than Once a Day	
Marijuana	88.0	46.6	19.0	7.1	4.0	6.0	2.6	2.8	41.5
Hallucinogens	82.0	75.5	4.9	0.7	0.2	0.2	0.2	0.0	6.4
Cocaine	83.0	67.7	11.0	2.5	0.6	0.7	0.3	0.4	15.5
Heroin	81.9	79.4	1.7	0.2	0.1	0.1	0.1	0.3	2.5
Inhalants	82.6	72.2	7.4	1.4	0.5	0.4	0.4	0.4	10.5
Stimulants	83.1	62.1	112.2	4.0	1.7	1.3	0.8	0.9	20.9
Depressants	82.2	70.9	7.3	2.1	0.6	0.6	0.2	0.5	11.3
Tranquilizers	81.7	72.3	6.5	1.4	0.6	0.3	0.2	0.4	9.4

*Because of missing responses, those who report having tried a drug in the past year will not always correspond to the percent who reported ever trying a drug.

TABLE T-4
LIFETIME EXPERIENCES WITH PSYCHOACTIVE
DRUGS BY GENDER

Females and Males Who Reported
Ever Having Tried a Drug*

Total Schools
Students Grades 7-12
(N = 3609)

<u>Drugs</u>	<u>Males</u> (N=1770)			<u>Females</u> (N=1732)		
	<u>1</u> Number Having Tried	<u>2</u> Percent of Males who Tried a Drug	<u>3</u> Percent of All Students who Tried Drug	<u>1</u> Number Having Tried	<u>2</u> Percent of Females who Tried a Drug	<u>3</u> Percent of All Students who Tried Drug
Marijuana	904	51.1	51.9	837	48.3	48.1
Hallucinogens	185	10.5	60.5	121	87.0	39.5
Cocaine	351	19.8	54.4	294	17.0	45.6
Heroin	57	3.2	73.1	21	1.2	26.9
Inhalants	317	17.9	54.7	262	15.1	45.3
Stimulants	466	26.3	46.8	489	28.2	49.1
Depressants	272	15.4	53.5	236	13.6	46.5
Tranquilizers	219	12.4	53.8	188	10.9	46.2

*107 students did not report gender.

TABLE T-5

LIFETIME EXPERIENCES WITH PSYCHOACTIVE DRUGS
Junior-Senior High School Comparisons

Total Schools
Students Grades 7-12
(N = 3609)*

Drugs	F***	Junior High School** Grades 7-9 (N=1950)			F***	Senior High School** Grades 10-12 (N=1567)		
		<u>1</u> Percent of Jr. H. S. Students who Ever Tried (N=479)	<u>2</u> Percent of All Students who Have Tried each Drug	<u>3</u> Percent of Total Sample (N=798)		<u>1</u> Percent of Sr. H. S. Students who Ever Tried (N=291)	<u>2</u> Percent of All Students who Have Tried each Drug	<u>3</u> Percent of Total Sample (N=798)
Marijuana	716	36.7	40.9	19.8	1033	65.9	59.1	28.6
Hallucinogens	105	5.4	34.1	2.9	203	13.0	65.9	5.6
Cocaine	199	10.2	30.7	5.5	450	28.7	69.3	12.5
Heroin	32	1.6	41.0	0.9	46	2.9	59.0	1.3
Inhalants	290	14.8	50.0	8.0	290	18.5	50.0	8.0
Stimulants	343	17.6	35.7	9.5	618	39.4	64.3	17.1
Depressants	207	10.6	40.5	5.7	304	19.4	59.5	8.4
Tranquilizers	151	7.7	37.1	4.2	256	16.3	62.9	7.1

*89 students did not report grade level.

**The differences in frequencies and percentages between junior and senior high students are statistically significant for each drug ($p < .01$).

***F=Frequency or number of students reported having tried each drug.

FIGURE T-5

PERCENT OF JR. AND SR. HIGH SCHOOL STUDENTS HAVING TRIED DRUGS

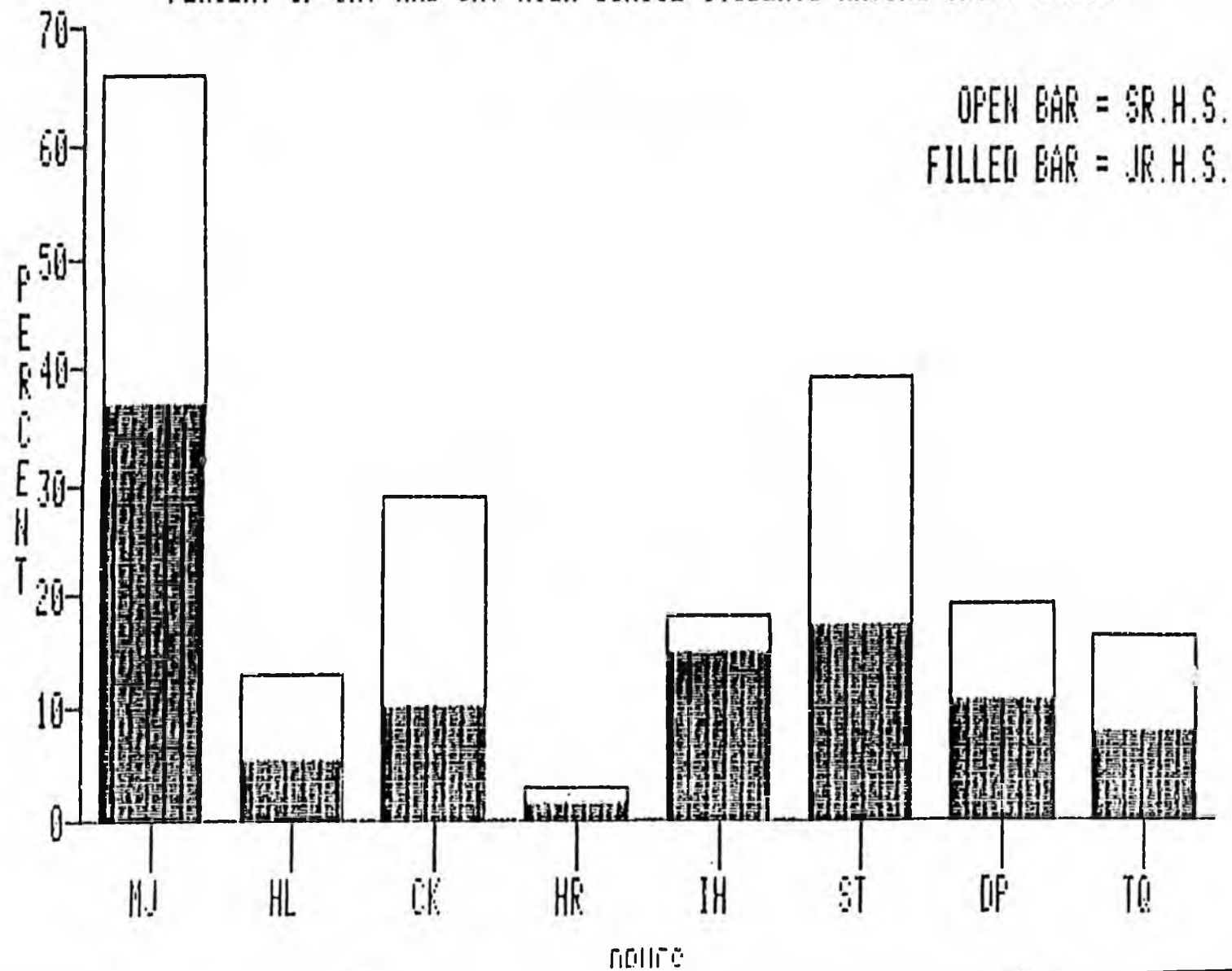


TABLE T-6A

FREQUENCY OF TAKING DRUGS:
Past Year ExperiencesTotal Schools
Junior H. S.*
(N = 1953)

Drug	Percent of Jr. H. S. Students Responding	Not Tried	Percent of Jr. H. S. Students who Have Tried Up to 3 Times a Month	Percent of Jr. H. S. Students who Have Taken Once a Week or More
Marijuana	86.4	63.6	24.5	11.9
Hallucinogens	80.9	94.8	4.5	0.7
Cocaine	31.9	88.0	10.6	1.4
Heroin	80.3	97.3	2.0	0.4
Inhalants	82.0	86.9	11.0	2.1
Stimulants	82.0	82.9	13.6	3.5
Depressants	81.4	89.3	8.9	1.8
Tranquilizers	80.5	91.7	6.9	1.4

*304 students did not report grade level.

TABLE T-6B

FREQUENCY OF TAKING DRUGS:
Past Year Experiences

Total Schools
Senior H. S.*
(N = 1567)

Drug	Percent of Sr. H. S. Students Responding	Not Tried	Percent of Sr. H. S. Students who Have Tried Up to 3 Times a Month	Percent of Sr. H. S. Students who Have Taken Once a Week or More
Marijuana	90.8	39.9	35.9	24.2
Hallucinogens	84.1	88.7	9.9	1.4
Cocaine	85.3	73.4	23.1	3.5
Heroin	83.9	96.6	2.3	1.1
Inhalants	84.1	88.2	9.9	1.8
Stimulants	85.3	64.7	26.8	8.5
Depressants	84.1	82.3	14.8	2.9
Tranquilizers	83.9	84.6	12.7	2.7

*304 students did not report grade level.

TABLE T-7

DRUG-TAKING BEHAVIOR BY GRADE

Percent Within Each Grade Who Reported
Trying/Taking a Drug

Total Schools
Students Grades 7-12
(N = 3609)

<u>Drug</u>	<u>Grade*</u>					
	<u>7</u>	<u>8</u>	<u>9</u>	<u>10</u>	<u>11</u>	<u>12</u>
	(N=665)	(N=685)	(N=603)	(N=658)	(N=564)	(N=345)
Marijuana	23.3	38.7	49.1	60.6	69.9	69.6
Hallucinogens	2.9	5.5	8.0	10.9	13.8	15.4
Cocaine	4.8	12.1	13.9	21.9	31.6	37.1
Heroin	0.9	1.8	2.3	2.6	4.4	1.2
Inhalants	12.0	18.0	14.4	18.8	18.8	17.4
Stimulants	8.1	20.0	25.2	36.0	42.6	40.9
Depressants	6.2	12.4	13.4	18.7	21.1	18.0
Tranquilizers	3.8	9.6	10.0	15.7	18.3	14.5

*304 students did not report grade levels.

FIGURE T-7

EVER TRY MARIJUANA, STIMULANTS OR COCAINE BY GRADE LEVEL

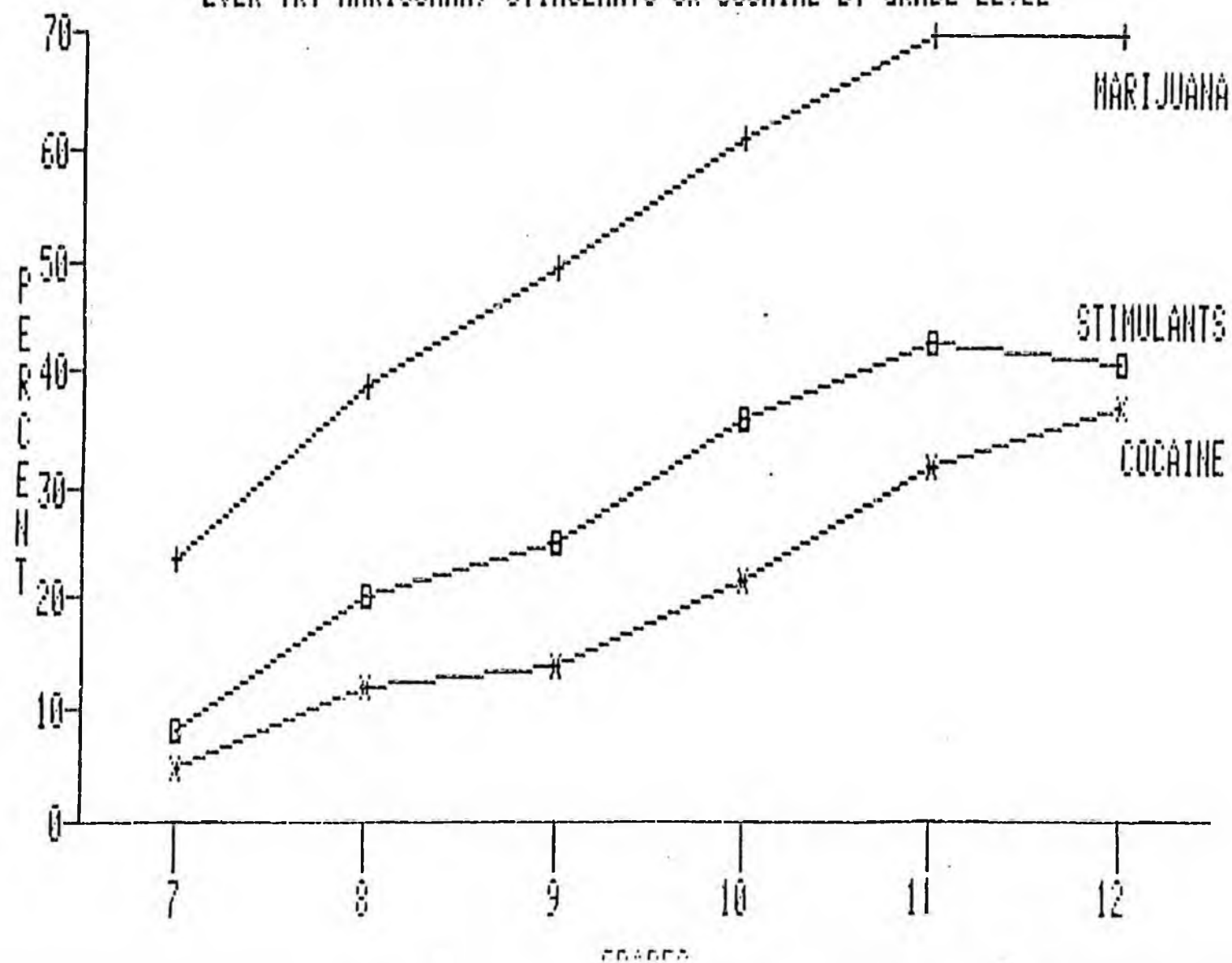


TABLE T-8

REASONS FOR NOT TRYING OR HAVING STOPPED
EXPERIMENTING WITH PSYCHOACTIVE DRUGS

Total Schools
Students Grades 7-12
(N = 3609)

<u>Reasons Given:</u>		<u>For Not Trying Drugs</u>	<u>For Having Stopped</u> <u>Experimenting with Drugs</u>
	<u>Total Number of Students Responding</u>	<u>Percent of Respondents Not Trying for each Reason</u>	<u>Percent of Respondents who Tried and Stopped for each Reason</u>
1. May hurt my body.	2779	18.3	41.9
2. May hurt my mind.	2780	15.8	44.6
3. May cause addiction.	2744	20.6	40.0
4. Friends disapprove.	1675	37.4	17.9

TABLE T-9

DRUG EDUCATION AND TRYING DRUGS

Percent of Students Responding

Total Schools
Students Grades 7-12
(N = 3609)

<u>Drug</u>	<u>Percent of Students Responding</u>	<u>Have Had Drug Education and Have Tried</u>	<u>Have Had Drug Education and Have Not Tried</u>	<u>Have Not Had Drug Education and Have Tried</u>	<u>Have Not Had Drug Education and Have Not Tried</u>
Marijuana	72.2	28.6	18.3	34.2	18.9
Hallucinogens	45.2	7.9	38.0	9.9	44.2
Cocaine	50.5	13.5	31.8	20.1	34.6
Heroin	37.7	2.1	42.5	3.0	52.4
Inhalants	47.7	15.4	31.5	16.2	36.9
Stimulants	54.5	20.5	26.0	25.1	28.4
Depressants	42.9	13.0	32.0	17.2	37.8
Tranquilizers	40.2	10.8	33.9	16.0	39.3

TABLE T-10
STUDENTS' PERCEPTIONS OF DRUG-TAKING BEHAVIOR

Total Schools
Students Grades 7-12
(N = 3080)

Students who:	Percent of Students who*		
	Expressed a need for drug education	Expressed no need for drug education	Total
Have Tried Drugs	43.2	12.8	56.0
Have Not Tried Drugs	37.1	6.9	44.0
Total	80.3	19.7	100.0

*The differences between classifications are not statistically significant:
 $\chi^2 = 14.1$, d.f. = 1, $p < .001$.

TABLE T-11

PERCENT OF STUDENTS RESPONDING "TRUE" TO VARIOUS STATEMENTS

Total Schools
By Grade Levels
(N = 3609)

Statement	Grades*						Total
	7	8	9	10	11	12	
1. I have missed school because of drug use.	2.1	5.8	8.2	11.7	14.8	17.3	9.2
2. I have had problems in school because of drug use.	4.3	5.6	8.5	11.1	11.4	12.9	8.6
3. I have had problems outside of school because of drug use.	6.3	10.0	11.6	16.0	15.3	15.0	12.1

*Each statistic represents the proportion of students within each grade who answered "yes" to each question. The total represents the percent of all students responding "yes" to each question.

TABLE T-12

COMPARISONS OF LIFETIME EXPERIENCES WITH PSYCHOACTIVE DRUGS

Surveys: Percent Who Ever Tried Each Drug

Total Schools
Students Grades 7-12

Drug	Total Sample (N=3609)	Anchorage Sitka Nome Barrow Kotzebue (N=2811)	Total Sample Less Anchorage (N=2021)	Bethel Juneau Fairbanks (N=798)	Barrow Kotzebue Nome (N=600)	Anchorage (N=1588)	1982* National Survey of 12-17 Yr. Olds (N=1581)
Marijuana	49.5	50.7	50.8	44.9	58.8	51.4	26.7
Hallucinogens	8.7	8.7	9.4	8.6	9.2	9.4	5.2
Cocaine	18.3	18.5	17.0	17.8	18.0	23.5	6.5
Heroin	2.2	2.1	1.8	2.3	2.2	3.2	<.1
Inhalants	16.5	15.5	17.3	20.1	15.0	18.4	-
Stimulants	27.2	26.9	28.6	28.2	25.8	29.6	6.7
Depressants	14.3	14.6	12.5	13.2	10.5	19.9	5.8
Tranquillizers	11.5	12.0	8.9	9.9	6.3	17.9	4.9
Alcohol	71.7	44.8	65.8	66.2	62.0	82.1	65.2
Tobacco	55.0	34.0	50.9	47.5	54.7	64.9	49.5

*Miller, 1983.

FIGURE T-12

COMPARISON OF ALASKA AND NATIONAL SURVEY DATA
LIFETIME EXPERIENCES WITH PSYCHOACTIVE DRUGS

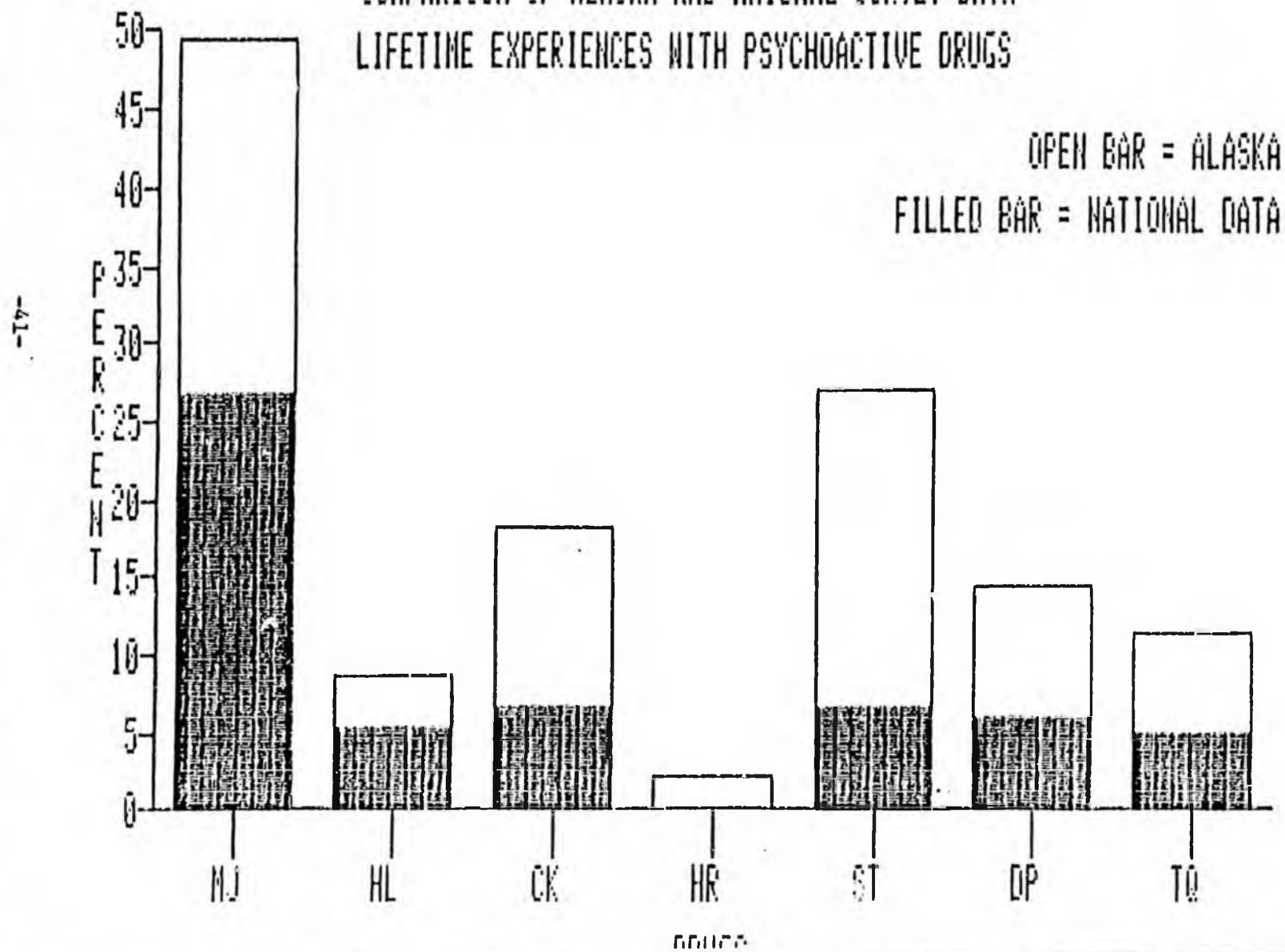


TABLE T-13

COMPARISONS OF LIFETIME EXPERIENCES WITH PSYCHOACTIVE DRUGS
ALASKAN SENIORS AND NATIONAL STUDENT SURVEY

High School Seniors Who Ever Tried Each Drug

Total Schools
Students Grades 7-12

Drug	Total Sample (N=345)	Anchorage Sitka Nome Barrow Kotzebue (N=277)	Total Sample Less Anchorage (N=215)	Bethel Juneau Fairbanks (N=68)	Barrow Kotzebue Nome (N=73)	Anchorage (N=123)	1982* National Survey of 12-17 Yr. Olds (N=17500)
Marijuana	69.6	77.2	77.2	72.1	78.9	60.2	58.7
Hallucinogens	15.4	17.7	17.7	14.7	9.4	12.2	12.5
Cocaine	37.1	40.0	40.0	42.6	39.7	34.1	16.0
Heroin	1.2	1.4	1.4	0.0	4.1	0.8	1.2
Inhalants	17.4	19.5	19.5	17.6	17.8	14.6	18.0
Stimulants	40.9	48.8	48.8	42.6	49.3	29.3	27.9
Depressants	18.0	17.7	17.7	17.6	13.7	19.5	15.2
Tranquilizers	14.5	12.6	12.6	11.8	8.2	18.7	14.0

*Johnston, Bachman, & O'Malley, 1982.

CONCLUSIONS AND RECOMMENDATIONS

The major objective of this project was to assess the extent, type of patterns, frequency and distribution of drug-taking behavior among school age youth in grades 7-12 in eight locations of the state: Anchorage, Barrow, Bethel, Fairbanks, Juneau, Kotzebue, Nome and Sitka. The results of this undertaking found generally high rates of lifetime experiences with mood-altering drugs among students surveyed. This high level of drug-taking behavior contrasts dramatically with reports from surveys conducted in the "lower 48," which indicate that "American young people are continuing to moderate their use of illicit drugs..." (Johnston et al., 1982, p. 9). Reports from two recent national surveys (Johnston et al., 1982; Miller, 1983) indicate that there have been declines in use of marijuana and in other drugs and a leveling off of cocaine use by youth. Although there is no previous survey data of Alaskan youth to compare trends, a comparison of current findings of Alaskan youth with their counterparts in the "lower 48" shows considerably higher levels of drug use, except for heroin, which is just slightly higher.

One factor which may contribute to the extensive differences found between the National Survey of 12-17 year olds and Alaskan youth may be related to differences in methodology. The National Survey conducted face-to-face interviews while our procedure involved anonymous responses to questionnaires. It may be that when youth are selected from a general population and interviewed, the reports of prevalence of drug use may be more guarded than when responding anonymously to a survey.

Prior to elaborating on these findings it should be restated that it is not known whether the students who report having tried a drug actually took the drug, that is, whether it is the "real thing" as opposed to a "look-a-like" or a substitute chemical. The important fact, however, is that students apparently believe that they took the reported drug. Also, students, whether taking real or substitute drugs, were involved in drug-taking behavior.

What is evident in the results is that when there is an opportunity to try a drug, particularly marijuana, large percentages of those students having the chance will try it. The question which arises is, Why is the opportunity to try drugs so very high among junior and senior high school students?

A factor which seemingly contributes to the high prevalence rates reported in our study is that drugs are generally available in the state, a phenomena which is supported by anecdotal evidence. The drugs which are available - albeit illegally - find their way down to adolescents and early teenagers who are willing to try them. Additionally, it also appears that these youngsters can afford to buy the available drugs.

Thus, with apparent opportunities to try, students are trying/taking drugs, and the number of students reporting such experiences is high. The pattern of drug use generally follows the pattern described for the "lower 48." Marijuana is the most frequently tried/taken drug, followed by experiences with stimulants and cocaine. While experiences with the other drugs vary, a consistency exists in that heroin is the least tried. In all, the findings indicate that at least half of all students are likely to try marijuana and/or some other drug by the time of high school graduation. More than 75% of students will have also have tried/consumed alcohol prior to their graduation from high school. Most of the "hard" drug use, however, will be experimental.

The important question is, Why do so many students experiment with and/or

take drugs? There are several possible answers to this question. One is that many of the illicit drugs such as marijuana, stimulants and cocaine, have become incorporated into the "lifestyle" of so many people that adolescents themselves experiment with them as part of their own "normative" behavior. That is, the wide scale prevalence of drug use in general makes it a phenomenon which adolescents may pursue in order to know what drug experiences are like. It appears that adolescent drug use may, to a large extent, be related to the attitudes and behaviors found in the larger adult society. Simply put, the "kids" do what the adults are doing!

Related to this "imitation" phenomena is what may be called a "curiosity" motive for trying drugs. This motive is discussed in greater detail in the Anchorage School District Report (see Appendix 2), in which an analysis of students' motives for trying/taking drugs was completed. Briefly, a common reason for many youngsters to try mood-altering drugs is curiosity -- just to see what it is like. Many students try a drug once, or several times, with no intention to continue use in the future. However, this motive may not be totally applicable to use of alcohol, cigarettes, marijuana and, to a lesser extent, stimulants and cocaine.

Another reason for the trying/taking of drugs, interrelated with the "curiosity" motive, is a willingness to seek new and different experiences. This motive was found to prevail within the Anchorage School sample and has been reported in other research (Segal, 1982; 1983, in press). Drugs do provide a new and different experience; some students seem to find it rewarding or gratifying whereas others do not find it pleasurable.

Some youngsters may use mood-altering drugs to gain the ability to cope with personal problems and/or stress. Drugs may not only temporarily help one to

escape from personal discomfort, but they also help to delay having to deal with conflict or stress. This motive for taking drugs has been found consistently in research investigating both adolescent and adult drug-taking behavior (Jessor & Jessor, 1977; Segal, Huba, & Singer, 1980). It is unlikely that the high level of drug use found in this study is attributable to this motive, but it is possible that a small percentage of students, particularly those who take a variety of drugs with some degree of frequency, may be using drugs to "feel better" as well as to feel "high."

An important finding in this study is that age, opportunity to try and first experiences with mood-altering drugs are significantly interrelated and also vary greatly for each drug. As experiences with some drugs, such as marijuana, begin to taper off, first experiences with other drugs, such as cocaine, tend to increase. The relationship between age and first experiences with drugs is revealing itself to be curvilinear, that is, a relationship which can change direction at any given age level for any given drug. The most frequent ages for trying drugs are 13 and 15, which are related to beginning junior and senior high school. It may be, as advocated within some recent research literature (Huba, Winegard and Bentler, 1979; Segal, 1983; Segal, Huba and Singer, 1980; Segal, Cromer, Hobfoll and Wasserman, 1982) that drug-taking behavior by adolescents is mainly experimental and is in large part "normative" and unrelated to any pattern of deviance or serious emotional distress.

Another interesting finding which characterizes the Alaskan findings (as discussed more fully in the Anchorage School District Report) is that peer pressure or influences do not appear to be as significant a factor as is reported in other studies (Jessor & Jessor, 1977; Kandell, Kessler, & Margulies,

1978). Why this is the case is not totally clear; it may be that drug-taking behavior has become so acceptable among all youth that the traditional schism between "users" and "nonusers" no longer exists, thereby making it unnecessary for those who take drugs to seek mutual support from others who take drugs. Additionally, the generally widespread use of drugs may offset any special status attributable to those who take drugs, thus reducing the peer influences to try or not try drugs.

In summary, it is evident that drug-taking behavior is attributable to many interrelated factors, some exerting greater influences than others at different points during one's secondary school career. Further research is needed to focus more specifically on students' perceptions of why they take drugs and the particular expectations that they have of what drugs will do for them.

The results of the present study have a number of implications concerning drug education/prevention programs. One important consideration is that the students perceive a need for such programs, particularly the ones who have had experiences with psychoactive drugs. This finding suggests that the students may be inferring that if other students are "educated," or if they themselves learned more about "drugs," the risks of taking drugs may be reduced. It is presumed that presentation of information regarding the "dangers" and risks of taking drugs, especially in light of the findings that most students fear the harmful psychological and physical effects of taking drugs, can help to lessen the curiosity to experience the anticipated sensations which drugs can engender. The issue becomes one of how to develop and implement an effective drug education/prevention program. This question is one which educators and researchers have been struggling with for over a decade. While the evidence supports the continued need for educational efforts (Wepner, 1979), it is apparent that such programs generally tend to restrain young persons who were

not inclined to try drugs in the first place. The major problem is how to identify those who are at greater risk of trying drugs. A variety of drug education/prevention programs have been implemented over the country, each to a large extent providing a uniform curriculum across age and grade level.

An important implication concerning drug education from the foregoing analysis of age/grade trends is that different prevention goals should be devised for different points in the incidence and prevalence curves. The most logical starting point is that age in the curve at which positive acceleration begins in the prevalence curve. Prior to this point prevention efforts should focus on delaying or preventing the onset of nonmedical taking of mood-altering drugs, and/or extrafamilial alcohol consumption. After this point intensive prevention efforts should concentrate on the reduction of prevalence, giving special emphasis to multiple substance use, frequency of drinking, regular use of marijuana, and on reducing the trying/taking of stimulants and cocaine. Emphasis should also be given to other types of mood-altering drugs, capitalizing on the apparent self-moderating factors that appear to already be "at work" with students to avoid taking drugs perceived as particularly harmful. What is needed is the involvement of a rational program of drug education/prevention - a program derived from an informational base which provides data on the prevalence and developmental trends of drug-taking behavior and on some of the psychosocial aspects related to use and nonuse of mood-altering drugs. This data base can serve as a conceptual basis for prevention strategies designed to prevent and reduce drug-taking behavior by school age youth.

Another important implication of the findings concerns the issue of availability of mood-altering drugs. It should be noted that if a reduction of experimentation with and continued use of drugs is to be achieved, the availabi-

lity of drugs needs to be reduced. There is, however, no easy solution to achieving such a reduction.

The recent history of attempts to address drug use in the United States has tended to deal with the problem through strong legislation aimed at reducing "drugs on the street" by increasing penalties for possession and use of drugs. Such an approach has led to a preoccupation with and elaboration of penalties associated with drug use which has not generally resulted in an overall reduction of "drug problems." Rather than focusing only on the elimination of drugs by legislation, efforts also have to be directed toward focusing on people and the circumstances which contribute to their use of drugs. It has been shown that the "legal" approach to drug misuse puts an unfair and sometimes overwhelming burden on the justice system, leading to the unrealistic expectation that this system will eliminate the problem.

Legal measures can only be effective if society perceives them to be reasonable and realistic. The experience of decades of having to confront drug use in this country makes it clear that without a comprehensive approach the likelihood of reducing drug use is low. This comprehensive approach, requires the joining together of legal, social, education and legislative bodies to pool resources, experiences and knowledge to develop an integrated, comprehensive and relevant approach to address problems of drug use in the community, as well as focusing on the drug-taking behavior of school age youth.

The accomplishment of the above goal requires that a price be paid. This price lies in the implications for policy decisions made by local and state governmental bodies regarding drug use. With respect to youth, in order to prevent the taking of drugs prior to the age at which most of the experimentation with and continued use of drugs occurs, and in order to reduce the incidence and prevalence thereafter, governmental bodies will have to appropriate program

funds. The level of funds will have to be sufficient to allow systematic research and comprehensive program development to be initiated, implemented, and evaluated over a period of time. Legislators and other governmental officials will also need to realize that the efforts of prevention programs are difficult to assess, especially since the effects may not be immediate. Efforts directed at fourth graders, for example, may not be realized until students reach junior high school, where exposure to drugs becomes more widespread and where influences to try drugs exert themselves. Additionally, the importance of drug education/prevention efforts directed at those students in the peak years of drug experimentation may not be fully realized until they reach young adulthood. What is important is the understanding that an investment in a rational educational/prevention program subject to ongoing evaluation, while costly at the point of initial undertaking, can save costs associated with health, social and legal consequences. Only through the acceptance and commitment to alter the attitudes and behaviors of the next generation can a reversal in the trend to take drugs be achieved.

List of References

- Huba, G., J. Wingard, & P. Bentler. Applications of a theory of drug use to prevention programs. Journal of Drug Education, 1980:10, 25-38.
- Jessor, R. and S. Jessor. Problem Behavior and Psychosocial Development. New York: Academic Press, 1977.
- Johnston, L., J. Bachman, & P. O'Mally. Student drug use, attitudes and beliefs. Washington, D.C.: NIDA, 1982.
- Johnston, L., J. Bachman, & P. O'Mally. Highlights from student drug use in America. 1975-1981, Washington, D.C.: NIDA, 1981.
- Kandel, D.B., R.C. Kessler, & R.Z. Margulies. Antecedents of adolescent initiation into stages of drug use: A developmental analysis. In D.B. Kandel (ed.), Longitudinal Research on Drug Use: Empirical Findings and Methodological Issues. Washington, D.C.: Hemisphere, 1978.
- Miller, J.D., & I.E. Cisin. National Survey on Drug Abuse: Main Findings. Washington, D.C.: NIDA, 1982 (in preparation).
- Richards, L.G. Demographic Trends and Drug Abuse, 1980-1995. Washington, D.C.: NIDA Research Monograph No. 35, 1981.
- Segal, B. Psychological aspects of drug-taking behavior. International Journal of the Addictions, 1981, 18, 611-615.
- Segal, B., F. Cromer, S.S. Hobfoll, & P.Z. Wasserman. Patterns of reasons for drug use among detained and adjudicated juveniles. International Journal of the Addictions, 1982, 17, 1117-1130.
- Segal, B., G. Huba, & J. Singer. Drugs, daydreaming & personality. Hillsdale, N.J.: Lawrence Erlbaum Associates, 1980.
- Wepner, S. Which Way Drug Education? Journal of Drug Education. 1979, 9, 93-103.

Prevalence of Drug-Taking Behavior Among Alaskan Youth: Comparisons With National Findings¹

by Bernard Segal, Ph.D.²

ABSTRACT

The present research identified the prevalence and patterns of drug-taking behavior among a statewide sample of youth in grades 7-12. The findings indicated that lifetime experience with psychoactive substances was fairly high. When a comparison was made with national data, prevalence rates within Alaska were found to be quite higher than rates reported among youth in the lower-48 states. Some of the reasons for this high level of drug use and the implications of the findings are discussed.

INTRODUCTION

The United States has witnessed an increase in the frequency and intensity of substance abuse since the late 1960's. The non-medicinal use of illicit mood-altering drugs by elementary, junior and senior high school students, in particular, has become a problem of national concern. Although legal and social sanctions exist against non-medicinal use of psychoactive drugs for recreational or social purposes, drugs continue to be taken, and those youth who take them place themselves at risk for potential legal, social and health problems.

Interest in learning more fully about the nature and extent of drug-taking behavior among the nation's youth prompted the National Institute on Drug Abuse (NIDA) to sponsor a number of national surveys and specific research studies (1-3). Alaska, however, was not included in any of these projects. The current research was undertaken to gain comparable information about Alaska because educators, community planners, policy makers, legislators, and governmental officials and authorities needed to have contemporary knowledge about drug abuse in the state to most efficiently allocate resources to address the problem. High levels of drug use were anticipated due, in part, to the state's last

frontier atmosphere which helped to attract many troubled people to the individualistic risk-taking attitude that prevails in the youthful population, and to significant disposable income, among other contributing factors.

The specific research objectives of this study were: (1) to assess the nature and extent of drug-taking behavior among Alaskan youth, (2) to examine age-cohort differences with respect to drug-taking behavior, (3) to identify psychosocial correlates of drug use, and (4) to explore some of the implications that such phenomena have for treatment and prevention programs. This paper presents the major findings pertaining to the prevalence of drug use in Alaska among youth, compares the findings with results from national surveys, and briefly reviews their implications. The findings pertaining to psychosocial correlates and age differences, as well as a complete description of the project, have been presented elsewhere (4-6).

METHODS

From 1981 through 1982 an extensive statewide study was undertaken to estimate the prevalence of drug use among Alaskan youth. The statewide survey involved eight widely separated urban and rural school districts, representative of the different regions of Alaska except for the Aleutian chain. The locations were Anchorage, Barrow, Bethel, Fairbanks, Juneau, Kotzebue, Nome, and Sitka. Sites were selected in order to obtain a representative sample of the state's junior and senior high school students, rather than sampling school districts. The schools in the sample contain over 75% of the state's junior and senior high school students. Representative samples in the Anchorage and Fairbanks school districts were obtained from each of the junior and senior high schools. Districts in the other locations contained only one junior and senior high school, of which the entire school populations were surveyed.

The sampling procedure within the schools involved two methods, each contingent upon the conditions prescribed by the school district: (1) a random sample from among all students in grades 7-12 whose parents

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gave parental consent (Anchorage, Fairbanks and Juneau); and (2) surveying the entire school population of students in grades 7-12 (the remaining five locations).

The first procedure could have presented a problem if the response rate for parental disapproval was high. The opposite happened. Very few (less than 2%) parents objected, thereby allowing a sufficiently large school population from which to obtain a representative sample. The requirement of parental permission did not appear to result in an underrepresentation of drug using students. This became evident when the results were analyzed separately by method of collection, by district, and by region. Despite the different sampling procedures the results were strikingly uniform across the state (6); no significant differences were noted, and the data was aggregated to form a comprehensive data base. The results reported herein are from the aggregated data.

Although the content of each survey was practically identical, in some cases wording and format were simplified to facilitate translation or to comply with school district's regulations. Survey administration was conducted or supervised by a member of the research team during a given school day. A total of 3,609 completed student surveys were obtained (which represented a 99% response rate); males and females were equally distributed (51% males, 49% females), and ages ranged from 11 to 19. The survey questioned nonprescriptive use of marijuana, stimulants, cocaine, hallucinogens, depressants, heroin, inhalants and tranquilizers. Inquiries were also made about use of alcohol and tobacco. Additional questions concerned age of first use of each drug, frequency and recency of use, reasons for use, and other related items.

RESULTS AND DISCUSSION

1. Lifetime Experience

Table 1 contains figures pertaining to opportunity to try different mood altering substances and the percentage of youth who reported having experienced one or more of these substances. Except for hallucinogens (48.1%) and heroin (29.9%), over half those students who had a chance to try one of the other drugs did so: marijuana 74.8%, depressants 71.2%, tranquilizers 72.6%, stimulants 76.2%, and cocaine 63.3%. It is readily apparent that large numbers of students have indicated an opportunity to try different types of psychoactive chemicals and that a correspondingly high number seem to have taken advantage of such opportunities.

Consistent with current national trends (1-2), marijuana is the drug that most students have had a chance to try and do try; half of the students (49.5%) reported using marijuana one or more times. It thus appears that

marijuana was available around the state, and that it was the most widely used illicit substance. In contrast to this finding, and also consistent with national trends, heroin was the drug students were least exposed to and the one least used (2.2% reported having tried this drug). Whether this finding was attributable to an unavailability of heroin in the state or to a reluctance by students to try it is difficult to discern. It may be that both conditions contributed to the low reported incidence of experience.

Table 1
Opportunity to Try and Trying Psychoactive Drugs
Lifetime Experience
(N = 3,609)

Drug	Percent of Sample Having Opportunity	Percent Having Opportunity and Trying	Percent of Total Sample Trying
Marijuana	66.1	74.8	49.5
Hallucinogens	18.1	48.1	8.7
Cocaine	29.0	63.3	18.3
Heroin	7.2	29.9	2.2
Inhalants	26.8	61.5	16.5
Stimulants	35.7	76.2	27.2
Depressants	20.1	71.2	14.3
Tranquilizers	15.9	72.6	11.5

Stimulant-type drugs are second to marijuana in terms of lifetime experience (27.2%), followed by experiences with cocaine (18.3%), inhalants (16.5%), depressants (14.3%), tranquilizers (11.5%), and hallucinogens (8.7%).

The pattern of drug experience reported by the students suggested that they tend to have avoided the more "addictive" substances, such as heroin, and others that can induce severe adverse effects (e.g., inhalants, depressants and tranquilizers). What seemed to be preferred, instead, was the use of drugs that induce more pleasant effects such as a state of euphoria (marijuana) or a "rush" as is associated with stimulants or cocaine.

Of those who tried drugs, the largest percentage (35.9%) used only one drug, 21.3% tried two drugs, 11.5% experienced three, 29.8% tried four or more drugs, and 1.5% tried all eight of the drugs listed in the questionnaire.

2. Frequency and Recency of Drug-Taking Behaviors

The survey inquired about the frequency and recency of students' drug-taking behaviors. One set of these questions (concerning frequency of use) differed for the Anchorage sample, thereby precluding their inclusion in the report of aggregated data. The results of the findings

Table 2
FREQUENCY AND REGENCY OF DRUG-TAKING BEHAVIOR
Past Year Experience

Percent of Students Who Have Tried/Taken a Drug

Drug	(N = 3,609)		Frequency* (N = 2,021)						Total Once or More
	Percent of Sample Respondin	Percent of Sample Who Tried Within Past Year	Once a Month or Less	2-3 Times a Month	Once a Week	2-5 Times a Week	Daily	More Than Once a Day	
Marijuana	88.0	42.6	19.0	7.1	4.0	6.0	2.5	2.8	41.5
Hallucinogens	82.0	7.1	4.9	0.7	0.2	0.2	0.2	0.0	6.4
Cocaine	83.0	15.6	11.0	2.5	0.6	0.7	0.3	0.4	15.5
Heroin	81.9	1.7	1.7	0.2	0.1	0.1	0.1	0.3	2.5
Inhalants	82.6	11.9	7.4	1.4	0.5	0.4	0.4	0.4	10.5
Stimulants	83.1	22.0	12.2	4.0	1.7	1.3	0.8	0.9	20.9
Depressants	82.2	11.8	7.3	2.1	0.6	0.6	0.2	0.5	11.3
Tranquilizers	81.7	11.4	6.5	1.4	0.6	0.3	0.2	0.4	9.4

*Because of missing responses, those who report having tried a drug in the past year will not always correspond to the percent who reported ever trying a drug.

describing frequency of students' use thus represent an aggregation of only seven districts (excluding Anchorage), while the findings pertaining to the recency of use represent the total sample.

Table 2 describes the recency and frequency of drug-taking behavior during the past year. The results indicate that marijuana is the drug experienced most, with 41.5% of the students indicating having experienced it one or more times, and 42.6% having used it during the past year.

Experiences with stimulants and cocaine are less extensive than those shown for marijuana, but are, respectively, the most commonly used substances. Most of the students who tried them did so less than 10 times and once-a-week or less. Experiences with the other drugs tended to be less frequent, with students expressing modest experiences with depressants, inhalants, and tranquilizer type substances. Except for marijuana, and to a lesser degree stimulants and cocaine, use of other drugs appeared to have been chiefly experimental.

3. Gender and Drug-Taking Behavior

Table 3 indicates that a higher percentage of males experienced all the mood-altering drugs except stimulants, for which females showed a slightly higher percentage. This finding is comparable to that reported by Johnston et al. (2) in describing drug use among high school seniors.

Table 3
LIFETIME EXPERIENCES WITH
PSYCHOACTIVE DRUGS BY GENDER

Drugs	Females and Males Who Reported Ever Having Tried a Drug*	
	MALES (N = 1,770)	FEMALES (N = 1,732)
	Percent of Males who Tried a Drug	Percent of Females who Tried a Drug
Marijuana	51.1	48.3
Hallucinogens	10.5	8.7
Cocaine	19.8	17.0
Heroin	3.2	1.2
Inhalants	17.9	15.1
Stimulants	26.3	28.2
Depressants	15.4	13.6
Tranquilizers	12.4	10.9

*107 students did not report gender.

4. Drug-Taking Behavior by Grade

As reflected in Table 4, there was a steady increase in experiences with all types of drugs rising to a peak at grades 11 and 12. The major exception to this pattern was for inhalants, where incidence of use peaked sharply

Table 4
DRUG-TAKING BEHAVIOR BY GRADE
 Percent Within Each Grade Who Reported
 Trying/Taking a Drug
 Students Grade 7-12

Drug	Grade*					
	7 (N = 665)	8 (N = 695)	9 (N = 603)	10 (N = 658)	11 (N = 564)	12 (N = 345)
Marijuana	23.3	38.7	49.1	60.6	69.9	69.6
Hallucinogens	2.9	5.5	8.0	10.9	13.8	15.4
Cocaine	4.8	12.1	13.9	21.9	31.6	37.1
Heroin	0.9	1.8	2.3	2.6	4.4	1.2
Inhalants	12.0	18.0	14.4	18.8	18.8	17.4
Stimulants	8.1	20.0	25.2	36.0	42.6	40.9
Depressants	6.2	12.4	13.4	18.7	21.1	18.0
Tranquilizers	3.8	9.6	10.0	15.7	18.3	14.5

*304 students did not report grade levels.

in the eighth grade. It may be that inhalant substances (such as gasoline, paint thinner, sprays, etc.) are more readily obtainable and less expensive for these youngsters than other substances, allowing emulation of the "highs" that older students achieve through the use of the "hard" drugs.

It may be inferred from this table that an orderly progression of drug use may exist. Segal (4), when analyzing the relationship between age and initiation into drug-taking behavior, did find a predictable sequential pattern of drug use, beginning with marijuana, followed by stimulants, cocaine, depressants, tranquilizers, and hallucinogens.

The data in Table 4 also permit a general comparison of drug use between junior (grades 7-9) and senior high school (grades 10-12) students. The findings indicate clearly that more senior high students have tried drugs than junior high students. (A separate Chi-Square analysis comparing drug use between the two groups of students found that the differences are statistically significant.)

Although the drug-taking behavior was more extensive among high school students, the pattern of use was similar to that of junior high school students. Marijuana, stimulants and cocaine were the three most experienced drugs, respectively, while heroin, tranquilizers and hallucinogens were among the least experienced. Moderate use of inhalants and depressants was noted.

5. Comparison with National Survey Data

Table 5 provides a comparison of the Alaska data

with findings from the 1982 National Survey on Drug Abuse (1). It should be noted that this comparison is not based on similar methodologies. The Alaskan study is based on responses to questionnaires, the national survey is based on responses to personal interviews; also the ecological environments of the two samples differ greatly. The comparison is provided, however, in order to demonstrate how patterns of use among Alaskan youth generally compare to those reported for youth in the "lower-48" states.

Table 5
COMPARISONS OF ALASKA WITH
NATIONAL SURVEY FINDINGS OF
LIFETIME EXPERIENCES
WITH PSYCHOACTIVE SUBSTANCES

Drugs	1982*	
	Alaska Youth 12-17 Years (N = 3,103)	National Survey 12-17 Years (N = 1,581)
Marijuana	47.4	26.7
Hallucinogens	7.9	5.2
Cocaine	16.6	6.5
Heroin	2.3	<0.1
Stimulants	25.9	6.7
Depressants	14.0	5.8
Tranquilizers	11.1	4.9
Alcohol	71.7	65.2
Tobacco	55.0	49.5

*Miller and Cisin (1).

Table 6
COMPARISONS OF LIFETIME EXPERIENCE WITH
PSYCHOACTIVE DRUGS BY HIGH SCHOOL SENIORS

Drug	Percent Trying			
	Alaskan Seniors (N = 345)	1982* National Seniors (N = 17,500)	1983* National Seniors (N = 16,300)	1984* National Seniors (N = 15,900)
Marijuana	70**	58	57	54.9
Hallucinogens	15	13	12	10.7
Cocaine	37	16	16	16.1
Heroin	1	1	1	1.3
Inhalants	17	13	14	14.4
Stimulants	41	36	36	27.9
Depressants	18	12.8	13.6	13.3
Tranquilizers	15	14	13	12.4

*Source: Johnston et al. (2), National Institute on Drug Abuse.

**Figures are rounded to nearest whole number.

The comparisons show that the rates for experience with drugs among Alaskans aged 12-17 exceeded the rates obtained in the national sample for every substance. The magnitude of the differences range from a low of 2:1 to a high of 3:1. It is apparent that drug-taking behavior occurred at a higher rate among Alaskan youth than among those reported in the national survey, but because of differences in sampling procedures and time of sampling, these differences should be interpreted as a relative comparison rather than exact differences. Nevertheless, the question that arises is: Why are the differences so extensive? One answer may lie in the sampling procedure; youth may be less reluctant to report drug use in a questionnaire than in a personal interview. Another possible explanation is that drug use in Alaska is actually higher. The latter explanation tends to be supported when a comparison is made between high school seniors in Alaska and seniors in Johnston et al's (2) national study. Representative findings from these more comparable surveys are presented in Table 6. Except for heroin, drug experience rates for Alaskan seniors exceed the rates obtained in the national senior sample.

CONCLUSIONS

The results of this study indicate a pattern of drug-taking behavior that is consistent among adolescents across the state. Furthermore, prevalence levels for lifetime experiences in Alaska, despite limitations in comparing the Alaskan data with national household data, are higher than the prevalence rates reported in the national survey, and in the national survey of high

school seniors. Another possible limitation to the study is the fact that it is not known whether the respondents who reported taking a drug actually took the "real thing" as opposed to a "look-alike" or substitute substance, except for marijuana.

While this problem is common to all forms of survey research, it need not detract from the basic findings. What is important to consider is that the respondents, regardless of whether they may have taken real or substitute drugs, reported that they were involved in some form of drug-taking behavior, and it is *their* account of their behavior in which we are interested. Additionally, the issue of the reliability and validity of self-reports concerning drug-taking behaviors always comes into question, but sufficient research has been conducted on this problem to conclude that self-reports are generally reliable and valid and tend to be free from systematic bias.

The major question that arises is: Why are the prevalence rates so high in Alaska? Part of the answer seems to be that drugs are readily available, and that many young people are actively interested in seeking these drugs. Furthermore, mood-altering drugs may have become incorporated into the "Alaskan life-style." In this context, experimental or recreational drug-taking behavior is viewed primarily as a social phenomenon and not as deviant behavior. In Alaska this life-style pattern takes on a special quality. Perhaps many who try or use drugs recreationally perceive their drug-taking behavior as part of a life-style that represents a breaking away from the traditional estab-

lishment—one that emphasizes a desire to develop free from conformity and a need to seek new, different, stimulating or exciting experience (5). Such behavior appears to be consistent with the "last frontier" individualistic, risk-taking behaviors practiced by many people in the state. Adolescents may tend to emulate these motives.

An important implication of this finding is that of determining more precisely how attitudes, life-style or value systems espoused within the larger context of society exert an influence on the younger members of that society. For many of them, experimentation with drugs may not only serve to satisfy curiosity, but also may be a means of obtaining new and exciting experiences. While these motives may also prevail among "lower-48" youth (8), Alaska's unique environment tends to heighten their reinforcement. While all drug-taking behavior cannot be accounted for by these reasons, research (5) has shown a strong relationship between these motives and such behavior.

The findings from the present study have significant implications concerning the prevention of drug-taking behavior. Different prevention goals may need to be devised for various points in the prevalence curves pertaining to first experiences with drugs. Since recent research (4, 9) has suggested that there may be critical periods for substance use initiation, there is every reason to underscore the importance of understanding these early use patterns as the first step in the design and implementation of primary prevention programs. The most logical strategy is to focus prevention efforts at the ages at which initiation into drug-taking behavior occurs. Prior to these ages prevention efforts should be directed at delaying or preventing the onset of non-medicinal use of mood-altering drugs; subsequent to these critical periods efforts should concentrate on the reduction of prevalence.

An important element of any prevention program should be a basic assumption that drug experimentation or limited recreational drug use may not necessarily represent deviant or pathological behavior. Rather, such behavior may have become a social norm, and youth in our society may be reflecting a form of behavior that has become acceptable among large segments of our society, even though it is illegal and poses a health risk. Prevention programs based on this premise should have a better chance at succeeding than programs that do not take this phenomenon into consideration. Prevention specialists, therefore, are faced with the task of developing a strategy that comes into effect after a drug has been tried—one that focuses on reducing use after initiation to or experimentation with mood-altering drugs has occurred.

In summary, it is evident that the lifetime prevalence rates for drug use were remarkably high in Alaska. It is

also apparent that there is a need for a greater understanding of the factors that contribute to Alaska's high level of drug-taking behavior. The understanding of these factors should be applicable not only to Alaska but also to other areas of the country experiencing a rise in drug use among youth.

REFERENCES

1. Miller JD Cisin I. Highlights from the national survey on drug abuse: 1982. Rockville, MD: National Institute on Drug Abuse, 1983.
2. Johnston LD, O'Malley PM, Bachman JG. Use of licit and illicit drugs by America's high school students 1975-1984. Rockville, MD: National Institute on Drug Abuse, 1985.
3. Richards LG (Ed.). Demographic trends and drug abuse, 1980-1995. Rockville, MD: National Institute on Drug Abuse, 1981.
4. Segal B. Age and first experience with psychoactive drugs. *Int J Addict* 1986; 21:1285-1306.
5. Segal B. Confirmatory analyses of reasons for experiencing psychoactive drugs during Adolescence. *Int J Addict* 1986;20:1649-1662.
6. Segal B, McKelvy J, Bowman D, Mala T. Patterns of drug use in Alaska: School survey. Juneau, AK: Department of Health and Social Services, 1983.
7. Segal B, Huba JG, Singer JE. *Drugs, daydreaming and personality*. Hillsdale, NJ: Earlbaum, 1980.
8. Grady K, Gersick KE, Snow DL, Kessen M. The emergence of adolescent substance use. *J Drug Ed* 1986; 16:203-220.

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The FIRST in a SERIES of
TRIENNIAL REPORTS to CONGRESS
from the SECRETARY, DEPARTMENT of
HEALTH and HUMAN SERVICES

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Alcohol, Drug Abuse, and Mental Health Administration

National Institute on Drug Abuse
5600 Fishers Lane
Rockville, Maryland 20857

JANUARY 1984

ACKNOWLEDGMENTS

Preparation of the first triennial report to Congress on drug abuse and drug abuse research has been made possible by the generous cooperation of distinguished members of the scientific community. By making available their research findings and specialized knowledge, these individuals have allowed us to provide a considerably more current picture than otherwise could be drawn. Their contributions in the following areas are gratefully acknowledged.

Introduction and Extent and Consequences of Drug Abuse:
Dr. Richard Clayton, University of Kentucky

Prevention Research: Dr. Gilbert J. Botvin, Cornell
University Medical College

Treatment Research: Dr. Charles O'Brien, University of
Pennsylvania

Marijuana and Cannabinoids: Dr. Sidney Cohen, University of
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Heroin and Narcotics: Dr. William Martin, University of
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Basic Research and Endorphins and Enkephalins: Dr. Floyd E.
Bloom, The Salk Institute

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We also wish to acknowledge the important contributions of two staff members at the National Institute on Drug Abuse's Addiction Research Center: Dr. Charles Gorodetsky and Dr. Jack Henningfield.

Whenever specific questions of scientific judgment arose in the preparation of this report, we deferred to the expertise of the researchers contributing to individual chapters.

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INTRODUCTION

The problem of drug use and abuse in the United States is pervasive. In fact, it is widely thought that the levels of use and abuse of drugs in our society are equal to or higher than those found in any other industrialized country. The drug abuse problem is also exceedingly diverse. Virtually every community in every State has, at one time or another, felt its impact, some more acutely than others. Drug abuse rates vary from community to community and, within communities, the rates often vary considerably from neighborhood to neighborhood. While there are some differences in the degree to which drugs are abused by sex, race-ethnicity, social class, and other personal and psychological characteristics, no segment of the population is immune to the problem. Further, the drug abuse problem spreads and changes with remarkable speed. For example, the phencyclidine (PCP) epidemic of the 1970s arose almost overnight and, just when research on this drug began to make some strides, the problem decreased dramatically.

Stated simply the problem of drug abuse in the United States is an extremely complex and almost constantly changing phenomenon. The more we learn about the problem, the more cognizant we are of the impact drug abuse has on individual lives, on the functioning of families and communities, and on the health and well-being of the entire society.

THE RESEARCH PROGRAM AT NIDA

The Federal agency responsible for monitoring drug abuse trends and sponsoring research on this complex problem is the National Institute on Drug Abuse (NIDA). It was established in September of 1972 and given statutory authority in 1973. Thus, NIDA has been in existence for less than a decade. For most of this time, it has operated under an extremely broad mandate that included providing direct financial assistance for drug abuse education, training, treatment, and rehabilitation, as well as funding and

conducting intra- and extramural research. However, since the advent of the Alcohol and Drug Abuse and Mental Health Services Block Grant program in fiscal year 1982, NIDA no longer provides direct financial assistance to treatment and prevention programs although it does conduct research in these important subject areas.

The Epidemiological Research Program provides the Institute with an understanding of the incidence of, prevalence of, and trends in drug abuse for the general population as well as for specific subgroups within the population. It is organized around several statistical reporting systems that monitor changes in some of the consequences of drug abuse, e.g., medical emergencies, drug overdose deaths, admissions to treatment, and it regularly surveys the correlates, causes, and consequences of drug abuse in various segments of the population (i.e., households, high school seniors, etc.).

Prevention and treatment research are not seen as totally separate entities. Rather, they are thought to exist on a continuum of prevention. The Prevention Research Program includes the design, delivery, and evaluation of different school, peer, family, media, and community-based strategies. The primary purpose of these studies is to learn the most effective means to teach young people how to choose healthy alternatives to drug use. Much of the research in the area of primary prevention involves learning how young people make decisions and learning how to influence that decision-making process. The Treatment Research Program at NIDA is focused on those persons who are already heavily involved in drug abuse and who are suffering the consequences of that involvement. Treatment research seeks to design and evaluate the best mixture of treatment strategies for persons with differing kinds of drug abuse problems, the ultimate goal being prevention of further drug abuse and its attendant consequences. The fourth and final segment of the research program at NIDA is Drug Specific Research. This type of research is usually "basic" in nature because the bulk of it deals with the chemical and pharmacological properties of specific drugs and their effects on organisms.

About half of NIDA's program consists of basic research, seeking to develop new knowledge about the mechanism of action of drugs; their sites of action, especially in the brain and central nervous system; and their pharmacology. Recent advances in receptor research under sponsorship of NIDA grants have done much to advance the field of basic knowledge about how drugs act in the body and how their effects are produced.

Other drug-specific research focuses on the hazards of various drugs, and ranges from the adverse biological effects of drugs on body systems to psychobehavioral effects, including effects on learning, performance, and cognition, and to social effects, such as crime. Chemical research focuses on the development of new compounds, prediction of drug action from structure-activity relationships, determination of metabolic pathways of drugs, and the development of assay methods of detecting drugs in body fluids.

SIGNIFICANT RESEARCH CONTRIBUTIONS

In somewhat less than 10 years NIDA has established a strong program of research in the four categories. Significant contributions have been made in each area. A host of longitudinal studies, i.e., studies of the same people at different points in time, have provided a much clearer understanding of the factors influencing the initiation, continuation, progression, and cessation of drug use. The Institute has sponsored tightly controlled and comprehensive studies of various prevention strategies delivered in schools, e.g., drug education courses, teacher training, decisionmaking courses. There are clear differences in how effective these strategies are in changing student attitudes about drugs and their use of drugs. An extensive series of studies has begun to reveal which types of treatment are most effective for particular types of individuals with serious drug problems. Over the past several years, NIDA-sponsored research into the chemistry and metabolism of various drugs, i.e., the ways in which the drug is broken down and chemically transformed in the body, has shed new light on the role played by endorphins, the body's own pain-fighting substance. This line of research has relevance for all of medicine. NIDA has also played a key role in the development and testing of new and more effective treatment agents, most notably LAAM, naltrexone, and buprenorphine, all of which have unique properties that contribute to better treatment for opiate addicts. Research on the dependence liability and addictive potential of tobacco has led to a new understanding and appreciation of why people who smoke cigarettes have such a difficult time quitting.

ORGANIZATION OF THE FIRST TRIENNIAL REPORT

This first triennial report to the U.S. Congress is organized to reflect the four foci of NIDA's research program. Following this introduction, Chapter 2 includes a review of some of the latest findings on the extent of drug abuse in

deaths, vehicular accidents attributed to drug use, the impact of drug abuse in the workplace, the relationship between drug abuse and crime, and the impact of early drug use on subsequent use of other drugs. Included in Chapter 3 are a review of what is known about the factors that promote drug use relative to adolescent development and the effectiveness of various educational and psychosocial approaches to preventing drug use and abuse among adolescents. Chapter 4 focuses on the relative effectiveness of different treatment approaches, including detoxification, methadone maintenance, residential, outpatient drug free, and other treatment modalities. Chapters 5 through 10 will deal with specific drug classes and what is known from basic research about their mechanisms of action and the health hazards associated with use and abuse of these drugs. The final chapter summarizes the emergent knowledge about a new class of drugs, endogenous opioids such as endorphins and enkephalins, and recent research about drug receptors in the central nervous system. This line of research has great potential not only for the field of drug abuse but also for neurology, mental health, cardiology, and alleviating pain.

It would not be possible in a short report to review everything that has been done in each of these research areas. The purpose of this first triennial report is to provide an overview of some of the more important recent research on drug abuse and on the health and other consequences attributable to drug abuse.

EXECUTIVE SUMMARY

Section 2(b)(7) of Public Law 98-24, the Alcohol and Drug Abuse Amendments of 1983, require the Secretary of Health and Human Services to submit to the Congress a report summarizing the health consequences and extent of drug abuse. Also included in this report are current research findings, such as the health effects of marijuana and the addictive property of tobacco. In an effort to provide most current information available, the National Institute on Drug Abuse (NIDA) drew upon experts from the field in each of the various areas covered to prepare the material used in the report.

Recent epidemiological data provide evidence that, as a general trend, the extent of drug use in the Nation has stabilized or is decreasing. Nonetheless, illicit drug in the United States remains at a level probably exceeding any nation in the western industrialized world. Drug abuse clearly is a major public health problem, demanding continuing priority attention and concern. Twenty years ago less than 2 percent of the Nation's young people had tried an illicit drug. Today about two-thirds have tried an illicit drug before they graduate from high school. In 1960 less than 7 percent of college-age young adults had tried marijuana; by 1982, 64 percent reported some use of the drug. There has been a 400 percent increase in heroin use since 1960. The adverse cost to society, particularly of drug-related crime and corruption, also remains unacceptably high. Studies have shown the total annual cost of drug abuse to society to be close to \$100 billion. Of this figure, approximately \$10 to \$16 billion is conservatively attributable to the impact of drug abusers on the health care system, the law enforcement system, the employment market, and the general welfare and social services. Another \$70 to \$80 billion in annual costs result from the costs of criminal drug trafficking.

Niilo Koponen

DRUG ABUSE AND DRUG ABUSE RESEARCH

ALASKA HOUSE OF REPRESENTATIVES
RESEARCH AGENCY
P.O. BOX Y, STATE CAPITAL
JUNEAU, ALASKA 99811-3100



THE SECOND TRIENNIAL REPORT TO CONGRESS
FROM THE SECRETARY, DEPARTMENT OF
HEALTH AND HUMAN SERVICES



ALASKA HOUSE OF REPRESENTATIVES
RESEARCH AGENCY
P.O. BOX Y
JUNEAU, ALASKA 99811-3100

DRUG ABUSE AND
DRUG ABUSE RESEARCH

Return to:

ALASKA HOUSE OF REPRESENTATIVES
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JUNEAU, ALASKA 99811-3100

The Second Triennial Report to Congress
from the Secretary, Department of
Health and Human Services

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Alcohol, Drug Abuse, and Mental Health Administration

National Institute on Drug Abuse
5600 Fishers Lane
Rockville, MD 20857

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Preparation of the Second Triennial Report on Drug Abuse and Drug Abuse Research to the Congress from the Secretary, Department of Health and Human Services, has been accomplished through the generous cooperation of many members of the scientific community. By making available their current research findings and recent work of other experts in the field of drug abuse, they have made it possible to include more up-to-date information than could otherwise have been presented.

Their contributions to the following chapters of the report are gratefully acknowledged:

The Nature and Extent of Drug Abuse

Dr. Richard R. Clayton, University of Kentucky

Prevention Research

Dr. Gilbert J. Botvin, Cornell University Medical College

Treatment Research

Dr. Charles P. O'Brien, University of Pennsylvania

Marijuana and the Cannabinoids

Dr. Sidney Cohen, University of California at Los Angeles

Nicotine

Dr. Jack Henningfield, Addiction Research Center,
National Institute on Drug Abuse

Stimulants

Dr. Scott E. Lukas, Harvard Medical School

Cocaine

Dr. Robert C. Petersen, Psychologist, Consultant

Sedatives and Anti-Anxiety Agents

Dr. Roland R. Griffiths, Johns Hopkins University School of Medicine

Hallucinogens and Inhalants

Dr. Edward F. Domino, University of Michigan Medical School

Heroin and Narcotics

Dr. William Martin, University of Kentucky

Basic Research on Endogenous Opioids

Dr. Floyd E. Bloom, The Salk Institute

Acquired Immunodeficiency Syndrome (AIDS)

Dr. Robert C. Petersen, Psychologist, Consultant

Additional assistance in reviewing the material contained in this report was provided by members of the staff of the National Institute on Drug Abuse and by:

Dr. Robert L. Balster, Virginia Commonwealth University

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Dr. Mary Jeanne Kreek, Rockefeller University, New York

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National Institute on Drug Abuse

Dr. Solomon H. Snyder, Johns Hopkins University School of Medicine

The contributions of those named and of the larger scientific community is gratefully acknowledged.

Mrs. Sally Breul and Mrs. Mary Louise Embrey, at NIDA, had overall responsibility for preparation of the report, and Dr. Robert C. Petersen served as technical editor.

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Introduction

Drug abuse (with the exception of alcohol abuse) became uncommon following the passage of the Harrison Narcotic Act of 1914. However, during the past twenty years it has emerged as a dominant public health and social concern. In 1960 less than 7 percent of college-age young adults had ever used marijuana; by 1982, a majority (64 percent) of young adults 18-25, nearly two out of three, had done so. Cocaine use for most of this century was restricted to a tiny minority of the population. But by 1985, more than one in six (17.3 percent) high school seniors had tried cocaine; nearly a third of our young adults (18-25) had done so.

With burgeoning abuse has come an equally dramatic increase in the human and economic costs associated with this unparalleled rise in illicit drug consumption. The estimated total annual cost to American society through decreased economic productivity, unemployment, increased health and social welfare costs, law enforcement, and associated costs of criminal trafficking in drugs has been estimated to be nearly \$100 billion. This does not begin to take into account the moral erosion that results when large numbers of our citizens consume illicit drugs -- and support an extensive criminal enterprise both here and abroad by doing so.

If the picture is frightening, there are some signs that it is becoming a little less so. As more and more of us have become aware of the implications for all of us of illicit drug use, drug abuse has been increasingly "deglamorized." It is no longer being portrayed in the mass media as the "in" thing it was described as only a few years ago. The tragic deaths of some of our most talented young people have sobered us. There are signs of a shift in public opinion -- and an increasing intolerance of the high human costs Americans pay for getting high. A few years ago -- in 1978 -- only a third of our high school seniors felt that regular use of marijuana posed "great risk." By 1985, seven out of ten seniors had come to that conclusion. But the number who still dismiss the risks of illicit drug taking by their continuing use remains unacceptably high.

This Second Triennial Report on Drug Abuse and Drug Abuse Research summarizes the changes that have occurred in our understanding of the health implications of drug abuse as a result of research since 1983. The Department is hopeful the report will contribute to an increasing resolve on all our parts to once again make illicit drug abuse the rarity it once was in American society.

WORK DRAFT

WORK DRAFT

WORK DRAFT

5-0131L
Chenoweth
5/4/88

Original sponsors: Fischer, Faiks,
Binkley, et al.

1 IN THE SENATE

2 HOUSE CS FOR CS FOR SENATE BILL NO. 32 ()

3 IN THE LEGISLATURE OF THE STATE OF ALASKA

4 FIFTEENTH LEGISLATURE - SECOND SESSION

5 A BILL

6 For an Act entitled: "An Act relating to marijuana; and providing for an
7 effective date."

8 BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF ALASKA:

9 * Section 1. FINDINGS. (a) The legislature finds that marijuana use
10 is a serious health problem for the following reasons, each of which con-
11 stitutes a legitimate and compelling state interest:

12 (1) marijuana and other cannabis preparations contain

13 (A) more than 420 different compounds, including 60 canna-
14 binoids that have mind-altering properties;

15 (B) tetrahydrocannabinol (THC), one of the pharmacologi-
16 cally active compounds in marijuana, a substance

17 (i) that is fat and lipid soluble;

18 (ii) that is attracted to the lipid tissues of the
19 body, including the brain, testicles, ovaries, liver, kidneys,
20 heart, and bone marrow;

21 (iii) that has increased in strength and potency from
22 less than one percent 10 years ago to as high or higher than 10
23 percent in marijuana obtainable today; and

24 (iv) whose metabolites can take longer than 30 days to
25 be eliminated from the body;

26 (2) medical and laboratory research have yielded findings that
27 demonstrate that marijuana has a detrimental effect on

28 (A) respiratory and cardiovascular systems, in that

29 (i) sinusitis, pharyngitis, bronchitis, and emphysema

1 are associated with chronic marijuana use;

2 (ii) evidence suggests that habitual marijuana smoking
3 may be a factor in the development of bronchogenic carcinoma;

4 (iii) during a marijuana "high," the user may experience
5 tachycardia as the heart rate increases to as much as 130 - 150
6 beats a minute;

7 (B) reproductive systems, in that

8 (i) marijuana affects the network of glands and hor-
9 mones that are involved in reproduction;

10 (ii) a pregnant woman who uses marijuana takes an
11 increased risk that the chemical compounds in the marijuana will
12 pass across the placenta to the developing fetus;

13 (C) the brain, in that

14 (i) THC accumulates in brain cell membranes;

15 (ii) neurons, the most specialized and complex cells in
16 the body, are affected more than any other cells by substances
17 that alter or block cell membranes;

18 (iii) use of marijuana impairs visual tracking and depth
19 perception and a reduction in coordination, reaction time, and
20 vigilance, making it dangerous to drive, fly, or operate machin-
21 ery;

22 (iv) chronic marijuana use may cause irreversible
23 changes of the brain, interfere with reading comprehension,
24 verbal and mathematical problem solving, perception of time and
25 distance, short term memory, and the ability to concentrate, and
26 reduce motivation;

27 (v) the psychological effects of marijuana use may
28 include anxiety, panic, paranoia, psychosis, illusions, and
29 hallucinations, and recent studies link marijuana to

1 schizophrenia;

2 (D) the body's immune system, in that marijuana use

3 (i) depresses the immune system and alters the funda-
4 mental cellular defenses against disease; and

5 (ii) reduces the chromosomes in T-lymphocyte cells, as
6 evidenced by a 1973 study of the immune system conducted at
7 Columbia University by Dr. Morishima; the study, validated by
8 other researchers, conducted on 51 men who smoked two marijuana
9 cigarettes per week for four years, demonstrated that of the 92
10 chromosomes normally present in T-lymphocyte cells, there was a
11 reduction of up to one-half;

12 (3) the use of marijuana has a social effect that is detrimental
13 to the public health and welfare:

14 (A) the legislature has received 70 resolutions, from
15 student organizations, school boards, municipal governing bodies, law
16 enforcement organizations, health and social services organizations,
17 citizen drug task forces, and civil organizations, asking for a tight-
18 ening of the laws governing possession of marijuana;

19 (B) the Criminal Justice Planning Agency's 1981 report,
20 "Crime in Alaska," states that juvenile arrests had increased by 19
21 percent from the previous year, noting that possession of marijuana
22 accounted for over 85 percent of all juvenile arrests;

23 (C) surveys conducted by Dr. Bernard Segal in 1981 and 1982
24 indicated that 47.4 percent of Alaska's youth between 12 and 17 re-
25 ported having used marijuana, compared to the reported national aver-
26 age for use among people in that age group of 26.7 percent;

27 (D) despite the fact that possession of marijuana by young
28 people is a crime, its use is common:

29 (i) in a 1987 follow-up survey conducted by the

1 Fairbanks North Star Borough School District, 47.8 percent of the
2 students in grades 7 - 12 reported having used marijuana, an
3 increase from the 40.1 percent who reported having used marijuana
4 in 1982;

5 (ii) in a 1987 follow-up survey conducted by the Juneau
6 School District, 69.4 percent of the students in grades 7 - 12
7 reported having used marijuana, compared to 68.7 percent who
8 reported having used marijuana in 1982; the Juneau School Dis-
9 trict survey suggests that marijuana continued to be the con-
10 trolled substance most commonly used, and gave evidence of a
11 downward trend as to the age of initiation of young people into
12 use of the substance.

13 (b) The legislature further finds that

14 (1) the federal Drug Enforcement Agency has classified marijuana
15 and other cannabis preparations in that agency's schedule I due to the high
16 potential for abuse and addiction;

17 (2) the Undersecretary for International Narcotic Affairs of the
18 United States Department of State, in an Anchorage address, stated, "Sever-
19 al foreign countries have questioned the sincerity of the United States
20 regarding suppression of illicit drugs by calling attention to Alaska's
21 legislation of small amounts of marijuana. This is significant because the
22 United States is a signatory nation to two international conventions con-
23 cerning control of narcotics--the Single Convention of Narcotic Drugs of
24 1961 and the Psychotropic Substance Act of 1971--that include outlawing of
25 marijuana";

26 (3) the Drug Report submitted to the Alaska Legislature by the
27 Alaska State Troopers for the period January 1, 1986 - June 30, 1987,
28 describes a marijuana eradication program that led to the seizure of 3,600
29 marijuana plants with an estimated value of more than \$866,000.

1 * Sec. 2. AS 11.71.060(a) is amended to read:

2 (a) Except as authorized in AS 17.30, a person commits the crime
3 of misconduct involving a controlled substance in the sixth degree if
4 the person

5 (1) [USES OR DISPLAYS ANY AMOUNT OF A SCHEDULE VIA
6 CONTROLLED SUBSTANCE OR] possesses, uses, or displays one or more
7 preparations, compounds, mixtures, or substances of an aggregate
8 weight of one ounce or more containing a schedule VIA controlled
9 substance [ON A PUBLIC STREET OR SIDEWALK OR ON THE PREMISES OF A
10 PUBLIC CARRIER OR BUSINESS ESTABLISHMENT OR IN ANY OTHER PUBLIC
11 PLACE];

12 (2) knowingly possesses any amount of a schedule VIA con-
13 trolled substance within the immediate control of that person while
14 operating a propelled vehicle;

15 (3) being under 19 years of age, possesses one or more
16 preparations, compounds, mixtures, or substances of an aggregate
17 weight of less than four ounces containing a schedule VIA controlled
18 substance; or

19 (4) [POSSESSES ONE OR MORE PREPARATIONS, COMPOUNDS, MIX-
20 TURES, OR SUBSTANCES OF AN AGGREGATE WEIGHT OF FOUR OUNCES OR MORE
21 CONTAINING A SCHEDULE VIA CONTROLLED SUBSTANCE; OR

22 (5)] refuses entry into a premises for an inspection
23 authorized under AS 17.30.

24 * Sec. 3. AS 11.71.070(a) is amended to read:

25 (a) Except as authorized in AS 17.30, a person commits the
26 offense of misconduct involving a controlled substance in the seventh
27 degree if the person

28 (1) manufactures or delivers, or possesses with the intent
29 to manufacture or deliver, one or more preparations, compounds, mix-

1 tures, or substances of an aggregate weight of less than one- half
2 ounce of a schedule VIA controlled substance; or

3 (2) possesses, uses, or displays one or more preparations,
4 compounds, mixtures, or substances of an aggregate weight of less than
5 one ounce containing a schedule VIA controlled substance [ON A PUBLIC
6 STREET OR SIDEWALK OR ON THE PREMISES OF A PUBLIC CARRIER OR BUSINESS
7 ESTABLISHMENT OR IN ANY OTHER PUBLIC PLACE].

8 * Sec. 4. This Act takes effect immediately under AS 01.10.070(c).
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DEPARTMENT OF THE TREASURY

U.S. CUSTOMS SERVICE

ANCHORAGE ALASKA

April 15, 1988



REFER TO

Chairman
State of Alaska
House of Representatives
Health, Education and Social Services Committee
P.O. Box 7
Juneau, Alaska 99811

Dear Chairman:

I thank you for allowing me to testify in the Alaska State Legislative hearings on the Recriminalization of Marijuana on April 13, 1988.

Enclosed is information you requested on drug seizure statistics at points of entry into Alaska. These statistics are for the eight month period from July 1987 through March 1988, which is prior to our new seizure guidelines. Note that these seizures took place predominantly during the very slow fall and winter months. Under our new guidelines, these figures will increase substantially.

July 1987 through March 1988:

165 marijuana seizures
8 cocaine seizures
5 other narcotic seizures
178 total narcotic seizures

143 vehicles seized (value \$1,624,465)

62 persons arrested

During the month of April 1988 to date:

17 narcotic seizures

15 vehicles seized

2 vessels seized

13 arrests

These figures are for the first 15 days of April.

If you need further information, please call me at 271-4043.

Sincerely,

A handwritten signature in cursive script, appearing to read "C. Duane Oveson".

C. Duane Oveson
District Director

3211 Providence Drive
Anchorage, Alaska 99508

COLLEGE OF NURSING
AND HEALTH SCIENCES

APR 2

April 22, 1988

Representative Niilo Koponen, Co-Chair
House HESS Committee
Pouch V
Juneau, Alaska 99811

Representative Johnny Ellis
Co-Chair
House HESS Committee
Pouch V
Juneau, Alaska 99811

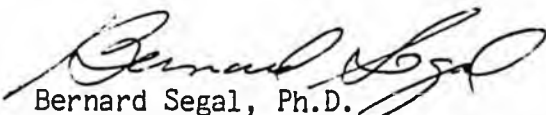
Dear Representatives Koponen and Ellis:

Thank you for your confidence in the Center for Alcohol and Addiction Studies to provide information on CSSB 32 (HESS). As with the legislature in its closing days, I am also caught up in meeting my end of term obligations, but this is an important enough issue for me to take time to attempt to address some of the concerns expressed in your letter. Given the short-time frame, however, I cannot undertake a comprehensive review to document the arguments for or against the specifications in the Bill. What I can do is provide a frame of reference from which the committee could address the issues and concerns currently being raised, and then attempt to provide a summary of the latest finding pertaining to marijuana.

The frame of reference that I am referring to above involves presenting a brief historical review of efforts to deal with marijuana in the United States. I think this review is necessary because it should provide a perspective to understand the current struggle faced by the Committee. This review is derived from a chapter in a book I wrote, "Drugs and Behavior: Cause, Effects, and Prevention," soon to be published by Gardner Press (New York). I have purposely highlighted specific words or phrases.

I trust that this review, presented in the attached document, will be of help.

Sincerely,



Bernard Segal, Ph.D.
Director, Center for Alcohol and Addiction Studies

BS/mh
attach:

Jim

Statement on Marijuana in Reference to CSSB 32 (HESS) to the
House of Representatives
Committee on Health, Education and Social Services
BY

Bernard Segal, Ph.D.
Director, Center for Alcohol and Addiction Studies
University of Alaska Anchorage
April, 1988

A Brief Contemporary History of marijuana in The united States

Just prior to the end of prohibition, congressional interest in marijuana increased as a result of public pressure. In response to this pressure, Congress passed legislation (in 1929) that classified marijuana as a narcotic drug. The Surgeon General in the same year issued a document, Preliminary Report on Indian Hemp and Peyote, that contained a **scathing** indictment of marijuana, describing it as "definitely a narcotic" and giving credence to popular notions that it was **addictive, criminogenic, and insanity producing**. This proclamation gave fuel to those participating in various prohibitionist movements; all who shared in an antihedonistic ethic united to prohibit legally all pleasure-producing chemicals, as well as various pleasurable nonchemical pastimes such as dancing, jazz music, and gambling. Marijuana was seen, with increasing ferocity, as evil and as physically, emotionally, and morally devastating to the individual, and unquestionably destructive to the culture. Users had to be protected from themselves even if they saw no danger in their habit (White, 1979).

The Federal Bureau of Narcotics (FBN), which was a unit in the Treasury Department formed to enforce the federal antiopiate and anticocaine laws, was established in 1930 under the direction of Harry J. Anslinger. The unit was not given any enforcement or legal powers over marijuana, but this did not stop Anslinger from pursuing legislation to ban what he perceived as a "lethal weed." One of his first acts was to foster the preparation of a Uniform State Narcotic Act, designed for adoption by state legislatures. Although accepted by many states, the act failed to include a ban on marijuana, but it did provide an opportunity for states to limit trafficking in marijuana.

Between 1930 and 1937, there was a continuous focus on marijuana as a particularly **evil drug**, but its control was left up to the states, of which only 16, by the early 1930s, had enacted laws prohibiting it. In 1936 an especially derogative and misleading report entitled Marijuana or Indian Hemp and Its Preparations was published by the International Narcotic Education Association in conjunction with the FBN. It provided the following description of

marijuana's effects (Rublowsky, 1974):

Prolonged use of marijuana frequently develops a delirious rage which . . . sometimes leads to high crimes such as assault and murder. Hence marijuana has been called the "killer drug." The habitual use of this narcotic poison always causes a very marked deterioration and sometimes produces insanity. Hence marijuana is frequently called "loco weed". . . . Marijuana often gives man the lust to kill unreasonably without motive. Many cases of assault, rape, robbery, and murder are traced to the use of marijuana. (p. 107)

This report, together with other allegations that marijuana causes murders, suicides, robberies, criminal assault, etc., especially among the young, was the basis upon which Anslinger launched his efforts to establish a federal marijuana law. His efforts were rewarded by Congress's enactment of the Marijuana Tax Act of 1937. Although this bill did not actually prohibit marijuana, it stipulated that all manufacturers, importers, dealers, and practitioners register and pay a special tax, and established a tax on all transfers. Only the nonmedical, untaxed possession or sale of marijuana was banned. Following passage of the tax act, FBN agents began to arrest marijuana users who previously had been either ignored or turned over to state authorities, but the bureau's major focus continued to be on heroin. Interest in prosecuting marijuana users gradually declined, and the FBN's concern with marijuana arrests remained secondary to its prosecution of heroin offenders.

Nevertheless, the dangers of marijuana continued to be portrayed. In an effort to determine the true hazards of marijuana use, which was very prominent in New York City, Mayor LaGuardia empowered a special committee to study the matter. Its report, issued in 1944 and known as the "LaGuardia Report," concluded that "the publicity concerning the catastrophic effects of marijuana smoking in New York City is unfounded . . . [and that] marijuana was a minor nuisance rather than a major menace" (cited in Griffenhagen, 1972, p. 1). These conclusions, however, were attacked by all circles, including the American Medical Association (AMA). The onslaughts were so pervasive that Mayor LaGuardia was put on the defensive and had to assure the AMA and the public that he would enforce the laws against marijuana. The issues and problems concerning marijuana, however, did not end there. After remaining somewhat dormant for the next 15 years, compared with prior years, concern about marijuana and other drugs suddenly leapt once more into America's consciousness.

Based on the above history, it would appear that the battle has started all over again in Alaska. What is important to realize from the above discussion is that none of the allegations made against marijuana were ever substantiated by scientific evidence. The arguments were governed more by emotion than reason or fact.

With respect to the scientific evidence about marijuana, let me present the following factual information and allow conclusions to be derived from it. The sources on which statements are based are cited in the narrative.

Psychopharmacological Aspects of Marijuana (and Hashish)

Of all the natural hallucinogens, marijuana (for which there are hundreds of different names all over the world) has the longest history. Although it may be questionable as to whether marijuana should be classified as a hallucinogen, a sedative-hypnotic, or in a class by itself, it is most often referred to as a hallucinogenic agent because it has come to be used primarily for its ability to induce intoxicating or euphoric effects.

The history of cannabis products and their use, particularly in the United States, has been well documented. Briefly the earliest use of cannabis has been traced to 2737 B.C. in China, where it was noted in the pharmacological literature of the time. It was introduced into India about 800 B.C., and continues to be known there as Bhang or Charas. It subsequently found its way into Arabic countries, where it was used extensively both medicinally and socially. Eventually the use of cannabis spread to Europe and then to the Americas. Recent interest in the medical use of marijuana has emerged in the United States (c.f. Blum, 1984), but such use remains highly restricted. Illicit social/recreational use, however, is fairly widespread, particularly among the younger members of our population. The most frequent means of using marijuana is by smoking it as cigarettes in which the dried, shredded leaves are rolled into a "joint." Hashish is typically consumed through a pipe, and marijuana can also be smoked in this manner. Both marijuana and hashish can also be eaten ("magic brownies") or made into a tea; each is seldom injected.

The name "marijuana" itself actually refers to the dried and chopped-up leaves, flowers, stem, and seeds of the hemp plant, of which there are two varieties - Cannabis indica, which represents the East Indian hemp plant, and Cannabis sativa, the American hemp plant. There are both male and female plants, and until fairly recently it was thought that only the female plant produced the active ingredients. Research, however, has shown that both plants produce active products, but the female plant yields a higher concentration. The term "hashish," which has sometimes been mistakenly used as a synonym for marijuana, represents the dried caked resin produced from the

tops and leaves of the female cannabis plant, and is more potent than marijuana.

Over 400 closely related chemicals have been isolated from the cannabis plant. These are collectively called cannabinoids, of which THC (delta-9-tetrahydrocannabinol) is believed to be the primary psychoactive or mind-altering compound. Although pure THC is alleged to be sold on the streets, it is almost never available in pure form and substitutes are provided, which often turn out to be PCP (Hollister, 1984). The fact that the chemical structure of cannabinoids does not contain a nitrogen atom distinguishes them from other naturally occurring hallucinatory compounds, and keeps them from being classified as alkaloids. The climate in which the plant grows, and the type of plant, together with other factors, determine the strength of the marijuana. Today's marijuana is ten times more potent than that used in the early 1970s. As the potency of the plant increases, there is a corresponding increase in its psychopharmacological effects.

In 1976 the average potency of marijuana seized and tested by the DEA, was one percent delta-9-THC. By 1977 that potency was just over 1.5 percent, and averaged only a 2 percent increase over the next six years. By 1982, the potency climbed to 3.6 percent, and by 1984 it had risen to 4 percent. In early 1985 the potency was found to be 5.5 percent (Korcok, 1985). The ability to grow higher potency cannabis has resulted in a sophisticated marijuana market that, in addition to requiring higher potency, also looks for special kinds of effects; many of the cannabis plants now grown are not only simply being pushed to achieve higher potency, but also to deliver specific effects (Korcok, 1985).

Much of today's marijuana comes from Mexico, Latin and South America, and the West Indies, but preference has now turned to more potent home-grown products. Maui Wowi, for example, has been a particularly popular variety of marijuana that is (illegally) grown in Hawaii and is considered to be exceptionally strong. More recently marijuana has become a profitable illicit cash crop in the mainland United States, where a very potent form is grown. Called sensimilla, it is gaining popularity because it is supposed to be extremely pure and capable of inducing a sustained high. Sensimilla's potency ranges from 6 to 7 percent, depending on where it is grown. "There is the increasing sophistication of the U.S. customer learning about sensimilla, being able to recognize 7% from 4% marijuana, demanding it, and paying for it" (cited in Korcok, 1985). Sensimilla growth in the United States, as a result of this demand, has been estimated to have doubled between 1979 and 1983 (Brecher, 1986).

Psychological Effects

Marijuana's effects are related to its quality or potency and to the user's set and setting. The nature of marijuana intoxication varies dramatically from one individual to another, and can range from very pleasant to highly unpleasant. In general its effects, when smoked, begin within five to ten minutes, and within an hour when eaten; they may last for two to four hours when inhaled and up to 24 hours when ingested.

A positive experience, based on a good quality of marijuana (currently averaging about 5 percent THC), may consist of a sense of well-being, a dreamy state of relaxation and euphoria, alterations in thought formations, a more vivid sense of touch and perceptions, and distorted concepts of time and space. Symptoms fairly commonly (but not always) associated with marijuana use are reddening of the eyes, dryness of the mouth, hunger, a mild rise in heart rate, and reduction of pressure in the ocular fluid of the eyes. A bad trip, experienced mostly by new users, tends to involve symptoms that resemble an anxiety attack, such as a feelings of panic, intense anxiety, and restlessness. Extremely high doses of marijuana may result in a toxic psychosis that may last up to a day. Hallucinations, illusions, paranoid delusions, feelings of depersonalization, and confusion may take place, and at times it may be difficult to determine whether such symptoms are an idiosyncratic reaction or a result of an overdose (Cohen, 1981). Flashback experiences have been known to occur with the use of marijuana (Cohen, 1981), and, as with most other psychoactive drugs, it has also been found to impair intellectual and psychomotor functioning and short-term memory (Blum, 1984). A unique characteristic of marijuana is that it remains in the body for a long period of time because cannabinoids are eliminated at a very slow rate; traces of the drug can be found in the body up to 50 hours or longer after its use.

Tolerance, Dependence, and Physical Effects

Whether the effects of marijuana are subject to tolerance and physical dependence is an issue that remains open to interpretation. Some strongly contend that tolerance develops, and that the onset is quite rapid (Nahas, 1979); others indicate that "tolerance and withdrawal symptoms with marijuana do not develop" (Cohen, 1981). Blum (1984) states, "Carefully conducted studies with known doses of marijuana or THC leave little question that tolerance develops with prolonged use" (p. 495). He goes on to note that:

The novice has a moderate degree of tolerance. With increasing exposure, tolerance appears to decrease, so that the occasional user has a low degree of tolerance and can smoke less to get the desired results. With increasingly heavy use, it rises again so a

high degree of tolerance is developed and the user can smoke ten or more joints daily and get only mildly high. Withdrawal of the drug, especially in the chronic user, may evoke a psychic response in that the individual feels the need for the drug and will seek it or some substitute. The anxiety, restlessness, insomnia, and other nonspecific symptoms of withdrawal are similar to those experienced by compulsive cigarette smokers. (p. 495)

The issue of whether one can develop tolerance to marijuana has not been completely resolved and studies continue. What is currently believed is that under conditions of heavy, sustained use, tolerance is manifested, but there is uncertainty about whether tolerance develops under conditions of low use.

There is also controversy over whether marijuana causes physical damage to the body, especially with long-term or chronic use. The research evidence suggests that some claims are substantiated, while others are in need of more research. **There is general agreement, however, that marijuana intoxication interferes with overall mental functioning, driving, psychomotor functioning, and learning.** "The effect on learning is pertinent, since much marijuana use occurs during schools hours. The psychomotor deficits can last up to 4 to 10 hours after smoking, well beyond the duration of the 'high'" (Cohen, 1985, p. 62).

Another substantiated effect is on the respiratory system. Marijuana tars contain 50 percent more carcinogens than high-tar tobacco cigarettes, with 70 percent more benzopyrene in marijuana than in tobacco smoke (WHO, 1981). Using marijuana thus increases the risk of bronchial problems, such as sore throats, coughing, and susceptibility to bronchitis and pneumonia. The marijuana smoker is also subject to the risk of lung cancer and other disorders to which cigarette smokers are exposed, but the risk is higher because the smoke inhaled is unfiltered and has five to ten times the cancer-causing agents found in cigarettes. Marijuana and tobacco users run a risk of lung cancer that is higher for use of either substance alone.

Other adverse physical effects that have been **attributed** to the use of marijuana are specific damage to the endocrine, immunity, and reproductive systems; organic brain damage; and chromosome abnormalities. Research also suggests that marijuana may adversely impact the reproductive system of both males and females (Blum, 1984; Nahas, 1979). Frequent use of marijuana has been linked to a decrease in levels of serum testosterone, but it appears that the testosterone level may return to normal after smoking stops. There have been no reports, however, of abnormal offspring associated with marijuana use by the father (Blum, 1984). In females the use of marijuana is

believed to affect the menstrual cycle, interfering with ovulation and lowering the period of fertility (Blum, 1984). In addition, since THC passes through the placental barrier, the **possibility** of damage to the developing fetus is always at risk. Marijuana use during pregnancy should be avoided. Moreover, if marijuana does adversely affect hormones related to sexual development as some believe (Nahas, 1979), its use **may be** especially harmful during adolescence, a period of rapid physical and sexual development.

Research investigating whether marijuana causes chromosome abnormalities, endocrine disorders, and organic brain damage is being conducted, but results thus far have been **inconclusive**. There has also been a question of whether marijuana adversely impacts the immunity system, but research results have been contradictory (Cohen, 1985) and the question has not been resolved. Recent concern, however, has been expressed that there may be a link between early marijuana use and an increased link to the risk of AIDS (McConnell, 1986). It has been pointed out by Dr. Ian Macdonald (cited in McConnell, 1986), administrator of the U.S. Alcohol, Drug Abuse and Mental Health Administration, that marijuana may depress the immune system, and "that about 26% of AIDS patients in the US are intravenous (IV) drug users whose first drug experience was with marijuana" (p. 1). Dr. Macdonald commented further that:

Experiments with mice and guinea pigs . . . show the herpes virus given to animals also given tetrahydrocannabinol (THC) grew faster and produced more changes in interferon - a natural immune resistor - and in lymphocyte functions than in control animals given only the virus without THC. . . . The increase in both AIDS and herpes in the US match the massive upswing in drug use. We know that almost all drugs have an effect on the immune system. At the moment we just don't have as good a handle on it as we'd like. . . . The immune link is not so easy to prove. (pp. 1, 2)

It should be noted that any unsubstantiated claim that marijuana (or other drugs) causes physical damage (e.g., chromosome damage, impairment of the immunological system) may be counterproductive because such claims make marijuana users (and users of other drugs) skeptical about any negative statements about drugs, even if such reports are accurate and supported by preliminary research findings.

One effect that has been reported to be associated with chronic marijuana use is the "amotivational syndrome." The phrase was used by McGlothlin and

West (1968) and Smith (1968) to describe a condition associated with regular marijuana use by youths in which the individual adopts an attitude and behavior that are asocial, non-directional, and a "cop-out" on established values. The amotivational syndrome is characterized by apathy, a loss of effectiveness, a diminished capacity to carry out complex, long-term plans, an inability to endure frustration and to concentrate for long periods, and an inability to follow routines or to master new material successfully.

There has been considerable controversy over whether the amotivational syndrome exists, and the debate continues. Cohen (1981) best summarized the issues concerning the amotivational syndrome as follows:

What must be remembered is that large amounts of cannabis have a depressant effect upon the central nervous system, and equivalent amounts of alcohol or sedatives also would produce a decreased desire to work, poor performance, and a blunted emotional response. One difference is that THC is retained in the brain . . . for long periods because of its aqueous insolubility.

Some young people do become sedated from considerable cannabis consumption. Others may become amotivated from discouragement about their situation, and marijuana ingestion simply reinforces their dropout from active participation in life. (pp. 37-38)

Legal Aspects of Marijuana

Although marijuana is a Schedule I drug under the federal Controlled Substance Act, several states have decriminalized marijuana and introduced minimal penalties for its possession when its use remains within the confines of the state's regulations. Under federal law, however, marijuana trafficking offenses are subject to the same penalties as those imposed for narcotics - 15 years' imprisonment, a \$25,000 fine, or both, for a first offense.

Review of CSSB 32

Based on the above discussion, and on my experience, I will try to address the specific allegations in CSSB 32 (HESS), commenting on the veracity of some statements.

Section 1:

(1) Probably true.

(2) As noted in the testimony by several experts on April 14th, although marijuana, specifically THC, may remain in the body for a long period of time,

it remains inactive, and well below threshold levels to impact behavior. Any adverse physical effects due to the fact that marijuana remains in the body so long have not, to my knowledge, been identified.

(3) As stated in the testimony on April 14th, this statement is inaccurate and is not supported by clinical evidence. (I cannot cite any specific references here, but given time I can probably find some.)

(4) Untrue! Refer to above discussion and appropriate references.

(5) Untrue! Marijuana and alcohol taken together result in what is referred to as a summative reaction or effect, in which the effects of both are stronger than either taken alone ($1 + 1 = 2$). Thus one would become twice as drowsy, uncoordinated, etc, than if either drug were taken by itself. **Marijuana does not have a synergistic effect on alcohol, that is, it does not *drive* the effects of alcohol, nor does alcohol *drive* the effects of marijuana.**

(6) Marijuana potency has increased (see documentation above), but not to the extent where 10% THC is common on the streets.

(7) True

(8) Patently untrue! There is **no evidence** that I know of to substantiate the claim that marijuana causes schizophrenia, etc. What is true that in special cases a severe marijuana overdose may result in a toxic state that produces behavior that is characteristic of or resembles schizophrenic-like behavior. But as soon as the marijuana is metabolized out of the body, that is, the toxic substance is reduced to below threshold level, the symptoms should clear up.

(9) See above discussion and references. There is no evidence to support this claim.

(10) There is no evidence to support this claim. See above discussion and references.

(11) I believe that there is some medical evidence to support these allegations concerning the harmful effects of smoking in general, as reviewed above, but they cannot be specifically attributed to marijuana.

(12) As reviewed above, some of these behaviors may be a function the short-term adverse effects of marijuana, subject to reversal upon its discontinuation. There is no evidence (see above) that marijuana's effects are lasting.

(13) If the intent here is to refer to the ingestion of passive smoke by the children as presenting a threat to health, evidence can substantiate that passive smoke can be harmful. But be aware that some researchers claim that passive smoke is not harmful. I believe, however, that sufficient documentation exists to support an argument that passive smoke, from tobacco products or from marijuana, appears to be harmful.

(14) True, but please interpret this statement in context of the historical discussion presented above.

In summary, it is my professional and personal opinion that this legislation, if passed in its present form, cannot be supported in court. The preponderance of research findings point to conclusions that are contrary to most of the allegations in the Bill. Moreover, passing the legislation as is would contribute, in my opinion, to an impression that Alaska is operating in a climate similar to that of the 1930's, one which may convey a message to scientists and others that emotions rather than rationality prevail. As such, I urge that the present legislation be deferred. If the legislature retains its interest in recriminalization of marijuana, then it has to prepare more factual and more rationale legislation, which accurately reflects what is known about the adverse effects of marijuana. A more objective approach would then allow the courts to weigh the arguments for or against, rather than dismiss poorly conceived legislation "out of hand."

List of References

- Blum, K. (1984). Handbook of abusable drugs. New York: Gardner Press.
- Brecher, E. M. (1986). Drug laws and drug enforcement: A review and evaluation based on 111 years of experience. In B. Segal (Ed), Perspectives on drug use in the United States (pp. 1-27). New York: Haworth Press.
- Cohen, S. (1981). The substance abuse problem. New York: Haworth press.
- Cohen, S. (1985). The substance abuse problems. Volume two: New issues for the 1980s. New York: Haworth Press.
- Griffenhagen, G. A history of drug abuse. Grassroots, pp. 1-8.
- Hollister, L. (1984). Effects of hallucinogens in humans. In B. L. Jacobs (Ed.), Hallucinogens: Neurochemical, behavioral and clinical perspectives (pp. 19-33). New York: Raven Press.
- Korcok, M. (1985, Oct.). Marijuana potency increases four fold. The U.S. Journal of Drug and Alcohol Dependence, p. 11.
- McConnell, H. (1986, May) US official links early marijuana use to AIDS risk. The Journal, pp. 1, 2.
- McGlothlin, W., & West, L. J. (1968). The marijuana problem: An overview. American Journal of Psychiatry, 125, 1126-1134.
- Nahas, G. (1979). Keep of the grass. New York: Pergamon.
- Rublowsky, J. (1974). The stoned age - A history of drugs in America. New York: Putnam.
- Smith, D. E. (1968). The acute and chronic toxicity of marijuana. Journal of Psychedelic Drugs, 2, 37-47.
- White, W. (1979). Themes in chemical prohibition. In W. P. Link et al., (Eds.), Drugs in perspective (pp. 171-181). Rockville, MD: National Institute on Drug Abuse.
- World Health Organization. (1981). Report of an ARF/WHO scientific meeting on adverse consequences of cannabis use. Toronto: Addiction Research Foundation.



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Gateway Center for Human Services

April 20, 1988

House Health, Education and
Social Service Committee
P. O. Box V
Juneau, AK 99811

My name is Chip Ames, and I would like to address the House Health, Education and Social Services Committee, which I understand is hearing testimony regarding the recriminalization of Marijuana. I have worked in various clinical and supervisory positions in the field of substance abuse and chemical dependency treatment for the last 9 1/2 years. During this time I have been involved in treating adult and adolescent patients in both inpatient and outpatient treatment settings. I am presently employed as a Lead Counselor for the Gateway Center's Alcohol Treatment Division in Ketchikan, Alaska.

While I do not believe that we can effectively legislate "morality", I do believe that the laws we pass reflect the position our society takes on specific issues and that when we decriminalize an act, the implied message is that we condone or sanction that act. I am especially concerned about the effect that these messages have on our youth.

My experiences in the treatment field, leave me convinced that marijuana poses a significant threat to the physical and emotional health of the user. I believe, too, that while the ingestion of marijuana by an individual may occur in the privacy of one's home, the consequences of regular and chronic use have become a burden for all of us in our society to reckon with. Last year, in January, February, and March I reviewed a great deal of the literature on marijuana use in the chronic young user at the University of Washington Medical Library. I found the literature to be frequently confusing and often contradictory. In most cases, the methodology employed in the studies was quite poor. The intent of this letter is not to provide a further synopsis or evaluation of the massive research literature available on the pros and cons of marijuana use and abuse. I'm not sure that should be the criteria on which a legislator makes a decision about whether or not to recriminalize marijuana. I have chosen to base my testimony on my personal experiences with the clinical treatment of chronic marijuana users on a daily basis over the last ten years.

Over the last ten to fifteen years we have noted a profound shift in the profile of the patient population entering treatment for chemical dependency. As recently as ten years ago the average patient was a male, middle-aged alcoholic, and it was quite rare to see what we now refer to as poly-drug or multi-substance dependent patients. Today the average patient is a male or female in their mid-twenties, who is frequently chemically dependent on two or more drugs. The primary drugs dependency that we see today are alcohol and marijuana. While they are often used simultaneously, we are seeing an ever increasing number of "pure" marijuana addicts. It is common knowledge that marijuana potentiates the destructive affects of alcohol and visa versa, one enhancing the other so that small amounts of each leads to a very profound state of intoxication.

Speaking with our jail counselor, Don Gonser, he has informed me that of the clients that he sees in jail he estimates that 90% committed the crime for which they were incarcerated while under the influence of marijuana and/or alcohol and others drugs. I would estimate that in our residential recovery unit that over 75% of our admissions involve clients who are dependent upon both alcohol and marijuana. Frequently clients will abstain from alcohol use after treatment but continue to use marijuana to induce intoxication and then almost always return to an alcoholic drinking pattern. Restated, marijuana is one of the three primary causes of relapse after treatment. Relapse inevitably results in readmission to the treatment program.

The average cost of a treatment episode at our facility, which is supported by State grant dollars, is approximately \$2,200. This figure does not including ancillary billing. Those clients who have insurance and can afford third party reimbursement for treatment, particularly adolescents who are unable to secure inpatient treatment in the Southeast area and are referred to private programs, the average cost of their treatment episode is between \$5,000 - \$8,000 for adults and \$14,000 - \$18,000 for adolescents. Many of the adolescents I see are exclusively dependent on marijuana. By their own self-accord they will acknowledge that their daily use from a young age has left them seriously addicted and unable to control their use.

We have only recently begun to see the destructive affects of chronic marijuana use on our young people. It seems the younger a person is when they begin their use the more rapidly the destructive affects of that use become apparent, and possibly, although no one is certain, the more irreversible the destructive affects of that chronic use may be. The symptoms that I commonly see displayed by the young, chronic users who frequently begin smoking prior to the beginning of their psycho-sexual development in adolescence, (I often see users who have

begun smoking regularly at 7, 8, 9 and very frequently by 12 or 13 have established a regular pattern of use) are: apathy, outbursts of rage and anger, a very low frustration tolerance, impaired short-term and long-term memory, an impaired ability to think in abstract symbols, an impaired ability to complete goal oriented activities in a sequential manner, impaired concentration, poor tracking of multiple or complex concepts and a very shallow, diminished affect, particularly when not intoxicated.

The withdrawal symptoms that I commonly see among the chronic marijuana users, both young and old, include a state of irritability with frequent outbursts of uncontrolled anger, extreme impulsiveness, extreme emotional lability, greatly diminished concentration span, extremely low frustration tolerance, impaired short and long-term memory and again an inability to carry out complex activities in a sequential manner. Other symptoms that they report are insomnia, periods of cold sweating during the evening, loss of appetite, occasional tremors along with intense and profound cravings for the drug. The more obvious and intense symptoms generally tend to wane within thirty days after last use. The craving and some of the other more subtle symptoms seem to persist for up to two years in a state which we term sub-acute withdrawal syndrome.

Another severe problem that I commonly see with the chronic marijuana users who began at a young age is that the long term affects of being constantly intoxicated have left them unable to function emotionally as an adult. It seems that they do not or are unable to grow emotionally and that the state of being "high" causes them to miss moving through the normal developmental stages of adolescent and young adulthood that lead one towards maturity. These patients are emotional cripples. When not intoxicated they seem to have very little insight or ability to deal with inter-personal relationships. The skills that are lacking in this area prevent them from being able to function effectively in their marriages, in their home life, in their community life and in their work life. This is a particularly insidious and frightening consequence of long term marijuana use because what is obvious to me and others from the outside looking in, they frequently do not or are unable to see themselves. I believe this "blindness" to be a direct consequence of the use itself. For further information about the treatment of marijuana addiction I would refer you to the University of Washington Medical School and the University of Washington School of Sociology which together have come up with some very innovative programs to treat marijuana addicts. They certainly can provide you information about the reality of marijuana addiction and the complexity of its effective treatment. Some of the destructive long term affects of marijuana use cannot be found to be well

documented in much of the literature because they are just becoming apparent today. It is only since the late 1960's that a sophisticated society like ours has had to contend with chronic drug use amongst all strata of its society. It is only recently too that we have had the medical technology available that allows us to effectively study the consequences of this chronic use. I have a strong sense that over the next ten years we will sadly come to see that a significant percentage of our population will be in need of permanent and ongoing clinical support for the duration of their lives as a consequence of long term chemical dependency that began in early adolescence with heavy marijuana consumption.

Finally, much has been said about marijuana being a gateway drug that leads later to heavier use of more destructive drugs like alcohol, heroine, cocaine, etc. In my experience this is not an alarmist tactic but rather an accurate description of what occurs among a significant proportion of young chronic marijuana users. Frequently, they do seek ways to enhance the state of being high and the most common drugs that they turn to are alcohol and cocaine, both of which are extremely destructive drugs. Comparing marijuana to alcohol in a society that has become as chemically dependent as ours is ludicrous. Alcohol is an extremely toxic drug that affects the central nervous system in exactly the same manner as a barbiturate. If alcohol were presented to the market today under current FDA guidelines, it would not be readily available in small amounts by prescription. Alcohol is toxic to every organ in the system with which it comes into contact. The rate and incidence of alcoholism and alcohol abuse in Alaska is higher than I have seen anywhere that I have worked in the field of chemical dependency treatment. (I have worked in many states in this country.) From this perspective, I see no logic whatsoever in comparing marijuana to alcohol to justify its being available to legally use in the home. They are both destructive drugs, and in a society that has become as chemically dependent as ours the last thing we need are new readily available drugs to be utilized for the purpose of intoxication.

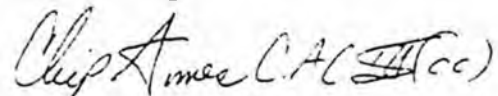
One further fact, the dollars spent on alcohol treatment and drug treatment in this state are greatly exceeded by the dollars spent on mental health. This is ironic because we are a combined mental health, drug-alcohol treatment center, with separate divisions. In speaking with the people that run and staff our mental health division they estimate that 80% of their clients are involved with serious alcohol and marijuana abuse and that a vast majority of their clients have chemical dependency problems that remain unaddressed, complicate treatment, and lead to chronic recidivism, and rehospitalization. I know from personal experience working with our Community Support Program with the

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chronically mentally ill that one of the most frequent causes of relapse and rehospitalization is use of marijuana and/or alcohol.

In closing I would like to say that I have found Alaska to be a beautiful land, populated by wonderful and interesting people. In Alaska I have met some of the most unique and kind people that I have met anywhere in my life, but there is a great sadness about Alaska too, and it is a sadness that I feel daily in my work, for never have I seen such an incidence of destructive alcohol and drug abuse as I have here in Alaska. To me it is a tragedy to see such a vast wealth of human potential being destroyed and it would behoove the state to spare no effort in doing what they can to combat a problem which threatens to overwhelm and ultimately devastate its people.

Sincerely,

Handwritten signature of Chip Ames in cursive script, followed by the initials "C.A." and "(cc)" in parentheses.

Chip Ames
Lead Counselor

cc: John Ellis, Co-Chairman
Nillo Kopnen, Co-Chairman
Robin Taylor



Alaska State Legislature

Please enter into the record my testimony to the H.E.S.S.
committee name
committee on S.B. 32 dated April 14, 1988
by subject

How Marijuana has Influenced my Life

This paper is done by a heavy marijuana user who has done this drug as his primary drug for the last 20 years but has used just about every abusive drug on the market. By all truth I should be a vegetable by now.

I first used marijuana at the age of 12 years. I was living with my father and step-mother and my step-brother Gary and I went over to a friends house and he offered some homemade blackberry wine to us. So I drank some and at the same time he offered a marijuana cigarette to me. I was real apprehensive at first but being a young curious kid I went ahead and smoked it. I choke and cough on every hit but finished the joint. I felt really carefree and very light headed.

For the next 2 years I smoked marijuana maybe once or twice a month, only on a recreational basis.

When I was 15 I was living with my step-father and mother and we moved from Oregon to Washington state and this is when I started a daily usage of pot. I didn't waste any time in finding how and where to get pot. I just enjoyed it too much. The high from pot was a major "Love Affair" with me at the age of 15. I would do just about anything to get a hold of it. I lie, cheat, steal or even beat somebody up to get it.

I was at the age of 16 when I had my first encounter with the law which was a combination of drinking beer and smoking pot. Marijuana has always made me feel powerful, brave and tough, so after a high school basketball game me and 3 friends went to a

By: Ronald E. Compton Ronald E Compton

Testifier

SELF

Representing (Optional)

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225-1573

Phone No

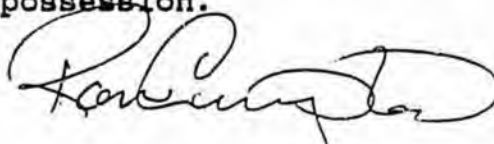
local gravel pit, loaded rocks in the pick-up and proceeded to drive down country roads and knocked down 20 mail boxes and after I got up the next morning there was a county sheriff at my house and to make it short I was busted at the age of 16 for a federal offense. That still didn't slow my pot smoking down because about this age I found out my parents smoked pot also. So I had the understanding that it was O.K. to smoke pot then. My parents talked to me and asked me not to smoke at school but do it at home so I respected their wishes. I would come home and mom would smoke a joint with me. She grew marijuana on our little farm and at one time she even stuffed the Thanksgiving turkey with it. So my parents were a big influence with my pot addiction. I do not disrespect my parents to this day at all for it because I could have quit anytime I wanted to.

When I went into the service my pot addiction was a lot worse. I was still cheating, lying and stealing to get it. I would lie to myself, by saying I will pay this bill next payday so I could buy pot now. Until a month ago I was still doing this.

I have been married to my present wife Diana 10 years and everyday in those 10 years I used. My wife also used. It was at the point that if I didn't wake up and have a morning joint we would instantly start fighting. As long as we have marijuana we were the happiest couple on earth. The last 8 months though have been real tough because my wife realized I was married to my drug habit and not her. I was not paying the bills and I was mentally abusing my wife to such an extreme she left me about a month ago and now we are separated.

That's alright. They say we learn by our mistakes and I have learned a big one. Stay off of drugs and I will live a full and comfortable life. I am proud to say as of April 14 my 34th birthday I have been clean for 30 days.

Thank you for your valuable time and God Bless you and keep the fight going against marijuana possession.



Ron Compton

Mailing Address:
P. O. Box 3067
Ketchikan, AK 99901

Subject: Addiction to Marijuana

Marijuana is an addictive drug and I am living proof of it. If I don't have marijuana I am a very different person. I don't like to associate with people or cope with today's problems. I get real disgusted with life in general, but when I have pot everything is just fine. Pot is my escape from my problems, but when I come down off this drug, it's real funny, my problems are still there so I smoke some more.

Don't tell me it's in my head because I am a well-educated person and I know right from wrong. Marijuana is wrong! I too have listened to pro and cons about marijuana and it just took me 19 years to discover the cons plus a good marriage down the tube because of it.

Marijuana does lead to harder drugs because we are told marijuana has a good high but there are more powerful highs than this so as curious as the human operates who is on drug dependency, we experiment with other drugs!

In closing Marijuana is an addictive drug, to hell with the scientific experiments, just ask a true marijuana addict, myself!

Thank you.

A handwritten signature in cursive script, appearing to read "Ron Compton".

Ron Compton

To: Co-chairs of the House HESS Committee, Rep. Koponen and Ellis.

From: Arthur J. McBay, Ph.D., Forensic Toxicologist

Re: Teleconference on Senate Bill 32. April 14, 1988.

I was frustrated listening to the entire teleconference and being unable to respond as I was asked in your letter of April 2, 1988. In my opinion the proponents did not offer any new evidence of the effects of marihuana use. What was offered was for the most part anecdotal, unfounded, unpublished and uncontrolled studies. Would they as I often am, be willing to testify under oath as to their opinions and offer scientific support?

I believe the same comments fit the Findings (a) 1-14:

1. The reason why more than 400 compounds have been found in marihuana is because so much money has been spent on research. I know of no reports that the trace amounts of these substances that were found have any physiological or psychological activity. Bread and milk contain many compounds but what does this mean? Alcohol is a single compound, yet it kills more people than any other compound.

2. Is this good or bad? Everyone has arsenic, lead, halogenated hydrocarbons, and many other compounds in their body!

3. THC reaches the highest concentration 5 to 7 minutes after starting to smoke marihuana, if it reaches about 100 ng/ml in serum it will be less than 5 ng/ml in an hour or so (encl.1).

4. Can the statements of this non sequitur compound sentence be documented?

5. I have been responsible for the toxicology of 110,000 deaths in North Carolina from 1969 to date and for a lesser number in Massachusetts for 13 years prior to 1969. I have never seen a marihuana overdose death nor have I been able to document any that anyone thinks they have seen. The three that are often cited did not occur in North or South America, did not have adequate toxicology and were not adequately investigated or documented. I talked to the author of one of these reports, his urine findings were not acceptable but even if they were about all they would prove is that the deceased had been a marihuana user.

I have enclosed our paper (encl. 2) of the investigation of 600 drivers killed in single-vehicle crashes in North Carolina where alcohol, marihuana and other drugs were sought. When cannabinoids were found in 47 of the 600 blood specimens, about 70% of the blood specimens contained at least 0.10% alcohol and most had low concentrations of THC.

6. I have heard the same high THC% marihuana is present in the 48 states, but government data reports that THC went from 2% to 2.8% from 1980 to 1986. Is data available from Alaska?

7. True see 6. What does it mean?

8. Documentation!

9. This is a new and startling report. Is there any reliable documentation of this? I suspect it is wild speculation and misinterpretation of Tashkin report. (New Engl.J.Med. 1988; 318: 347-51)

10-13 Documentation would be helpful!

14. Since it is illegal to use marihuana, any use must be "abuse." and if many people use it then there is a "high potential." Tetrahydrocannabinol is in Schedule II. I have enclosed some of our studies as well as a report on the non-effects of heavy chronic long term smoking of marihuana in Costa Rica. I am not now or have I ever been affiliated with NORML or any similar organizations. I have never used marihuana nor do I intend to even legally.

Arthur J. Bay

CURRICULUM VITAE

NAME: Arthur John McBay 102 Kings Mtn. Ct.
Chapel Hill, NC 27514
(919) 929-4954

PLACE OF BIRTH: Medford, Massachusetts; Citizenship, U.S.

DATE OF BIRTH: January 6, 1919

MARITAL STATUS: Married, two children; Wife: Avis L. Botsford

EDUCATION: Massachusetts College of Pharmacy, Boston
B.S. in Pharmacy 1936-40
Massachusetts College of Pharmacy, Boston
M.S. in Pharmaceutical Chemistry 1940-42
Purdue University
Ph.D. in Pharmaceutical Chemistry 1946-48

OTHER EDUCATION: Harvard University, Massachusetts Institute
of Technology, Boston University

REGISTRATION: Pharmacist, Massachusetts 1940

CERTIFICATION: Toxicological Chemist, American Board of
Clinical Chemistry 1963
Diplomate, American Board of Forensic
Toxicology 1976

POSITIONS HELD: Assistant Professor of Chemistry,
Massachusetts College of Pharmacy 1948-53
Associate Professor of Chemistry,
Massachusetts College of Pharmacy 1953-55
Research Consultant,
Harvard Medical School 1952-53
Assistant in Legal Medicine, Dept. of Legal
Medicine, Harvard Medical School 1953-63
Toxicologist, Criminalist, Consultant in
Charge of the Massachusetts State Police
Chemistry Lab. 1955-63
Teacher of Introduction to Criminalistics,
Northeastern University 1962-63
Associate Professor of Toxicology, Law
Medicine Inst. at Boston University 1963-69
Associate Professor of Pharmacology,
Boston University Medical School 1963-69
Lecturer on Legal Medicine,
Harvard Medical School 1965-67
Supervisor of Laboratory, Massachusetts
Department of Public Safety 1963-69
Associate Professor of Pathology and
Toxicology, University of North Carolina
at Chapel Hill 1969-73

MILITARY STATUS: Aviation Meteorological Cadet, AAFCTTC, 1943

Weather Officer, USA Air Forces 1943-45

Captain, U.S. Air Force Reserve 1945-53

NORTH CAROLINA POISON FATALITIES 1970-1987
Office of the Chief Medical Examiner, Toxicology Laboratory, Chapel Hill

Year	1970-82	1983	1984	1985	1986	1987	Total
Number of cases	73892	6478	6635	6682	7208	7465	108360
Antidepressants	265	40	44	36	46	42	473
Barbiturates	320	18	9	8	6	11	372
Propoxyphene	325	13	13	16	18	11	376
Salicylates	88	8	6	6	7	6	121
Opiates	139	10	18	19	9	17	212
"Heroin"		11	11	13	6	13	
Cocaine	20	11	16	9	27	21	104

DRUGS	70-86	87	ABUSED DRUGS	70-86	87	SOLVENTS	70-86	87
Meprobamate	47		Cocaine&Heroin	above		Isopropanol	95	2
Ethchlorvynol	41	2	MDA	12		Methanol	18	
Thioridazine	21	1	Meperidine	11	1	Trichloroethane	9	
Glutethimide	14		Methadone	12		Halothane	5	
Pentazocine	17	1	Codeine	19	1	Kerosene	2	
Caffeine	14	1	Methaqualone	4		Toluene	4	1
Phenothiazine	11		Phenmetrazine	1		Benzene	3	
Paraldehyde	8		Oxycodone	2		Hydrocarbon	2	
Strychnine	7		Hydromorphone	7	2	Ethylene glycol	9	
Quinidine	6		Hydrocodone	2		Ether	3	
Quinine	5					Dichloromethane	2	
Chloral Hydrate	7		<u>CHEMICALS</u>			Gasoline	5	1
Methapyriline	3		Arsenic	31		Enflurane,hexane,xylene,	1	each
Diphenhydramine	10		Cyanide	18	1			
Acetaminophen	8		Lead	5		<u>GASES</u>		
Chlordiazepox.	3		Mercury	3		Freons	26	
Lidocaine	4		Fluoride	3		Nitrous Oxide	8	1
Digoxin	4		"Pine Oil"	2		Propane	4	
Theophylline	6		Lye	3		Hydrogen Sulfide	2	
Propranolol	7	1	Detergents	2		Utility Gas	1	
Phenylpropanol.	2		Formaldehyde	2		Methyl bromide	1	
Haldoperidol	5		<u>Single cases:</u>			<u>PESTICIDES</u>		
Phenelzine	3		Phenolresorcinol			Pesticides	2	
Insulin	2		Selenium,Nitrates			Parathion	4	
Single cases:			Phenol			Paraquat	3	
Methotrexate,BMDA			Copper,Naphthol			Diazinon	6	1
Methypyrilol,Camphor			Phosphorus,"Navane"			Malathion	2	
Stramonium,Atropine			Methylsalicylic Acid			Organophosphate	2	
Ketamine,Verapamil(2)			"Paint thinner"			Lannate	2	
Ipecac,Disopyramide						Methomyl	2	
Chloroquine,Phenytol						Nicotine	2	
Flurazepam,Propylhexadrine(2)						Single cases:Telone-C		
Diethylpropion,Bupivacaine						Baygon,Dieldrin		
Coumadin,Doxylamine,Tamazepam						Azodren-S,Sevin		
Procainamide,Mesoridazine.						"Vacor","Raid"		
Fentanyl						Lindane		
						Dichlorophenoxyacetic acid		

The above are the poisons detected,
excluding ethanol and carbon monoxide.

McBay 3-4-88

OFFICE OF THE CHIEF MEDICAL EXAMINER
CHAPEL HILL, NORTH CAROLINA
TOXICOLOGY

ALCOHOL AND AUTO FATALITIES IN NORTH CAROLINA

SINGLE VEHICLE OPERATORS

Year	1981	1982	1983	1984	1985	1986
Sober*	92(25%)	80(27%)	79(31%)	92(30%)	115(38%)	145(37%)
Drinking	48(13%)	33(11%)	15(6%)	29(9%)	24(8%)	37(9%)
Influenced	227(62%)	184(62%)	163(63%)	185(60%)	164(54%)	213(54%)
Tested # (%)	367(86%)	297(88%)	257(84%)	306(87%)	303(86%)	395(90%)
Deaths	427	339	305	350	351	439

MULTIPLE VEHICLE OPERATORS

Sober	170(64%)	179(67%)	191(70%)	214(69%)	277(76%)	318(75%)
Drinking	27(10%)	24(9%)	22(8%)	20(6%)	25(7%)	26(6%)
Influenced	70(26%)	64(24%)	60(22%)	74(24%)	62(17%)	78(18%)
Tested # (%)	267(81%)	267(86%)	273(85%)	308(84%)	364(86%)	422(89%)
Deaths	331	310	321	365	424	473

PEDESTRIANS

Sober	78(42%)	84(45%)	65(45%)	98(47%)	90(47%)	91(43%)
Drinking	13(7%)	10(5%)	7(5%)	8(4%)	6(3%)	17(8%)
Influenced	95(51%)	91(49%)	73(50%)	100(49%)	94(49%)	102(49%)
Tested # (%)	186(75%)	185(78%)	145(73%)	206(79%)	190(77%)	210(81%)
Deaths	248	238	199	260	247	259
MV deaths	1551	1388	1314	1521	1552	1743

*= % alcohol: Sober= <0.02 Drinking 0.02-0.09 Influenced >0.09

Passengers and motorcyclists excluded

McBay 4/8/87

Cannabis in Costa Rica by William E. Carter, Editor, A publication of Inst. for the Study of Human Issues, Philadelphia, 1980.

This is the report of a study, funded by NIDA (National Institute on Drug Abuse), of the effects of marihuana use where 86 chronic users were compared with 156 non-users.

The users chronically smoked an average of 10 marihuana cigarettes a day (2.5 to 40) for a minimum of 10 years and an average of 17 years. The cigarettes contained from 1.3 to 3.7% THC.

Most of the users were stable smokers, "invisible" solid productive citizens. The objective was to study was to identify gross or subtle changes in body and central nervous system functions which could be attributable to marihuana, none was found. No real consequences of prolonged use of the drug were uncovered. This was found to be in keeping with the controlled studies carried out in Jamaica and Greece.

On the basis of their research they were convinced "that if chronic marijuana use leads in the long run, to deleterious effects, these must be subtle indeed.

Arthur J. McBay, Ph.D., Forensic Toxicologist

Full copy Available from HHS Comm Are Staff

Andrew P. Mason,¹ B.S. and Arthur J. McBay,² Ph.D., DABFT

(1)

Cannabis: Pharmacology and Interpretation of Effects

REFERENCE: Mason, A. P. and McBay, A. J., "Cannabis: Pharmacology and Interpretation of Effects," *Journal of Forensic Sciences*, JFSCA, Vol. 30, No. 3, July 1985, pp. 615-631.

ABSTRACT: A selective introductory review of the *Cannabis* literature is presented. Subjects reviewed include the relative psychoactivities of *Cannabis* constituents, the disposition and distribution of THC and its metabolites, the relative psychoactivities of THC metabolites, and the use of cannabinoid concentrations in physiological fluids in interpretations of the significance of *Cannabis*-induced effects. The pharmacology of cannabinoids in humans is emphasized.

KEYWORDS: toxicology, marijuana

Marijuana and other *Cannabis* products are used by a significant proportion of people in our society. When smoked or ingested, these substances produce perceptual, cognitive, affective, and behavioral changes in the user. The *Cannabis* constituent that is responsible for the production of the majority of this psychoactive response is (–)-trans-delta-9-tetrahydrocannabinol or THC [1]. There has been great concern that the psychoactive response experienced by marijuana users has a detrimental effect on the performance of complex coordinated psychomotor skills. Naturally, the impairment of performance would be of greatest concern in those individuals with direct responsibility for the health and safety of others and in individuals whose impaired actions could potentially be dangerous to themselves or to others near them. Motor vehicle operators, pilots, air traffic controllers, law enforcement or emergency aid personnel, military personnel, and industrial workers are all good examples of people whose impaired performance could potentially be dangerous.

During the last decade, remarkable progress has been made in the ability to analyze biological samples for cannabinoid compounds. This ability was developed as a prerequisite for, and was instrumental in the acquisition of data concerning the pharmacology, pharmacokinetics, metabolism, behavioral effects, and toxicology of *Cannabis* constituents. These analytical methods and the knowledge derived from their use in basic research on cannabinoids are now being used in attempts to interpret the significances of cannabinoid concentrations found in forensic science specimens. The frequency with which these analytical methods are used and the frequency with which forensic scientists are required to provide estimates of the probable significances of *Cannabis*-induced effects or the degree of impairment experienced by a *Cannabis* user based on cannabinoid concentrations in biological specimens are both expected to increase. Use of these methods and in-

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1984

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Andrew P. Mason,¹ B.S. and Arthur J. McBay,² Ph.D.;
D.A.B.F.T.

Ethanol, Marijuana, and Other Drug Use in 600 Drivers Killed in Single-Vehicle Crashes in North Carolina, 1978-1981

REFERENCE: Mason, A. P. and McBay, A. J., "Ethanol, Marijuana, and Other Drug Use in 600 Drivers Killed in Single-Vehicle Crashes in North Carolina, 1978-1981," *Journal of Forensic Sciences*, JFSCA, Vol. 29, No. 4, Oct. 1984, pp. 987-1026.

ABSTRACT: Although the use of ethanol, marijuana, and other drugs may be detrimental to driving safety, this has been established by direct epidemiological evidence only for ethanol. In this study, the incidences of detection of ethanol (and other volatile substances), delta-9-tetrahydrocannabinol (THC), barbiturates, cocaine and benzoylecgonine, opiates, and phencyclidine were determined in an inclusive population of 600 verified single-vehicle operator fatalities that occurred in North Carolina in 1978 to 1981. The incidence of detection of amphetamines and methaqualone were determined for drivers accepted for study during the first two years ($n = 340$) and the last year ($n = 260$), respectively. Blood concentrations of 11-nor-delta-9-tetrahydrocannabinol-9-carboxylic acid (9-carboxy-THC) were determined in THC positive drivers. EMIT cannabinoid assays were performed on blood specimens from all drivers accepted for study during the third year, and the feasibility of using the EMIT cannabinoid assay as a screening method for cannabinoids in forensic blood specimens was investigated. The incidence of detection of ethanol (79.3%) was far greater than the incidences determined for THC (7.8%), methaqualone (6.2%), and barbiturates (3.0%). Other drugs were detected rarely, or were not detected. Blood ethanol concentrations (BECs) were usually high; 85.5% of the drivers whose bloods contained ethanol and 67.8% of all drivers had BECs greater than or equal to 1.0 g/L. Drug concentrations were usually within or were below accepted therapeutic or active ranges. Only a small number of drivers could have been impaired by drugs, and most of them had high BECs. Multiple drug use (discounting ethanol) was comparatively rare. Ethanol was the only drug tested for that appears to have a significantly adverse effect on driving safety.

KEYWORDS: toxicology, motor vehicle accidents, alcohol, marijuana

It is accepted that ethanol use has a detrimental effect on the performance of drivers because it impairs sensory input and perception, judgement and cognition, motor control, and their integration and coordination. It is also known that the use of ethanol is strongly associated with traffic fatalities. Nationally, between 40 and 55% of all drivers involved in fatal crashes have blood ethanol concentrations (BECs) greater than or equal to 1.0 g/L [1],³ the

Presented at the 34th Annual Meeting of the American Academy of Forensic Sciences, Orlando, FL, 8-11 Feb. 1982. Received for publication 9 Jan. 1984; accepted for publication 30 Jan. 1984

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²Chief toxicologist, Office of the Chief Medical Examiner and professor, Division of Pharmaceutics, School of Pharmacy, and Department of Pathology, School of Medicine, University of North Carolina, Chapel Hill, NC.

³1.0 g/L = 100 mg/dL = 100 mg% = 0.10%.

To: Alaska State Legislature
House of Representatives
Committee on Health, Education
and Social Services
Pouch V
Juneau, AK 99811

From: Tod H. Mikuriya, M.D.
1168 Sterling Avenue
Berkeley, CA 94708

Date: April 18, 1988

Re: Senate Bill 32 (Hess)

Thank you for the opportunity of testifying yesterday via teleconference regarding the medical aspects of cannabis four days ago. This is in response to the request to address the 14 findings enumerated in the proposed legislation.

I am in sympathetic understanding of the legislator who complained of the bewildering contradictory evidence on the subject. Regretfully, things have not changed since I began researching the effects of cannabis during my sophomore year in medical school in 1959. Review of the medical literature in that year revealed a significant bias against the medicinal use and for the adverse effects coinciding with the national efforts to criminalize marijuana in 1937.

That federal effort resulted in the City of New York setting up a blue ribbon panel of medical, psychiatric, psychological, and social services experts to study the real vs fantasied hazards of marijuana use. The result of this commission started in 1938 facilitated by the New York Academy of Medicine in response to concerns expressed by mayor Fiorello LaGuardia was reported six years later after a well-funded careful study. It was rejected and condemned by Harry Anslinger, head of the Federal Bureau of Narcotics.

Things have not changed much since.

My book "Marijuana Medical Papers 1839-1972" which are attached under separate cover describes medicinal applications commonly recognized in all the lists of drugs such as the U.S. Pharmacopeia prior to being purged. The official contemporary federal stance is that these listings and descriptions are "folk medicine". The resultant policy is to classify crude cannabis preparations as new drugs to avoid the dissonance of having the substances "grandfathered" in under FDA regulations.

Deprived of availability to the physician as a medicinal tool, clinical ignorance has prevailed permitting the ascendancy of the moral pharmacologists and the "send them a signal" school of drug propaganda which prevails today.

The "Findings" in section 1 are the flawed products resulting from this defective information derived from this bias.

1. marijuana and other cannabis preparations may contain over 420 different compounds.

Irrelevant. So do all complex organic compounds. One could go crazy with fear analyzing one's food using a specious premise of complexity of compounds in itself constituting a threat.

2. THC is insoluble in water, soluble in fat and goes into the fatty tissues where it takes as long as 30 days to be eliminated from the body.

True, but the connection between presence of inactive breakdown products with dysfunction has yet to be shown. The slow breakdown may be a factor to prevent the drug from being addictive as compared with the water soluble opioids.

3. the buildup of THC in the system means accumulation of higher drug levels reach at any time after a single dose.

False. Three wrongs don't make a right- just three times as wrong. There is no "buildup" which redundantly does not mean accumulation and ignores the rapid conversion from THC to inactive metabolite. The origin of finding #3 appears to be the product of contamination of a grade school level science class with a commercial for floor wax.

4. the buildup of THC causes the user to smoke more marijuana to achieve the desired high and may result in loss of sleep, appetite, and initiative, as well as moodiness and depression.

False & bizarrely contradictory. If anything LESS marijuana is needed to achieve the desired high as described in the literature starting from the 1944 Mayor's Committee report. How could this be if we were to believe finding #3? Perhaps finding 4 was used to cover cases not explained by finding 3.

5. it is possible for a human being to overdose from the use of marijuana, especially if it is used in conjunction with alcohol, because it increases the effects of alcohol;

False, confused and mixed up with alcohol. Both drugs have distinctly different profiles of pharmacologic activity. Some interactions may be synergistic, others antagonistic and highly dependent on dose level of each.

6. the THC content of commonly obtainable marijuana has increased from less than one percent 10 years ago to as high as 10 percent today;

False. See attached prepublication copy of Cannabis 1988 Old Drug "New" Dangers to appear in the current Journal of Psychoactive Drugs.

7. No comment.

8. Review of the literature does not support the notion that the use of cannabis causes schizophrenia. Starting with the first large scale inquiry on the subject by the Indian Hemp Drugs Commission 1893-1896 by the British Government, and every health commission that has studied the very same issue subsequently has concluded there is no causal connection.

Cannabis in large doses in naive subjects is a familiar theme in the early medical literature that has an initial acute intoxication phase which may include symptoms of illusions and hallucinations. (Marijuana Medical Papers 1839-1972)

These stimulating symptoms of oral cannabis overdose give way to a sedative effect roughly complementary to the initial excitatory effects: the more stimulating the initial effects, the deeper the resulting sedation.

The question of the analgesic aspects of the experience are probably overstated in that the decrease in sensitivity to painful stimuli is absent unless there is "superdose" level intoxication.

Otherwise the analgesic effects are probably most useful on pain originating from irritability of the central nervous system or possibly local effects on certain blood vessels in covering of the brain.

9. False. There are no reputable studies that cannabis may cause lung cancer in 3 years.

10. Still Unknown. There is no epidemiologic data to support the in vitro studies that claim teratogenicity. A study of the quality and longevity of the Framingham, Massachusetts study that conclusively established the connection between tobacco smoking and lung cancer and other illnesses is desperately needed to look into this issue.

11. No irreversible changes in the brain have been proven.

There is clearly a hazard from the irritation to the tracheobronchial tree from smoked marijuana with high levels of chronic use causing sinusitis, bronchitis and pharyngitis.

Increase in heart rate is dose related but should pose no

hazards unless an individual was unusually susceptible because of preexisting heart disease.

There is no evidence to support the assertion that there is decreased circulation.

12. Cannabis in either overdose or use by a naive subject can induce loss of memory, anxiety, panic, paranoia, and psychosis which wears off as soon as the effects of the drug enter the sedative phase.

Cannabis in chronic use patterns is clearly an effective anxiolytic or minor tranquillizer and sedative. This is the effect sought by most users. Indeed in many individuals the chronic sedative effects will adversely effect thinking, reading comprehension or any activity requiring sustained mental acuity.

Indeed some individuals will attempt to self-medicate away feelings of anxiety and depression and this will lead to a psychological dependence that may be harmful.

13. The assertion that the use of even small amounts of marijuana by adults in the home subjects children present to a substantial health hazards is without foundation and cannot be demonstrated.

14. No comment.

Review of the type and content of research discloses a heavy investment to depict cannabis as a "killer weed" without medicinal redeeming importance. I consider this an abuse of the medical profession by special interest groups within the enforcement/corrections community whose existence depend on the current social policy.

I concur with the other medical witness who opined that the findings themselves would be the basis of voiding the legislation because they would not stand up to court scrutiny.

Tod H. Mikuriya, M.D.

**FAX TO AREA CODE (907) 586-9548 -- URGENT, PLEASE
FORWARD AS SOON AS POSSIBLE**

ATTENTION: Representative Johnnie Ellis, Co-Chair ~~House~~ HESS Committee, and Nillo Coponen, Co-Chair, HESS Committee ~~of the~~ ~~Nordlund~~ (907) 465-3759.

The request that I comment on some of the Statement of Facts and Findings in SB 32 only arrived in my mail yesterday, April 27th. Thus, my comments, if they are to be of any value to you, must be presented in this somewhat hasty fashion. I think the status of the facts is fairly clear and easy to comment on. If I would have had more time, I would have chosen my words more carefully than those that follow. I do not think my conclusions would be any different, however.

I will consider the list of findings as they appear in SB 32 on the document sent to me that has the date 3/31/87 at the top of it.

Finding No. 1. Yes, cannabis contains hundreds of compounds whose biological activity has not been determined.

Finding No. 2. Yes, this is true, but not necessarily relevant as to health problems. All psychoactive drugs used for therapy (tranquillizers, antidepressants, antianxiety, antihistamine, etc., drugs) have these properties to a degree.

Finding No. 3. Yes, this is quite true, both as to THC and for any psychoactive drug with the properties in Finding No. 2.

Finding No. 4 deals with a complex issue on which there is relatively little data. It is not necessarily the "build-up" of THC that causes these things. Far more complicated adaptive measures are likely to be the cause.

Finding No. 5. This seems to be stated just backwards. The use of marijuana, at least in theory, would more likely lead to overdose from alcohol. Overdose from alcohol is a far more dangerous condition than overdose from marijuana under most circumstances. Although laboratory data suggests this is a possibility, I'm aware of relatively little clinical data that suggests it happens very often. Remember, 18 million people are said to be using marijuana regularly and most of them are using alcohol regularly as well.

Finding No. 6. This is true, though the 10% estimate is probably not a precise one.

Finding No. 7. I would assume this is true in Alaska.

Finding No. 8. Marijuana does not "cause" schizophrenia. People who have the disease schizophrenia seem more sensitive to the psychoactive effects of marijuana. Marijuana certainly can produce a psychotic state that in some ways resembles schizophrenia, but it does not cause it. It does cause delusions, hallucinations and alteration in sensation. I am aware of no good medical evidence that users are unable to respond to pain, at least to the degree that it has come to anyone's attention clinically.

Finding No. 9. I am aware of no evidence that marijuana causes lung cancer in "three years". There is much data to expect that in some people marijuana smoking may cause the same lung diseases as does tobacco smoking. There is some laboratory data that suggests that the progression of such lung diseases may be faster after marijuana smoking, but there is no body of medical evidence from clinics or hospitals that say this is occurring.

Finding No. 10. This is true to the extent that eggs, sperm, hormones and, in animals, fetus development is altered by exposure to cannabinoids. Marijuana users do have more

undersized offspring, but to separate marijuana use from their tobacco and alcohol use, which clearly affect the fetus, is so difficult to do that the data must remain tentative. I am aware of no clinical cases where "deformed" fetuses have clearly been a result of marijuana use alone.

Finding No. 11. "Irreversible changes in the brain" have been demonstrated by some scientists in some animals, though not all scientists agree that this is an effect of the marijuana. Certainly, the evidence from the experience with humans is not convincing. So far as the other physical reactions listed in this finding, they do occur.

Finding No. 12. Yes, these all do occur and are among the more predictable, expected effects of marijuana.

Finding No. 13. This seems to overstate the facts. Children growing up in a home where the adults are using marijuana are more likely, other things being equal, to use marijuana than they would if the adults were not using drugs. There is a fair amount of data that suggest that is so. Whether it's fair to call this a "substantial health hazard" is less clear to me.

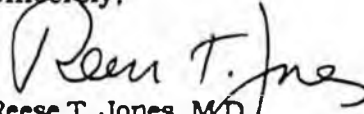
Finding No. 14. Yes, cannabinoids have a high potential for abuse. Abuse, of course, is a term that is not necessarily predictive of health hazards or any spectrum of health hazards. It mainly reflects behavior that society or some significant subset of society views with disfavor.

I am intrigued by the findings listed under Item B 1 through 4. If, in fact, patterns of marijuana use in Alaska represent more or more frequent use than elsewhere, then in a way the Alaska experiment has produced some useful findings. Many of us predicted that as marijuana possession laws become more liberal, other things being equal, frequency and amount of use are more likely to increase. Certainly, in most states in the United States, particularly amongst younger people, marijuana use either has leveled off or is dropping in recent years. If the pattern really is different in Alaska (and I am not familiar with the data), then that is certainly a compelling reason to re-examine your state's policy regarding possession.

I am puzzled by just how your legislature arrived at the magical figure of 4 ounces of marijuana as being an amount worthy of some special attention. Four ounces is enough to make about 120 good size marijuana cigarettes. If one is considering material of the high potencies now available, 4 ounces is enough to make 300 or 400 marijuana cigarettes. That strikes me as a lot of marijuana smoking?

In summary, my overall impression of the findings listed in SB 32 is that none of them represent anything new that wasn't reasonably well accepted and known to researchers of marijuana in the early 1980's. Certainly the public's perception, the media's perception, and perhaps law maker's perception of the issues has changed considerably since the early 1980's. Unfortunately, as is often the case, these changes in perception do not necessarily reflect any new data, but rather just a belated recognition of something that was there all the time but unappreciated.

Sincerely,



Reese T. Jones, M.D.
Professor of Psychiatry
University of California, San Francisco
San Francisco, California 94143
(415) 476-7452

RTJ:kw



ALASKA STATE LEGISLATURE
HOUSE OF REPRESENTATIVES
RESEARCH AGENCY

P.O. Box Y, State Capitol
Juneau, Alaska 99811-3100
Mail Stop 3100
(907) 465-3991

April 19, 1988

MEMORANDUM

TO: Representatives Johnny Ellis and Niilo Koponen

ATTN: Jim Nordlund

FROM: Karla Hart *KH*
Legislative Analyst

RE: Background on Findings in CSSB 32 (HESS)--Marijuana
Research Request 88.245

You requested background information on the findings in CSSB 32 (HESS), an Act relating to marijuana. The original version of SB 32 is an exact copy of CSHB 698 (Jud) which was considered in 1984. The 1987 HESS Committee Substitute for SB 32 added four new findings to Section 1(a) and all of the findings in Section 1(b). It also incorporated minor revisions to five Section 1(a) findings (Attachment A).

Following is a summary of committee activity relating to the consideration of the recriminalization of marijuana during the Thirteenth and Fourteenth Legislatures.

- March 5, 1984-- HB 698 was introduced by the Judiciary Committee (then chaired by Representative Charlie Bussell). The original version of the bill did not include findings.
- March 14, 1984-- the committee heard testimony in favor of HB 698 from the Department of Law.
- March 16, 1984-- Representative Bussell held a public hearing on HB 698 in Barrow. Two individuals testified, one in support and one opposed to the recriminalization of marijuana.
- March 17, 1984-- the committee met in Anchorage to receive public testimony on HB 698. Nine individuals testified, one in support and eight opposed to the recriminalization of marijuana.

- March 27, 1984-- the committee heard expert testimony from Dr. Reese T. Jones, Professor of Psychiatric Institute, University of California, San Francisco and Dr. Gabriel G. Nahas, Professor of Anesthesiology, Columbia University (both via telecommunications).
- April 17, 1984-- the committee heard testimony against the recriminalization of marijuana from Dr. Aaron Wolf of Anchorage and discussed various aspects of the effect of marijuana on the body.
- April 18, 1984-- HB 698 passed out of committee (five do pass, two do not pass) with a zero fiscal note.
- May 5, 1984-- HB 698 was recommitted to the Judiciary Committee to add the findings of the committee at the recommendation of the Department of Law. A list of "some of the sources" of the committee's findings is found in Attachment B, along with a clipping from the Anchorage Daily News and background on the expert witnesses.
- May 7, 1984-- without discussion, a Judiciary Committee substitute which included findings was adopted (one do not pass, five committee substitute) along with a Judiciary fiscal note (Attachment C--fiscal note). A Finance Committee referral was added by unanimous consent.
- 1984-- CSHB 698 (Jud), an Act relating to Marijuana, died in the Rules Committee.

Jack Chenoweth, Legislative Counsel, reviewed the drafting file for HB 698, an Act relating to marijuana. He said that the only backup in the file is a one and one-half page typewritten list of statements relating to marijuana (with no citations) and a brief memorandum stating that the bill should show the hazards of marijuana.

I found no committee minutes indicating any formal discussion of the recriminalization of marijuana during the Fourteenth Legislature (1985-86). Several bills providing for the recriminalization of marijuana were introduced, as was one resolution proposing a change to the Alaska Constitution to limit the right to privacy with regard to the use of illegal drugs. None of the legislation passed out of the first committee of referral.

I hope this information is helpful. If you have questions, please call.

Attachments

ATTACHMENT A

CSSB 32

Original sponsors: Fischer and Faiks

BY THE HEALTH, EDUCATION AND
SOCIAL SERVICES COMMITTEE

1 IN THE SENATE

2 CS FOR SENATE BILL NO. 32 (HESS)

3 IN THE LEGISLATURE OF THE STATE OF ALASKA

4 FIFTEENTH LEGISLATURE - FIRST SESSION

5 A BILL

6 For an Act entitled: "An Act relating to marijuana; and providing for an
7 effective date."

8 BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF ALASKA:

9 * Section 1. FINDINGS. (a) The legislature finds that marijuana use
10 is a serious health problem for the following reasons, each of which con-
11 stitutes a legitimate and compelling state interest:

12 (1) marijuana and other cannabis preparations may contain over
13 420 different compounds; *New Finding.*

14 *Revised* (2) tetrahydrocannabinol (THC), one of the pharmacologically
15 active compounds in marijuana, is not soluble in water, but goes into the
16 fatty tissues of the brain, testicles, ovaries, and other internal organs,
17 and takes as long as 30 days to be eliminated from the body;

18 (3) the buildup of THC in the system means that repeated
19 administration of even small doses may lead to an accumulation of the drug
20 higher than levels reached at any time after a single dose; *New Finding*

21 (4) the buildup of THC in the body causes the user to smoke more
22 marijuana to achieve the desired high and may result in loss of sleep,
23 appetite, and initiative, as well as moodiness and depression;

24 (5) it is possible for a human being to overdose from the use of
25 marijuana, especially if it is used in conjunction with alcohol, because it
26 increases the effects of alcohol;

27 *Revised* (6) the THC content of commonly obtainable marijuana has in-
28 creased from less than one percent 10 years ago to as high as 10 percent
29 today;

1 (7) marijuana with THC content higher than one percent is
2 generally available in the state, through both importation and local
3 cultivation; *New finding*

4 *Revised* (8) marijuana may cause schizophrenia, illusions, and hallucina-
5 tions, including a dulling of the senses, creating the possibility that the
6 user is unable to respond to body signals such as pain;

7 (9) although it may take a heavy cigarette smoker as long as 20
8 years to develop lung cancer, one marijuana cigarette a day may cause lung
9 cancer in three years;

10 (10) THC affects eggs, sperm, sexual hormones, and the develop-
11 ment of a fetus and marijuana use may result in deformed or undersized
12 offspring;

13 (11) other physical reactions to marijuana include irreversible
14 changes in the brain, sinusitis, pharyngitis, bronchitis, emphysema, in-
15 creased heart rate, and decreased blood circulation;

16 *Revised* (12) other psychological reactions to marijuana include loss of
17 memory, anxiety, panic, paranoia, psychosis, psychological dependence, and
18 impairment in thinking, reading comprehension, verbal and arithmetic prob-
19 lem solving, and perception of distance and time;

20 (13) the use of even small amounts of marijuana by adults in the
21 home subjects children present to a substantial health hazard; and

22 (14) marijuana and tetrahydrocannabinols have been found by the
23 United States Congress to possess a high potential for abuse. *New finding*

24 (b) The legislature further finds that *All new*

25 (1) patterns of marijuana use in the state have changed over the
26 past decade;

27 (2) the daily use of marijuana in the state has increased to as
28 high as four percent among the general population and as high as six
29 percent among secondary school students;

1 (3) marijuana use in the state within both the general popula-
2 tion and among adolescents is significantly higher than in the nation as a
3 whole;

4 (4) there is a direct relationship between the use of marijuana
5 at home by adults and the percentage of secondary school students who
6 experience disciplinary and academic problems in public schools; over the
7 last three years in the Anchorage School District, of the 230 students who
8 have been suspended from school for possession or use of marijuana, 29
9 percent have indicated that marijuana is used by adults in their living
10 environment;

11 (5) the changing patterns of marijuana use and the relationship
12 between marijuana use by adults and adolescents have significantly com-
13 promised the state's legitimate efforts to prevent the spread of marijuana
14 use to adolescents and protect the health of adolescents; and

15 (6) these efforts constitute a legitimate and compelling state
16 interest.

17 Revised The legislature further finds there is a legitimate and com-
18 pelling governmental interest, based on testimonial and scientific evi-
19 dence, that the public health and welfare will suffer if personal use of
20 marijuana even in small amounts is allowed.

21 * Sec. 2. AS 11.71.060(a) is amended to read:

22 (a) Except as authorized in AS 17.30, a person commits the crime
23 of misconduct involving a controlled substance in the sixth degree if
24 the person

25 (1) uses or displays any amount of a schedule VIA con-
26 trolled substance or possesses one or more preparations, compounds,
27 mixtures, or substances of an aggregate weight of less than one-half
28 pound [ONE OUNCE OR MORE] containing a schedule VIA controlled sub-
29 stance [ON A PUBLIC STREET OR SIDEWALK OR ON THE PREMISES OF A PUBLIC

1 CARRIER OR BUSINESS ESTABLISHMENT OR IN ANY OTHER PUBLIC PLACE]; or

2 [(2) KNOWINGLY POSSESSES ANY AMOUNT OF A SCHEDULE VIA
3 CONTROLLED SUBSTANCE WITHIN THE IMMEDIATE CONTROL OF THAT PERSON WHILE
4 OPERATING A PROPELLED VEHICLE;

5 (3) BEING UNDER 19 YEARS OF AGE, POSSESSES ONE OR MORE
6 PREPARATIONS, COMPOUNDS, MIXTURES, OR SUBSTANCES OF AN AGGREGATE
7 WEIGHT OF LESS THAN FOUR OUNCES CONTAINING A SCHEDULE VIA CONTROLLED
8 SUBSTANCE;

9 (4) POSSESSES ONE OR MORE PREPARATIONS, COMPOUNDS, MIX-
10 TURES, OR SUBSTANCES OF AN AGGREGATE WEIGHT OF FOUR OUNCES OR MORE
11 CONTAINING A SCHEDULE VIA CONTROLLED SUBSTANCE; OR]

12 (2) [(5)] refuses entry into a premises for an inspection
13 authorized under AS 17.30.

14 * Sec. 3. AS 11.71.070 is repealed.

15 * Sec. 4. This Act takes effect immediately under AS 01.10.070(c).

ATTACHMENT B

Miscellaneous Documents on Marijuana

9 PAGES, 1st

3.9.66

Bussell's Close door on marijuana use!

By R.G. BOON

Daily News reporter

House Judiciary Chairman Charlie Bussell, Anchorage, has drafted a bill that would "close the door on marijuana use" in the state by making illegal the possession of any amount of the drug.

The bill was introduced by the committee earlier this week.

Current statutes, barely a year old, permit possession of up to a quarter pound of marijuana for personal use in one's own home.

Rep. Don Clickata, a minority member of the committee, said the bill is "a waste of time" for legislation because they decided that marijuana laws just two years ago.

Law enforcement officials say the proposed law would not have a substantial effect on current enforcement patterns. Busting drug dealers, not users, would continue to be the focus of police and courts.

Bussell said he drafted the bill because Alaska's current law is "out of step with other states' laws and federal guidelines regarding marijuana."

Alaska, Hawaii and Ore-

gon are the only states that permit any use of marijuana. Federal laws prohibit marijuana possession.

He said the bill reflects a conservative view that he said is sweeping the country. "As a tough guy, I would say that the public would support decriminalizing marijuana about 60-40."

Rep. Clickata, D-Anchorage, said he doubts Bussell's reasons for introducing the bill. "There's no justification for it."

"The law we passed in 1964 was a mistake and fair compensation," he said. "We should stick with it. This new bill is a waste of the legislature's time."

The Alaska Legislature voted to allow private use of marijuana and decriminalize public use in 1970, the same year the state Supreme Court ruled that possession of marijuana in a person's home for personal use was constitutionally protected.

But court rules that allowed in-home possession of marijuana use were not substantial enough to justify the state's transition into criminal jurisdiction right to privacy.

Revised drug laws passed

in 1964 made public use of marijuana a criminal offense but allowed possession of less than one ounce for personal use.

The latest proposal would make possession of smaller amounts of the drug a misdemeanor offense with a maximum punishment of \$1,000 fine and 90 days in jail.

Bussell said, without evidence published since the 1974 court decision, that the state makes enough in tax marijuana-smoking completely.

He cited no scientific health studies, saying such research would be brought out when hearings on the bill begin.

Don Kitchey, chief prosecutor for the state, said the state's policy of prosecuting drug users would not change if lawmakers pass a blanket ban on marijuana.

"Our emphasis is not in the prosecution of drug users," he said. "Our focus is on major distribution and production."

"Our opinion on that would not change if this bill becomes law."

Anchorage Police Chief Brian Foster said he supports banning all marijuana use but does not see the department shifting its sights to individuals

if more. "We might make a few arrests initially to get the message out," he said. "I don't see the department putting out 100 officers to look for users."

Foster said such a law would be the state at hypocrisy in its current campaign, which has the aim of marijuana eradication, punishing the user.

"There's a hole in the current law," said Lt. George Novelly, who heads the Anchorage Police Department's Metro Drug Unit. "We're creating a market for the use of marijuana — allowing people into possession — while the sale of pot is still illegal."

"Obviously the majority of users don't grow their own," he said. "If they are, I want to know who's buying all the stuff that's being smuggled into the state."

Clickata said he has heard nothing about health studies that would justify prohibiting private use of marijuana. "What Bussell is trying to do is to walk into people's homes and tell them what to do," he said.

He called Bussell a "conservative extremist" who doesn't represent the mainstream of public sentiment.



PRUCH V
JANUARY ALASKA 99511
(907) 465-6000

Alaska State Legislature
HOUSE OF REPRESENTATIVES

Representative
Charles E. Sullivan
Chairman

Committee on Judiciary

GUEST SPEAKERS

2:00 P.M.

Dr. Reese T. Jones
Professor of Psychiatry
Langley Porter Psychiatric Institute
University of California - San Francisco

Dr. Jones is a clinical psychiatrist at the University of California at San Francisco and served as a member of the distinguished commission of scholars sponsored by the Institute of Medicine to study the physiological and psychological effects of marijuana. The report, entitled "Marijuana and Health," is recognized by the medical community as one of the preeminent academic works on the subject.

2:30 P.M.

Gabriel G. Nahas O.B.E., M.D., Ph.D.
Professor of Anesthesiology
Columbia University
College of Physicians and Surgeons

Dr. Nahas is a professor at Columbia University in New York City and is renowned as a pioneer in the research of the biological effects of marijuana. Considered by many as the foremost authority on the subject, Dr. Nahas has authored two books Keep off the Grass and Marijuana: Biological Effects.

Rep. JOHN LILLA, Vice Chairman Rep. RICHARD CHAPMAN, Secretary
Rep. JOE HARTY Rep. PAUL HANSEN Rep. BOB CLARKSON Rep. PAUL BRADY

"Charlie-Blurb to be read into record on H5698 Monday, 8a.m., May 7th

Other than hearing considerable testimony from witnesses including that of Dr. Reese T. Jones, Professor of Psychiatry, University of California, San Francisco and that of Dr. Gabriel G. Nahas, ~~M.D.~~ O.B.E., M.D., Ph. D., Professor of Anesthesiology, Columbia University, New York City,

the Committee also considered the report, "Marijuana and Health," by the Institute of Medicine, U. of California;
or excerpts from them.
the books "Keep Off the Grass" and "Marijuana: Biological Effects," both authored by Dr. ~~William~~ Nahas;

"Health Consequences of Marijuana Use," by William Pollin, M.D., Director, National Institute of Drug Abuse (written 1980);

a printed interview with Dr. D. Harvey Fowelson, of the mental health program of Calaveras County, California, who once termed marijuana "harmless" but who now calls it "Our Most Dangerous Drug," the title of the printed interview;

a pamphlet called "Marijuana - What Parents Need to Know" from the Alaska Council on Prevention of Alcohol and Drug Abuse;

a pamphlet, "Marijuana" by Charlotte Drug Education Center, Inc., Charlotte, North Carolina;

pamphlet, "Marijuana Update," a Readers' Digest reprint of May, 1980;

article, "Marijuana: The Myth of Harmlessness Goes Up in Smoke," by Peggy Mann, a Saturday Evening Post feature, 1980;

article, "The Marijuana Epidemic," by Stuart M. Butler, analyst, The Heritage Foundation, Washington, D.C.;

booklet, "Report on Adverse Health and Behavioral Consequences of Cannabis Use," World Health Organization, 1981;

an assortment of Drug Abuse Newsletters of 1982, 1983;

articles printed in the Congressional Record entitled "Marijuana and Health," the ninth report to the U.S. Congress, by the Secretary, Health and Human Services, (1982);

booklet, "Marijuana Today" by George K. Russell, (1963), and
article, "Marijuana Smoking and Its Effects on the Lungs," by
Donald P. Tashkin, M.D. and Sidney Cohen, M.D., of the Department
of Medicine and Psychiatry, U.C.L.A. School of Medicine, Los Angeles,
California.

ATTACHMENT C

Fiscal Note

DEVISION 10127 APR 17, 1984

REQUEST

Bill/Resolution No. 1 RD 699

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

Sponsor: House Judiciary

Requester:

Date of Request:

FISCAL DETAIL

Agency Affected: Department of Law

Program Category Affected:

Administration of Justice

EDU, Program or Subprogram(s) Affected:

Prosecution

EXPENDITURES/REVENUES: (Thousands of Dollars)

	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89
OPERATING						
100 PERSONAL SERVICES		143.2	131.1	140.6	170.2	180.2
200 TRAVEL		6.2	6.9	7.2	7.7	8.2
300 CONTRACTUAL		61.5	63.8	61.2	63.2	65.5
400 SUPPLIES		17.1	12.2	12.8	13.6	14.2
500 EQUIPMENT		7.1				
600 LAND & STRUCTURES						
700 GRANTS, CLAIMS						
800 MISCELLANEOUS						
TOTAL OPERATING		235.8	234.5	221.9	235.2	249.5

CAPITAL

REVENUE

FUNDING: (Thousands of Dollars)

GENERAL FUND		235.8	234.5	221.9	235.2	249.5
FEDERAL FUNDS						
OTHER						
TOTAL						

POSITIONS:

FULL-TIME						
PART-TIME						
TEMPORARY						

SOURCE OF FUNDS TO OFFSET FISCAL IMPACT OF BILL:

ANALYSIS: Attach a separate page for analysis

Prepared By: Richard L. Parnell
 Divisions: Administrative Solutions

Approved by Commissioner: Bernard C. Parnell
 Agency: Department of Law



Phone: 665-7777
 Date: 4/19/84

Date: 4/19/84

Distribution (by Agency preparing fiscal note):

Legislative Finance
 Legislative Sponsor
 Requester
 Office of Management and Budget
 Impacted Agency(ies)

12/1/83

Fiscal Note
Analysis
HB 698

April 10, 1984

HB 698 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 HB 698 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 Levin v. State, 337 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 HB 698 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 require additional legal research, a thorough review of the record, the drafting of briefs, and oral argument before the

appellate court. Although these appeals would present an increased workload for the criminal division attorneys assigned to appellate work, no additional funding is requested for this aspect of HB 698's fiscal impact.

2. New Criminal Cases

Although some of the conduct included within the scope of HB 698 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 HB 698 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 HB 698 becomes law.

Prosecutors generally predict a lesser number of new potential criminal cases under HB 698 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 1973, 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 one Attorney III.

position. It is anticipated that this additional position will be used to add one half-time attorney in both the Anchorage and Fairbanks District Attorney's offices.

It is anticipated that a large percentage (perhaps 50-75%) of the defendants in the new cases will be first time offenders who will be eligible for pretrial diversion. Given the light sentences which these persons are likely to receive if convicted, pretrial diversion (including required community work service) appears to be a well justified use of criminal justice system resources. Even if a case is diverted however, attorney time is required to screen the case and make the diversion arrangements. New pretrial diversion personnel will be needed to supervise the new cases. Existing pretrial diversion offices are now working at full capacity. The addition of hundreds of new cases to an already full caseload will require, at a minimum, the addition of two new full-time positions. This fiscal note therefore includes funding for a paralegal II position for the Anchorage office. (This person would also be responsible for new cases in Palmer.) Funding of one additional community counselor is also required. This position will be divided into two half-time positions, one assigned to the Northern region (Fairbanks), and one in the Southeast region.

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 \$15,000 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.

Fiscal Analysis
WB 698

4/19/84

1. Defending the New Law

Admin. & Support Component/Prosec. - BRU

<u>Object</u>	<u>Total</u>
Contractual Services -	
Professional fees scientific experts 120 hrs. X \$100 = \$12,000	\$12,000
Experts' staff support, preparation of exhibits, written testimony 30 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 6 trips X \$1,500 = \$9,000 travel	1,920 9,000
	<u>\$24,920</u>

This amount will be required for both FY 85 and FY 86, to cover both trials and appeals.

2. New Criminal Cases

Third Judicial District - Anchorage

	<u>Atty. III (PPT)</u>	<u>Total</u>
Personal Services	30.0	30.0
Travel - Witness travel subsistence, atty. travel	1.5	1.5
Contractual Services		
office commo. equip. repairs	2.4	2.4
copy - postage	1.2	<u>1.2</u>
		3.6
Commodities - Ongoing		
office consumables	1.8	1.8
Law library	1.2	<u>1.2</u>
		3.0
Commodities - one time		
New position materials	1.2	<u>1.2</u>
		1.2
Equipment - one time		
New position equipment	1.5	<u>1.5</u>
		1.5
		<u>40.8</u>

Fourth Judicial District - Fairbanks

	<u>Atty. III (PPT)</u>	<u>Total</u>
Personal Services	34.1	34.1
Travel - Witness travel subsistence, Atty. travel	1.5	1.5
Contractual Services		
office commo., equip. repair	2.4	2.4
copy - postage	1.2	<u>1.2</u>
		3.6
Commodities - Ongoing		
office consumables	1.6	1.6
Law library	1.2	1.2
Commodities - one time		
New position materials	1.2	<u>1.2</u>
		1.2
Equipment - one time		
New position equipment	1.5	1.5
		<u>44.9</u>

Pratirial Diversion

	Paralegal Asst. <u>ANC-PPT</u>	Comm. Couns. <u>FAL-PPT</u>	Comm. Couns. <u>JNV-PPT</u>	<u>Total</u>
Personal Services	40.6	20.3	17.9	78.8
Travel - Staff travel/subsistence to outlying areas	1.5	1.0	1.0	3.5
Contractual Services				
Office commo./equip repair	4.8	2.4	2.4	9.6
copy - postage	2.4	1.2	1.2	4.8
				<u>14.4</u>
Commodities - Ongoing office consumables	1.8	1.8	1.8	5.4
Commodities - one time New position materials	1.2	1.2	1.2	3.6
				<u>9.0</u>
Equipment - one time	1.5	1.5	1.5	4.5
	<u>53.8</u>	<u>29.4</u>	<u>27.0</u>	<u>110.2</u>

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.

15.0	15.0
	15.0

Summary of Expenses

	<u>Defending the new law</u>	<u>New Criminal Cases</u>	<u>Public Education</u>	<u>Total</u>
Personal Services		142.9		142.9
Travel		6.5		6.5
Contractual	24.9	21.6	15.0	61.5
Commodities		17.4		17.4
Equipment		7.5		7.5
	24.9	195.9	15.0	235.8

Costs beyond FY 85 include a 6% inflation factor, less one-time items. The costs for defending the new law will occur in both FY 85 and FY 86 and they will be eliminated thereafter.

1. POSITION TITLE PARALEGAL ASSISTANT II				RANGE/SUP 16A	EMPL. UNIT 008	FORM IS PAGE/LINE			
2. TYPE OF POSITION PFT		STAFF MONTHS 12	AP NUMBER	PCX NUMBER	BRU POSITION Anchorage	LOCATION Anchorage	ELECTION DISTRICT 8		
3. CONTINUATION LEVEL				JUSTIFICATION					
4. TYPE OF EXPENDITURE									
5. PERSONAL SERVICES									
6. Salary		2,575 X 12	30,876						
7. Benefits			3,064						
8. Supplemental Benefits			1,893						
9. Fixed Benefits			2,756						
10. TOTAL PERSONAL SERVICES			40,589						
11. Travel			1,500						
12. Contractual			7,200						
13. Commodities			3,000						
14. Equipment			1,500						
15. Other									
16. TOTAL COST			53,769						
RECEIPT CODE				FUNDING SOURCE					
6.				Federal Receipts 1002					
7.				G.P. Match 1003					
8.				General Funds 1004					
9.				I-A Receipts 1005					
10.				Program Receipts 1010					
11.				Other					
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This full-time position is required to oversee community work service assignments for those misdemeanor offenders who are screened into the state's Pretrial Diversion Program. Because a large percentage of defendants in the new cases that will result from enactment of HB 598 will be first-time offenders, as many as 50% of these defendants may be eligible for pretrial diversion. This position will be responsible for providing pretrial diversion services in the Anchorage and Palmer area.

3 REQUEST FOR
NEW POSITION

AGENCY DEPARTMENT OF LAW

PROGRAM BOX PROCESS

BRU PROSECUTION

PRETRIAL DIVERSION

Page 1 of 1

FY.8

1.	POSITION TITLE ATTORNEY III				RANGE/STEP 22A	BASAL UNIT PX	PAGE 12	PAGE/LINE
2.	TYPE OF POSITION PPT	STAFF MONTHS 12	NP NUMBER	PCI NUMBER	NEW PRIORITY	LOCATION Fairbanks	ELECTION DISTRICT 16	
3.	CONTINUATION LEVEL				JUSTIFICATION			
4.	TYPE OF EXPENDITURE							
	1		2		3			
	PERSONAL SERVICES							
5.	Salary	2,332 X 12	26,784					
6.	Benefits		4,593					
7.	Supplemental Benefits		1,642					
8.	Other Benefits		1,320					
9.	TOTAL PERSONAL SERVICES		31	34,339				
10.	Travel		83	1,500				
11.	Contractual		83	3,600				
12.	Commodities		84	4,100				
13.	Equipment		85	1,500				
14.	Other							
15.	TOTAL COST			44,939				
16.	RECEIPT CODE		FUNDING SOURCE					
17.			Federal Receipts 1002					
18.			G. . Match 1003					
19.			General Funds 1004		44,939			
20.			I-A Receipts 1005					
21.			Program Receipts 1078					
22.			Other					
FOR BLM USE ONLY								
AA KEY NUMBER								

This permanent part-time position 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 AS 690. 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.

13 REQUEST FOR
NEW POSITION

AGENCY DEPARTMENT OF LAW
PROGRAM BUREAU PROCESS
DIV PROSECUTION
OFFICE JUDICIAL DISTRICT

PAGE 1 of 1

FY.81

1.	POSITION TITLE ATTORNEY III				RANGE/STEP 22A	SERIAL UNIT FX	FROM NO	FROM/LINE
2.	TYPE OF POSITION PPT	STAFF MONTHS 12	RF NUMBER	PCN NUMBER	BRN PRIORITY	LOCATION Anchorage	ELECTION DISTRICT 8	
3.	CONTINUATION LEVEL				JUSTIFICATION			
4.	TYPE OF EXPENDITURE				AMOUNT			
	1				2			
	PERSONAL SERVICES							
5.	Salary	1.950 X 12	23,400					
6.	Benefits		3,838					
7.	Supplemental Benefits		1,434					
8.	Vacation Benefits		1,320					
9.	TOTAL PERSONAL SERVICES		81	29,992				
10.	Travel		61	1,500				
11.	Contractual		63	3,600				
12.	Commodities		64	4,200				
13.	Equipment		65	1,500				
14.	Other							
15.	TOTAL COST			40,792				
	RECEIPT CODE	FUNDING SOURCE						
16.		Federal Receipts 1002						
17.		G.P. Match 1003						
18.		General Funds 1004			40,792			
19.		I-A Receipts 1005						
20.		Program Receipts 1028						
21.		Other						
FOR BSA USE ONLY								
NA KEY NUMBER								

This permanent part-time position 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 such offenses will occur each year as a result of the enactment of HB 498. This position will be responsible for prosecuting those new cases that are brought in the Third Judicial District. Because these new cases will be classed as misdemeanor offenses, allocation of the position to the Attorney III level is appropriate.

3 REQUEST FOR
NEW POSITION

AGENCY DEPARTMENT OF LAW
PROGRAM DUE PROCESS
BRN PROMOTION

Page 1 of 1

FY.8

1.	POSITION TITLE COMMUNITY COUNSELOR				RANGE/ST 1-4	SERIAL UNIT 000	FORM 12 PAGE/LINE
2.	TYPE OF POSITION PPT	STAFF MONTHS 12	AP NUMBER	FOR NUMBER	BMU PRIORITY	LOCATION Juneau	ELECTION DISTRICT 4
3.	CONFIRMATION LEVEL				JUSTIFICATION		
4.	TYPE OF EXPENDITURE				AMOUNT		
	1	2					
	PERSONAL SERVICES						
5.	Salary	1,121 X 12	13,452				
6.	Benefits		2,206				
7.	Supplemental Benefits		825				
8.	Flood Benefits		1,368				
9.	TOTAL PERSONAL SERVICES		81	17,851			
10.	Travel		82	1,000			
11.	Contractual		83	3,600			
12.	Commodities		84	3,000			
13.	Equipment		85	1,500			
14.	Other						
15.	TOTAL COST			26,951			
6.	RECEIPT CODE	FUNDING SOURCE					
7.		Federal Receipts 1002					
8.		G.F. Match 1003					
9.		General Funds 1004		26,951			
10.		I-A Receipts 1005					
11.		Program Receipts 1018					
12.		Other					
FOR BLM USE ONLY							
NA KEY NUMBER							

This permanent part-time position is required to oversee community work service assignments for those misdemeanor offenders who are screened into the state's Pretrial Diversion Program. Because a large percentage of defendants in the new cases that will result from enactment of HB 698 will be first-time offenders, as many as 50% of these defendants may be eligible for pretrial diversion. This position will be responsible for providing pretrial diversion services in the Southeast Region, centered at Juneau.

3 REQUEST FOR
NEW POSITION

AGENCY DEPARTMENT OF LAW

PROGRAM DUE PROCESS

PROSECUTION

FY. 81

Page 1 of 1

1. POSITION TITLE COMMUNITY COUNSELOR				NAME/STEP 1AA	CARE UNIT CCU	PAGE 12	PAGE/NO
2. TYPE OF POSITION PPT	STAFF NUMBER 12	SP NUMBER	FOR NUMBER	ORG FACILITY	LOCATION Fairbanks	ELECTION DISTRICT 16	
3. CONTINUATION LEVEL				4. JUSTIFICATION			
5. TYPE OF EXPENDITURE				AMOUNT			
1				2			
PERSONAL SERVICES				3			
5. Salary	1,287 X 12	15,444					
6. Benefits		2,533					
7. Supplemental Benefits		947					
8. Fixed Benefits		1,568					
9. TOTAL PERSONAL SERVICES		20,292					
0. Travel		1,000					
1. Contractual		3,600					
2. Commodities		1,000					
3. Equipment		1,500					
4. Other							
5. TOTAL COST		29,392					
RECEIPT CODE FUNDING SOURCE							
6.		Federal Receipts 1002					
7.		G.F. Match 1003					
8.		General Funds 1004	29,392				
9.		I-A Receipts 1005					
0.		Program Receipts 1020					
1.		Other					
FOR BAK USE ONLY							
LA KEY NUMBER							

This permanent part-time position is required to oversee community work service assignments for those misdemeanor offenders who are screened into the state's Pretrial Diversion Program. Because a large percentage of defendants in the new cases that will result from enactment of AS 698 will be first-time offenders, as many as 50% of these defendants may be eligible for pretrial diversion. This position will be responsible for providing pretrial diversion services in the Northern Region, centered at Fairbanks.

3 REQUEST FOR
NEW POSITION

AGENCY DEPARTMENT OF LAW

PROGRAM DUE PROCESS

SUB PRESCRIPTION

Page 1 of 1

FY.8

INSTITUTE OF MEDICINE

Marijuana and Health



COPY

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

Behavioral, Psychosocial, and Epidemiologic Issues

Charles P. O'Brien* and H. Carl Haywood*, Co-Chairmen

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Denise Kandel*

Robert B. Edgerton*

Barbara M. Korsch*

Beatrice Hamburg*

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Study of the Health-Related Effects of
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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
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- Edward Khantzian, Cambridge Hospital
- Kaye Kilburn, University of Southern California School of Medicine
- Warren Levinson, University of California, San Francisco
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- Bruce Petersen, Lilly Laboratory for Clinical Research
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- 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

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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 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 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.

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 suggestions to improve the quality and usefulness of future research; and
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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 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.

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 Federal Register of February 24, 1981. Responses were received and incorporated into the records of the committee. (See Appendix A for a complete description.) The responses fall into three categories:

1. The dangers of marijuana. 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.

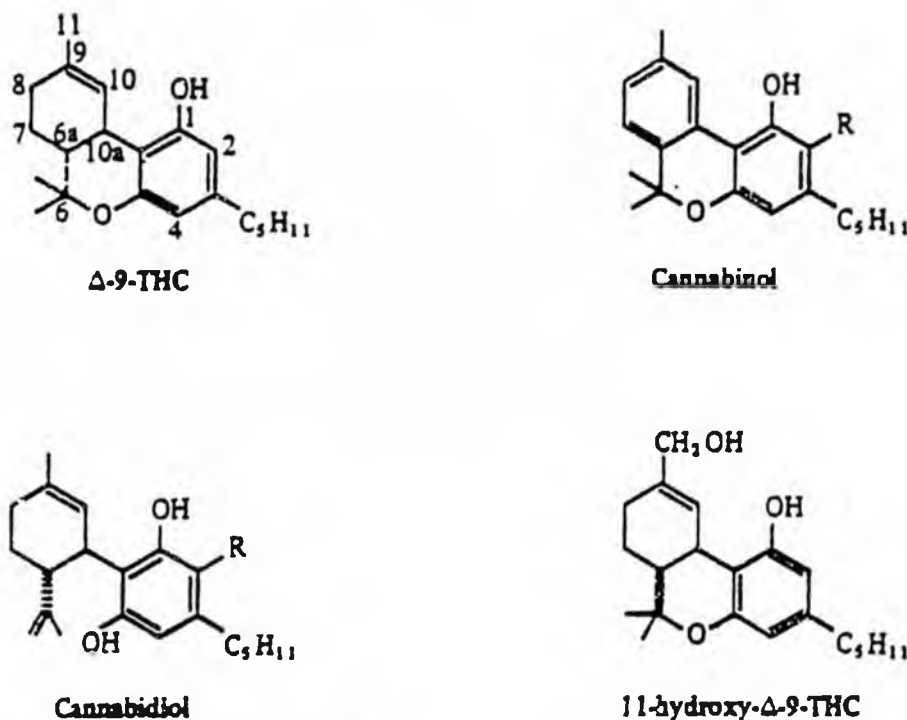


FIGURE 1 Cannabinoid structures.

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 pharmacological effects of the complex, crude cannabis mixtures. A number of synthetic cannabinoids have pharmacological effects similar to Δ-9-THC. Other cannabinoids in the plant, for example, cannabinol (Figure 1), are almost inactive pharmacologically or may 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 Turkianis, 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) ^h	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) Rosenkrentz, 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 [‡]	5.4	12.4
Dimethylnitrosamine, ng [‡]	75	84
Methylethylnitrosamine, ng [‡]	27	30
pm, 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	480	-
Nicotine, µg	-	2850
N-Nitrosonornicotine, ng [‡]	-	300
Naphthalene, µg	3.0	1.2
1-Methylnaphthalene, µg	6.1	3.65
2-Methylnaphthalene	3.6	1.4
Benz(a)anthracene, ng [‡]	75	43
Benzo(a)pyrene, ng [‡]	31	21.1

[‡]Indicates known carcinogens.

SOURCES: Hoffmann et al., 1975, 1976; Brunemann 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; normalized 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 through 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 LD₅₀. 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 LD₅₀ 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 cannabinoids 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-4-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 ^{14}C -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. Marijuana 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 marijuana 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 marijuana cigarette smoke on growth and DNA metabolism of human lung cultures, pp. 595-612. In Braude, M.C. and Szara, S. (eds.) Pharmacology of Marijuana. New York: Raven Press, 1976.
- Llana, R., Hart, D.R., and Schneider, N.S. Allergic bronchopulmonary aspergillosis associated with smoking moldy marijuana. Chest 73:871-872, 1978.
- Llewellyn, G.C. and O'Hear, C.E. Examination of fungal growth and aflatoxin production on marijuana. 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.E., et al. Stereochemical requirements for cannabinoid activity. J. Med. Chem. 23:1068-1072, 1980.
- Ohlsson, A., Lindgren, J.E., Wahlen, A., et al. Plasma Δ -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 Δ -9-tetrahydrocannabinol. Clin. Pharmacol. Ther. 14:48-55, 1973.
- Ritzlin, R.S., Gupta, R.C., and Lundberg, G.D. Δ -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-tetrahydrocannabinol 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.P., 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

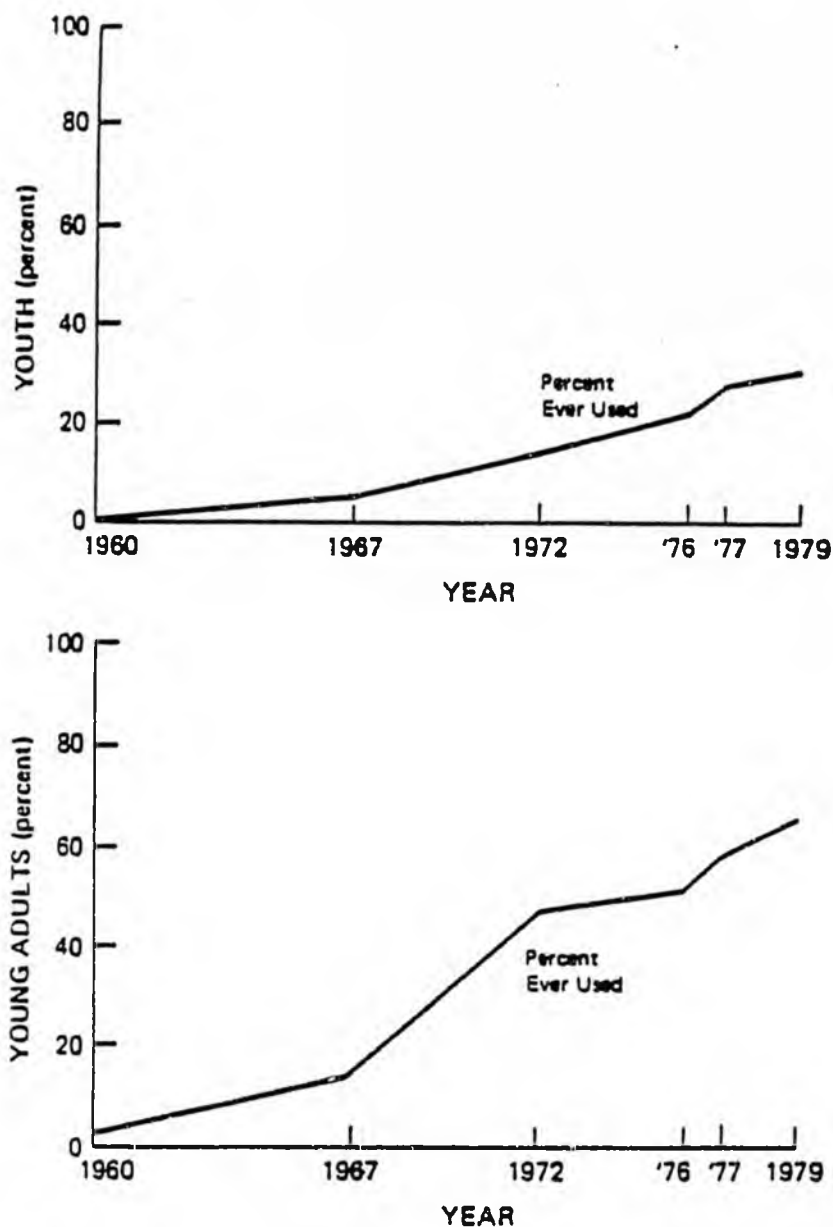


FIGURE 2 Marijuana: trends in lifetime experience, youth, and young adults. Adapted from J.D. Miller and I.H. Cisin. Highlights from the National Survey on Drug Abuse: 1979. Washington, D.C.: U.S. Government Printing Office, 1980. Youth = 12 to 17 years old; young adults = 18 to 25 years old.

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

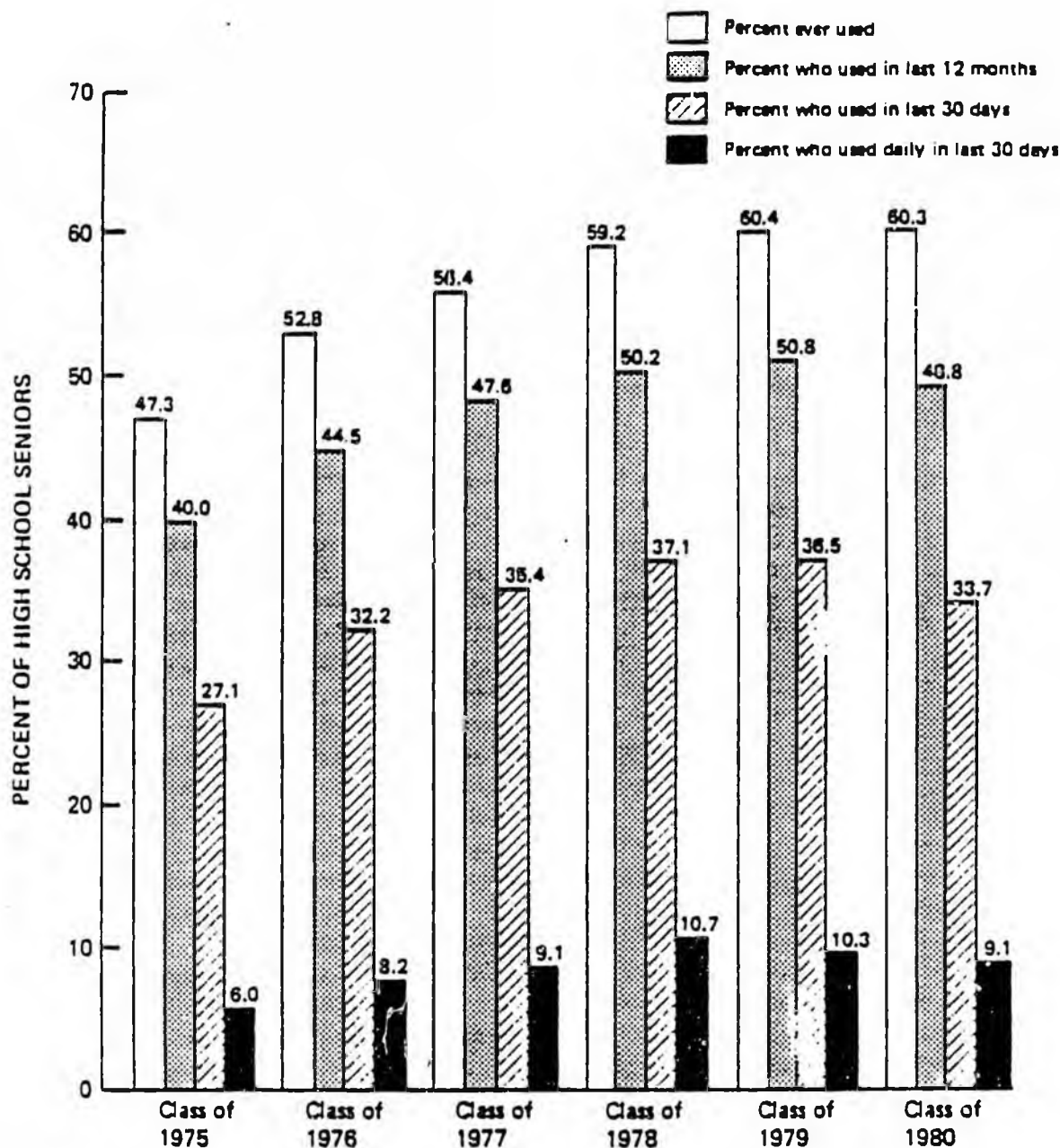
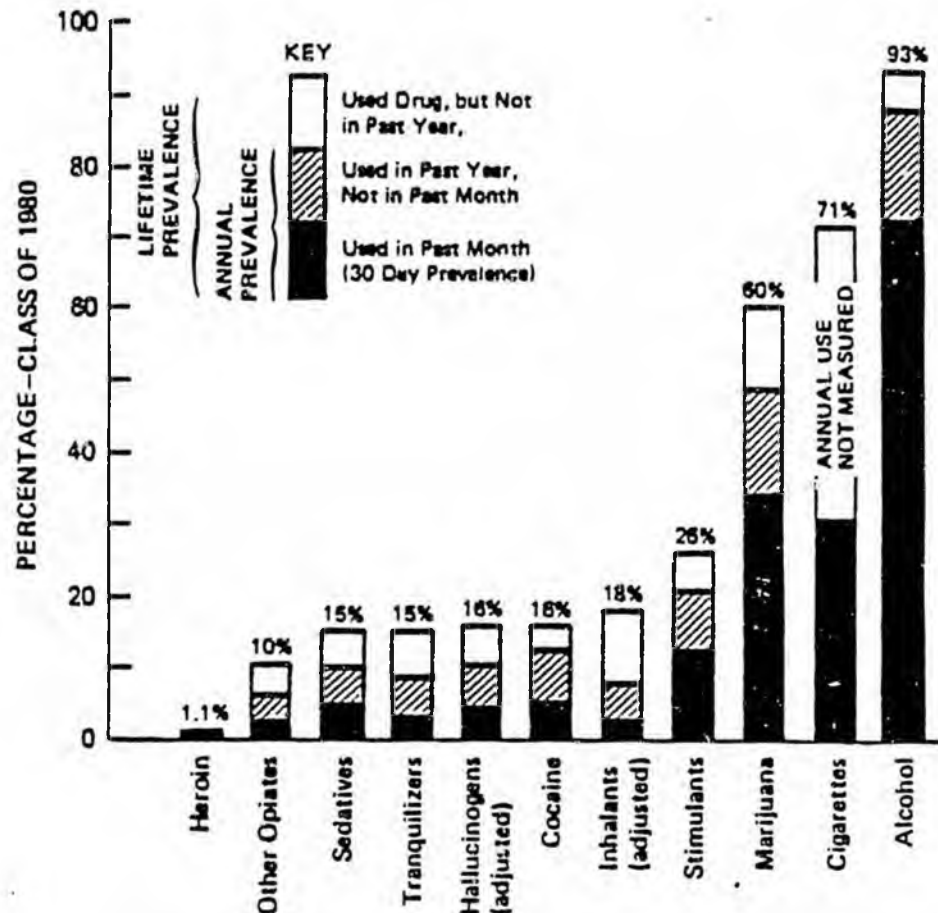


FIGURE 3 Trends in prevalence of marijuana use by high school seniors, 1975-1980 (in school). Adapted from L.D. Johnson, J.G. Bachman, and P.M. O'Malley, Highlights from Student Drug Use in America, 1975-1980. DHHS Publication No. (ADM) 81-1066. Washington, D.C.: U.S. Government Printing Office, 1980a.



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 underrepre-

sented 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 prevalence 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

One 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 drug. 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 these 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 began 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 significance. 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 marijuana user. Am. J. Sociol. 54:235-242, 1953.
- Brook, J.S., Lukoff, I.P., 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.P. and Whiteman, M. Initiation into adolescent marijuana 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 marijuana 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. Marijuana and youth: A generation gone to pot, pp. 81-108. In Scarpitti, P.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 71:258-265, 1981.
- Kandel, D.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 Seixas, F.A. (ed.) Currents in Alcoholism. Volume IV: Psychiatric, Psychological, Social and Epidemiological Studies. New York: Grunne and Stratton, 1976.

- 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)

The lungs 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. ~~The~~ Marijuana cigarette generally stimulates ventilation (air exchange between the lungs and the ambient air) in conjunction with an increase in the metabolic rate and a heightened response to carbon dioxide (CO_2) as a regulatory stimulant (Vachon et al., 1973; Zivkovich et al., 1978). On the other hand, larger doses of smoked marijuana ~~may depress~~ the ventilation and responsiveness to the CO_2 stimulus (Weil et al., 1968; Bellville et al., 1975). The intravenous administration of Δ -9-THC in equivalent doses has much less of an effect either on the ventilation or on the effectiveness of CO_2 as a respiratory stimulant (Malit et al., 1975).

Much more consistent and predictable is the effect of marijuana on the ~~airways~~. The inhalation of small amounts of marijuana smoke causes bronchial dilation in persons without demonstrable lung disease (Tashkin et al., 1973; Vachon et al., 1973). The bronchodilation is easily demonstrable; the inhalation of 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; the bronchodilator effects of smoked marijuana last as long as 60 minutes ~~that of ingested~~ Δ -9-THC up to 8 hours. Aerosolized 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).

Except for bronchodilation, acute exposure to marijuana has little effect on breathing as measured by conventional pulmonary tests. Thus, in young marijuana smokers (21-30 years of age) who smoked at least four cigarettes per week and no tobacco for at least 6 months before, ventilatory mechanics and gas exchange were normal by conventional tests (Tashkin et al., 1976). In contrast, heavy marijuana smoking, i.e., at least 4 days per week for 6 to 8 weeks did cause mild airway obstruction (Tashkin et al., 1976).

Acute smoking of marijuana, as well as the ingestion of Δ -9-THC, also causes bronchodilation in individuals with mild to moderate asthma (Tashkin et al., 1974). Marijuana smoking or ingestion of Δ -9-THC also dilated airways in asthmatics in whom bronchoconstriction was deliberately provided either by exercise or by the inhalation of methacholine, a bronchoconstrictor (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; Caverio 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 much 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 (Auerbech 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 (Fleishman 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 presence 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).

Effects on Heart Rate 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. ⁶Almost invariably this improvement can be attributed to the increase in heart rate (Gash et al., 1978). The acute administration of Δ -9-THC (25 μ g/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 (Burststein 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; Kocher 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 marijuana and placebo-marijuana 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. Marijuana smoking: Cardiovascular effects in man and possible mechanisms. N. Engl. J. Med. 287:209-212, 1972.
- Bellville, J.W., Swanson, G.D., and Agleh, 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.) Marijuana: 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 marijuana-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 marijuana smoke condensates. Cancer Lett. 6:319-324, 1979.
- Cavero, I., Buckley, J.P., and Jandhyala, B.S. Parasympatholytic activity of (-)- Δ -9-trans-tetrahydrocannabinol 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-trans-tetrahydrocannabinol 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. Infect. Immun. 25:268-272, 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, R.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.
- Kocher, 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., Leuchtenberger, 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.

- Laughtenberger, C. and Laughtenberger, R. Cytological and cytochemical studies of the affect 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 Marijuana. New York: Raven Press, 1976.
- Loewe, S. Pharmacological study, pp. 149-220. In The Marijuana 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 marijuana induced tachycardia. Life Sci. 11:999-1005, 1972.
- Marriott, J.C., Crawford, W.J., Alexander, P.C., et al. Effect of marijuana 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.
- Peraz-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 marijuana inhalation toxicities in the rat. Toxicol. Appl. Pharmacol. 28:428-441, 1974.
- Roy, P.E., Magnan-Lapointe, F., Huy, N.D., and Boutat, 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 marijuana 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 Marijuana. 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 marijuana 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 Δ -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 marijuana 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 marijuana 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 autonomic 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 marijuana 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; Kuhnle 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, ultra-structural 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 ganja 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 46 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 ganja 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 (ERPs) (Harning 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 (Berning 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 (12-15 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; Freeman, 1974) or no change has been reported (Barratt et al., 1974; Kosko et al., 1973; Prankoff 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 (Fujiwara and Hirvich, 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 cannabinal and cannabidiol, is to decrease rather than increase seizure susceptibility (see Karler and Turkkanis, 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 informa-

tion 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 variables 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 withdrawal 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. Marijuana 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 Marijuana. New York: Raven Press, 1976.
- Heath, R.G., Fitzjarrell, A.T., Garey, R.E., and Myers, W.A. Chronic marijuana 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-tetrahydrocannabinol 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 4-9-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 marijuana-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 luteinizing 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 luteinizing 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 (Harclerode 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 cannabinal at doses approaching or exceeding the LD₅₀ (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 LD₅₀ 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 disassociation 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 amenorrhea (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 exercised 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 (Jones, 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; Said 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 Ober, 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 (Stanchever 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, cannabimol, 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, 1977; 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 (intra-peritoneally) 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 Teratogenicity

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 in vivo 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. Fertil. Steril. 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 (Macaca mulatta). J. Clin. Endocrin. Metab. 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. Neuroendocrinology 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 Marijuana 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 marihuana en mujeres,

- pp. 85-97. In Simposio Internacional Sobre Actualizacion en Marihuana, 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.
- Conen, 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., Lela, 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: Mutagenicity investigation in the Ames test. Mutat. Res. 66:329-335, 1979.

- Gupta, S., Grieco, M.E., 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 chronic 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.E., 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. 35:151-162, 1976.
- Jones, E.P., Brown, 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., Tubergan, 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 Klagar, K. Effect of delta-9-tetrahydrocannabinol on in vitro sensitization of mouse splenic lymphocytes. Immunol. Commun. 7:557-566, 1978.
- Lefkowitz, S.S., Klagar, K., Nemeth, D., and Pruass, 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 Marijuana. 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., Leuchtenberger, 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 marijuana. 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 Marijuana. 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 marijuana 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., Ahluwalia, 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 speratic cells in vivo. Pharmacology 21:277-287, 1980.
- Zimmerman, A.M., Stich, E., 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 (Rafaelson 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 memorizing 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.

Time Sense 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).

State-Dependent Learning 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 (Shilling 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 (Talbot 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 indications 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-naïve 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 marijuana 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-4-9-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. DHEW 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.
- Hanstaen, R.W., Millar, R.D., Lonerio, 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 Brauda, 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 marihuana 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. Marijuana and driving, pp. 257-263. In Harria, 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., Hiplinger, 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., Nlonoff, 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-tetrahydrocannabinol: 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, P., Grove, R.N., et al. Effect of chronic administration of Δ^1 -tetrahydrocannabinol on learning and memory in developing 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., Andryziak, 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.
- Shilling, D.J. and Stillman, R.G. (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 effects 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. Marijuana 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 marijuana in man. Science 162:1234-1242, 1968.
- Weil, A.T. Adverse reactions to marijuana, 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 (Heppler 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, cannabinal, cannabidiol, and 8-8-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 (Heppler 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 (Heppler 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 (Innemees 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-TBC, 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 anti-cancer 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-fluorouracil 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 prochlorperazine or the placebo.

Another cannabinoid, a synthetic, nabilone, has been provided to several investigators for evaluation as 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.

Lavonandrol 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 cannabinal (CBN) and cannabidiol (CBD). Tolerance to the effect has frequently been reported. However, the tolerance ~~produced~~ with cannabinoids is similar to that seen with phenytoin (1973). 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.

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 methacholine (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.

Methacholine 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 sedation 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 cannabinal 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.

ANTI-ANXIETY 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 anti-anxiety 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 unipolar depressed patients, Lotin 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 M1210 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-tetrahydrocannabinol in mongrel dogs. Eur. J. Pharmacol. 19:301-304, 1972.
- Chang, A.E., Shilling, 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., McCaughy, 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 marijuana 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., Jonas, 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., Torrello, 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., Torrello, 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.
- Inneme, 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. 4-9-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 delta-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 delta-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 39:155-158, 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 manifestations of the cannabinoids. 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 and analgesic properties of delta-9-tetrahydrocannabinol (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 Karlar, R. Anticonvulsant properties of cannabidiol. Res. Commun. Chem. Pathol. Pharmacol. 8:231-246, 1974.
- Turkanis, S.A., Chiu, P., Borys, E.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, E.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)			Total (78)			Total (79)		
	No. of grants	Funds	Percent	No. of grants	Funds	Percent	No. of grants	Funds	Percent
ADAMHA^b									
NIDA	75	3,940	90	64	3,596	88	65	3,536	84
NIMH	8	167	4	8	214	5	7	207	5
NIAAA	2	8	<u>.2</u>	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	<u>.2</u>	1	15	<u>.2</u>
NIRRR	--	--	0	2	26	0	--	--	0
NIGMS	--	--	0	--	--	0	1	9	<u>.2</u>
OTHER AGENCIES									
VA	7	52	1	6	26	1	8	25	1
DOT	5	55	1	1	--	<u>.2</u>	2	104	2
USDA	1	41	1	-	--	0	1	85	2
TOTAL	102	4,354		92	4,106		94	4,202	

^aless 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
 NIRRR 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)	56,500	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

^aData unavailable at present time.

^bMean NIM 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	8	3,683	9	4,500	11
Depressants	3,642	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	11,398	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	6,721	22	12,286	32	11,875	28	8,000	20
TOTAL	31,575	100	31,198	100	31,491	100	31,138	100	38,775	100	42,024	100	43,400	100

^aEstimate.

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 respiratory 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 1980 is presented in Table 6. 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 (exp. 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

^aDue 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)

	<u>Grants</u>		<u>Contracts</u>		<u>Intramural</u>		<u>Total</u>	
	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)

	<u>Grants</u>		<u>Contracts</u>		<u>Intramural</u>		<u>Total</u>	
	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	<u>a</u>	--	--	1	<u>a</u>
USDA	--	--	--	--	--	--	--	--
TOTAL	65	2,534	15	1,460	12	112	92	4,106

aIndicates 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)

	<u>Grants</u>		<u>Contracts^a</u>		<u>Intramural</u>		<u>Total</u>	
	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
NIDRR	--	--	--	--	--	--	--	--
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

^aFY '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 foreseeable 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 support 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; Monson, 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), NICHD 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.

SUPPLIERS OF MARIJUANA CIGARETTES AND Δ -9-THC CAPSULES

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REFERENCES

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- 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.
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- 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.
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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 ²	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 Houston area, predominantly white and middle-class	Grades 4-11	1969	1973	2-5	1 year	12,800 (approx.)	Variable	Self-administered questionnaires in classrooms; school records; peers' ratings of students' personalities	Cigarettes, liquor, marijuana, uppers, downers, 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	3,148	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	183 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 5 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
Randel	(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, marijuana, hashish, amphetamines, methedrine, barbiturates, tranquilizers, 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 6 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, methadone, 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	2,305	1,420	Self-administered questionnaires, (unclear whether in or out of class)	Alcohol
Guise 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
Naagan	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	308	T2-100 T3-201 T4-100	Personally administered questionnaires	Alcohol, marijuana, hashish, LSD, mescaline

*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 Investigator	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 18 of students at Illinois State University not reporting marijuana use	College undergraduates and graduate students	1969	1973	3	2 years	127	T2-128 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 16 months 28 months	778	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 1,800 (1970)	College freshmen and juniors	1970	1971	2	1 year	7,368	3,961	Mailed questionnaires	Caffeine, alcohol, marijuana, hashish, methedrine, other amphetamines, barbiturates, sedatives, tranquilizers, LSD, other psychedelics, cocaine, opium, heroin, other narcotics, cough syrups
Hellingar	(1) Probability sample of male freshmen of University of California at Berkeley in fall 1970	College freshmen	1970	1973	2	1 1/2 years	960	836	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	228	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	150	Not Given	Semi-structured 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	1973	4	1 year	222	160		
Ginsberg and Greenley	Students enrolled at University of Wisconsin-Madison 1971-1974	College freshmen and sophomores	1971	1974	2	2 years	319	274	Mailed questionnaires	Marijuana
Bédard	(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
Ray	Random sample of male students entering Lehigh University	College freshmen	1971	1974	4	6 months	130	68	Self-administered questionnaires, adjective check list, California Psychological Inventory	Marijuana
			1972	1974	3	1-T2,	124	85		
			1973	1974	2	1 year, T2-T3, T3-T4	112	98		
Moos	Entering classes of two universities	College freshmen	Not Given	Not Given	3	9 months 3 years	1,286	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	(1) Vietnam veterans random sample of army (mean) enlisted males who returned from Vietnam to the United States in September 1971, or (2) 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	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=1,818, with abstainers and very infrequent drinkers subsampled at a lower rate	21 and over	1964-1965	1967	2	2 years	1,810	1,259	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 socioeconomic schools	Grades 7-9	1976	1980	4	1 year 2 years 1 year	1,614	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, sniffling stuff, amyl nitrate, nonprescription: sleeping pills, stimulants, cough medicine, cold medicine, cocaine, heroin, other narcotics, PCP, coca paste
Luboff 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	458	Not yet completed	Personal interviews	Cigarettes, alcohol, marijuana, psychedelics, stimulants, sedatives, heroin, other opiates, cocaine, tranquilizers, inhalants

Part 3. Ongoing Studies: B--From Adolescence to Young Adulthood

Carpenter, Lester, Pardina, and Labouvie	Cohort-sequential design--Random samples of New Jersey adolescents-- a) 9 cohorts born 1967-73 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	1974	ongoing	14 tele- phone 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 com- pleted	On-site: -personal inter- views -self-admini- stered question- naires -behavioral tests -blood sample -psychological test -medical exams	Alcohol, cigarettes, marijuana, amphet- amines, barbiturates, LSD, other psycho- delics, heroin, other narcotics, tranquil- izers, quaaludes, cocaine, inhalants, PCP, amyl and butyl nitrates, over-the- counter psychothera- peutics, caffeine
									Telephone contact: -major life events -alcohol and drug taking outcomes	
Elliott	National Youth Survey-National probability multi- stage cluster sample of dwellings	11-17 years	1976	1980	5	1 year	1,725	T2-1655 T3-1626 T4-1543 T5-1494	Personal struc- tured inter- views	Tobacco, beer, wine, liquor, marijuana, hallucinogens, co- caine, heroin, medical and non- medical use of amphetamines, bar- biturates
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-ad- ministered ques- tionnaires in school (high school sample) in small groups (college sample)	Beer, wine, hard liquor, marijuana, LSD, amphetamines, cocaine, heroin, tranquil- izers, barbitu- rates, morphine
	College sample-- random sample of freshman class arts and science university students in a small Rocky Mountain city	College freshmen	1970	1981 ^B	6	1 year 1 year 1 year 6 years 2 years	205	n.t. yet completed	T5,T6--Adult follow-ups; mailed self-administered questionnaires	

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 100 seniors, and subsamples (N=100) 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)	2,488 (target for each cohort; 1,200 for each cohort 1/2 sample)	Not yet completed	T1--Self-administered questionnaires in classrooms T1, adult follow-ups -- Mailed questionnaires	Alcohol, cigarettes, marijuana, amphetamines, barbiturates, LSD, other psychedelics, heroin, other narcotics, tranquilizers, quaaludes, cocaine, inhalants, PCP, amyl and butyl nitrites, over-the-counter psychotherapeutics, caffeine
Kandel	Multistage random sample of adolescents 10-11 enrolled in New York public secondary school selected from 18 schools a) regular students b) absentees	Grades 10-11	1971	1980 ²	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)

Epian	Seventh grade students enrolled in 18 of 16 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 completed	Self-administered questionnaires in classroom Helix test	Cigarettes, chewing tobacco, snuff, cigars/pipe
Schlegel	Random sample of students in 2 school boards (urban, rural) in northern Ontario	9-12	1974	1980	7	4 months 4 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	1964	1981	4-6	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, uppers, tripping stuff, cocaine, heroin and other opiates, drug store medicine, sniffling stuff, combination drugs

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 (Fairshir 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 or 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 1973 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.