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MARIJUANA AND HUMAN PERFORMANCE:

AN ANNOTATED BIBLIOGRAPHY (1970-1975)

By

Melody L. Pagel and Michael G. Sanders

March 1976

Final Report

U. S. ARMY AEROMEDICAL RESEARCH LABORATORY

Fort Rucker, Alabama 36362

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The effects of marijuana upon human performance is currently an area of major concern. No place is this concern more acute than in complex man-machine systems, such as those found in aviation, where degradations in psychomotor and/or cognitive performance can result in catastrophic losses. This annotated bibliography consisting of 199 references was compiled to aid the reader in determining the impact of this drug on psychomotor, cognitive, and physiological factors considered perti-

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SUMMARY

The effects of marijuana upon human performance is currently an area of major concern. No place is this concern more acute than in complex man-machine systems, such as those found in aviation, where degradations in psychomotor and/or cognitive performance can result in catastrophic losses. This annotated bibliography consisting of 199 references was compiled to aid the reader in determining the impact of this drug on psychomotor, cognitive, and physiological factors considered pertinent to flight performance. The bibliography contains an index which categorizes the references into the following major areas: (1) Reviews or overviews of issues, literature or research; (2) Psychological effects of marijuana use; (3) Physiological and pharmacological research; (4) Medical comments and research critiques; and (5) Additional reference sources. The basic period of coverage is 1970-1975, although selected studies from earlier years are also included.

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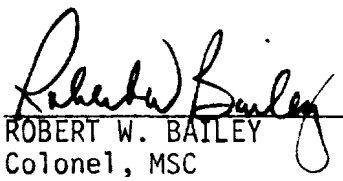

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INTRODUCTION

The effects of marijuana upon human performance is currently an area of major concern. No place is this concern more acute than in complex man-machine systems, such as those found in aviation, where degradations in psychomotor and/or cognitive performance can result in catastrophic losses. This annotated bibliography consisting of 199 references was compiled to aid the reader in determining the impact of this drug on psychomotor, cognitive, and physiological factors considered pertinent to flight performance.

In an effort to aid the reader, the bibliography contains an index which categorizes the references into the following major areas: (1) Reviews or overviews of issues, literature or research; (2) Psychological effects of marijuana use; (3) Physiological and pharmacological research; (4) Medical comments and research critiques; and (5) Additional reference sources. The basic period of coverage is 1970-1975, although selected studies from earlier years are also included.

While this bibliography is by no means inclusive of all available literature on marijuana over the last five years, every attempt was made to include the major works pertinent to the above mentioned factors. The references related to the effects of marijuana upon aviator and automobile driver performance, however, are considered to be a comprehensive listing. For those investigators desiring information about marijuana as related to topics not noted in this bibliography, the resources category should be of particular interest--especially the bibliographies by Coy W. Waller and others.

A

1. Abel, E. L. Effects of marijuana on the solution of anagrams, memory, and appetite. Nature, 1971, 231, 260-261. (a)

Subjects who had smoked two marihuana cigarettes took longer to solve anagrams and were less capable of recalling either ideas or words than control subjects. Individuals under the influence of marihuana also made more errors in recall and consumed more marshmallows during testing than controls. (Coy W. Waller & others)

2. Abel, E. L. Marijuana and memory. Nature, 1970, 227, 1151-1152.

Recall of words and ideas was impaired in subjects who had smoked two marijuana cigarettes. Subjects were used as their own controls. (Coy W. Waller & others)

3. Abel, E. L. Marihuana and memory: Acquisition or retrieval? Science, 1971, 173, 1038-1040. (b)

Two experiments were conducted to determine the means by which marihuana affects human memory. The results of these studies indicated that marihuana did not affect retrieval of information in memory when the method of free recall was used, but did affect recognition processes such that subjects were less able to discriminate between items that had been presented previously and items that had not appeared a short time before. With respect to initial learning, marihuana was shown to affect acquisition processes involved in the storage of information. (Journal abstract)

4. Abel, E. L. Retrieval of information after use of marihuana. Nature, 1971, 231, 58. (c)

Volunteers who had smoked one marihuana cigarette were not as able as control subjects to distinguish between words previously presented and new words. Recognition of familiar items remained the same, but false recognitions increased markedly. Immediate and delayed free recall was not affected. (Coy W. Waller & others)

5. Adams, A. J., Brown, B., Flom, M. C., Jampolsky, A., & Jones, R. T. Influence of socially used drugs on vision and vision performance (Preliminary annual report, Contract No. DADA 17-73-C-3106). Optical Sciences Group, Visual Sciences Division, San Rafael, California, April 1975.

Eight visual functions were measured in the experiments reported here; twenty-seven experienced marijuana and alcohol users participated as subjects. The experiments were performed double blind with placebo controls. The results are: (a) Dynamic visual acuity is reduced in a dose related fashion by both alcohol and marijuana; (b) Alcohol produces large, dose related increases in time taken to recover foveal sensitivity after bright light exposure; (c) Recovery of contrast sensitivity function in the peripheral retina after exposure to a bright light flash is prolonged by 1.0 ml/kg alcohol; (d) The maximum velocity of sinusoidal tracking is markedly reduced by alcohol and not by marijuana. This effect is seen for the smooth pursuit system and the saccadic eye movement system; the effect is dose related for both systems; (e) Using power spectrum analysis (a technique which allows examination of individual frequency components of eye movements), we have demonstrated alcohol and marijuana induced deficits in oculomotor tracking; (f) Color discrimination appears to be significantly reduced after alcohol (1.0 ml/kg) and marijuana (15 mg THC) in the blue region of the spectrum without any apparent change in other spectral regions; (g) Static visual acuity, measured in 10 subjects using a psychophysical procedure, is unaffected by alcohol or marijuana in doses up to 1.0 ml/kg of alcohol and 15 mg THC; (h) Peripheral gaze nystagmus is increased after alcohol and to a lesser extent after marijuana ingestion. (Authors' abstract)

6. Adams, A. J., Brown, B., Flom, M. C., Jones, R. T., & Jampolsky, A. Alcohol and marijuana effects on static visual acuity. American Journal of Optometry & Physiological Optics, 1975, 52, 729-735.

Static visual acuity was measured at two contrast levels (12 and 49%) in 10 subjects in a double blind experiment involving 5 drug conditions of alcohol and marijuana (0.5 ml and 1.0 ml/kg body weight of 95% ethanol, 8 and 15 mg Δ-9-tetrahydrocannabinol (THC), and a placebo). We found no statistically significant change in static visual acuity for any of the dose levels at any of the measurement times up to 6 hours following drug ingestion; this is sharply contrasted with the marked decrements in acuity which were found in the same subjects under the same drug conditions when the targets were in motion and required coordinated eye movements for their resolution. (Authors' abstract)

7. Allentuck, S., & Bowman, K. Psychiatric aspects of marihuana intoxication. In D. Solomon (Ed.), The marihuana papers. Indianapolis: Bobbs-Merrill, 1966; New York: Signet, 1968.

This paper, originally published in 1942, reports studies made on the effects of marihuana on 77 subjects. Observations are based on research made by the authors in New York City under the auspices of the Mayor's Committee on Marihuana. The major findings cited include: (1) marihuana is unique in the reactions it produces in the users,

although its physiological effects have been likened to those of the atropine group of drugs, and its psychic effects to those of alcohol; (2) marihuana may precipitate a psychosis in an unstable, disorganized personality, when it is taken in amounts greater than he can tolerate; (3) marihuana will not produce a psychosis de novo in a well-integrated, stable person; (4) marihuana differs from the opium derivatives in that it does not give rise to a biological or physiological dependence; and (5) marihuana, by virtue of its property of lowering inhibitions, accentuates all traits of personality, both those harmful and those beneficial. (W. H. Rickles, Jr. & others)

8. Ames, F. A clinical and metabolic study of acute intoxication with Cannabis sativa and its role in the model psychoses. Journal of Mental Science, 1958, 104, 972-999.

Ten medical volunteers were given a single oral dose of Cannabis sativa and the following parameters were studied: (1) subjective experiences and behavior, (2) clinical changes, and (3) special investigations, e.g. blood sugar, urine output, EEG. The results are discussed and several interviews with cannabis addicts are presented. (W. H. Rickles, Jr. & others)

9. Antone, E. J., Jr. A study of the relationship of the use of various drugs to the visual-motor performance of college students (Doctoral dissertation, Oregon State Univerity, 1972). Dissertation Abstracts International, 1972, 33, 1963A. (University Microfilms No. 72-27, 619)

The purpose of the study was to compare the visual-motor performance of college students who reported ingestion of certain drugs with those college students who reported no drug ingestion. The study drugs included the following drugs or groups of drugs: tobacco, alcohol, marijuana, LSD, mescaline, barbiturates, and amphetamines.

A total of 201 students from Chico State College and Pacific Union College volunteered as subjects to participate in the study, with 151 subjects in the Experimental Group (drug users) and 50 in the Control Group (non-drug users). A confidential questionnaire was given concerning the subject's drug use involving frequency and length of time. The Bender-Gestalt Test was administered to determine visual-motor performance. The Bender-Gestalt Test was administered to determine visual-motor performance. The Bender-Gestalt Tests were evaluated and rated on a scale of performance by three highly-qualified psychologists.

One tailed t-tests were employed to test six hypotheses that significant differences would occur in favor of the Control Group (non-drug users) over the Experimental Group (drug users) on the Bender-Gestalt Test in all drug or combination of drug usage. The .05 level of significance was chosen as the critical region of rejection.

The findings indicated that there was a significant difference in the visual-motor performance in favor of the Control Group (non-drug users) over the entire Experimental Groups (drug users) and also in the "Tobacco, Alcohol, Marijuana, Barbiturate, and Amphetamine Group." It was determined that there was no significant difference in visual-motor performance between the non-drug users and other single or multiple drug groups in the study. However, in all cases the mean difference between the groups was consistently in the direction of the non-drug users. Therefore, the non-drug users consistently performed better on the visual-motor performance test than the drug users in all categories.

It is recommended that further investigation into the visual-motor performance of drug users be continued for reasons of personal health, public health and safety.

B

10. Barrett, E., Beaver, W., White, R., Blakeney, P., & Adams, P. The effects of the chronic use of marijuana on sleep and perceptual motor performance in humans. In M. F. Lewis (Ed.), Current research in marijuana. New York: Academic Press, 1972.

The purposes of this paper are four-fold: (I) to present a hypothesis which partially explains the effects of chronic marijuana usage on everyday behavior or life styles; (II) to review marijuana experiments which involve measures of perceptual-motor performance, cognitive problem-solving, and psychophysiological functioning (including sleep-wakefulness cycles) as dependent variables; (III) to present a progress report on the UTMB human level laboratory and field marijuana research; (IV) to discuss selected findings to date which relate to the rationale for the above hypothesis. (Authors' abstract)

11. Beaconsfield, P., Ginsburg, J., & Rainsbury, R. Marihuana smoking: Cardiovascular effects in man and possible mechanisms. New England Journal of Medicine, 1972, 287, 209-212.

Marihuana smoking by subjects without previous experience causes an increase in limb blood flow concomitantly with a rise in pulse rate. These responses are still evoked after administration of atropine but not after pretreatment with propranolol, a beta-adrenergic blocker. The tachycardias of atropine and of epinephrine are potentiated by marihuana. These findings suggest that the increase in pulse rate and peripheral blood flow induced by cannabis involves beta-adrenergic vascular mechanisms, and counsel caution in the administration of vasoactive drugs and anesthetics for those who may have been smoking marihuana. (Journal abstract)

12. Beaconsfield, P., Rainsbury, R., Ginsburg, J., and Carpi, A. Marijuana smoking: Effects on blood and urine in man. British Journal of Clinical Practice, 1973, 27, 207-210.

Ten volunteers with no experience of cannabis smoked marijuana leaf cigarettes, each containing approximately 10mg. of tetrahydrocannabinol. Blood and urine analyses were carried out on samples taken at intervals before and up to three hours after smoking. Most blood constituents were unaltered, although a discrepancy between the level of transketolase activity and thiamine pyrophosphate effect after smoking suggests the possibility of interference with metabolism of some of the vitamins of the B complex. The expected diuresis occurred, and in addition there was a marked antihistaminic effect which was reproducible in vitro and in vivo animal studies, using THC extract.

It is suggested that industrial-type investigation rather than individual research endeavour is required to elucidate the effects of cannabis and reduce the controversy based mainly on insufficient knowledge that surrounds it. (Authors' summary)

13. Bech, P., Rafaelsen, L., & Rafaelsen, O. J. Cannabis and alcohol: Effects on estimation of time and distance. Psychopharmacologia, 1973, 32, 373-381.

The effect of cannabis and alcohol on estimation of time and distance during simulated car driving was studied. Cannabis resin containing 4% Δ^1-tetrahydrocannabinol (THC) was administered orally in 3 doses equivalent to 8, 12, and 16 mg THC. Alcohol was given orally in one dose of 70 g. The subjects were 8 men, 21 to 29 years old. Cannabis showed much stronger effect than alcohol on the estimation of time and distance. The effect of cannabis was more marked on the "subjective" than on the "objective" estimation. A dose-response type of effect was seen on cannabis. (Journal abstract)

14. Benjamin, F. B. The effect of marijuana on driving performance. In M. F. Lewis (Ed.), Current research in marijuana. New York: Academic Press, 1972.

Summarizes available data relating marihuana use to automobile driving. Preliminary evidence indicates impairment of ability to drive, but no strong association of marihuana with accidents. (Psychological Abstracts)

15. Borg, J., Gershon, S., & Alpert, M. Dose effects of smoked marihuana on human cognitive and motor functions. Psychopharmacologia, 1975, 42, 211-218.

Graded doses of marihuana were administered to five adults in a longitudinal repeated-measurements design. Speed of response was the basic parameter measured across tests of increasing cognitive involvement. Marihuana produced significant dose-response effects of impaired performance in all test scores. However, single automatic motor abilities demonstrated greater sensitivity than tests of greater complexity. Evidence is presented for tolerance development. (Journal abstract)

16. Bourassa, M. [Marijuana and research] (Fren). Toxicomanies, 1971, 4, 19-50.

The current article describes the contemporary state of scientific research on the use of marihuana by humans, and attempts to highlight the respective value of the various experiences achieved in this area.

The author briefly describes the Cannabis Sativa plant in its pharmacologic, historic, and social aspects. Secondly, he reviews a number of research projects and criticizes in detail five of them: (a) Mayor's Committee on Marijuana, 1944; (b) Isbell, H. et al., 1967; (c) Clark et Nakashima, 1968; (d) Weil, Zinberg, & Nelsen, 1969; (e) Manno et al., 1970.

Following the critical review of up-to-date research in this area, the author comes to conclusion that science has much to do as yet to grasp the real effects of marihuana. He underscores the necessity of undertaking on this drug chemical, pharmacological, and psychological research in order to judge its effects on human beings with greater accuracy. (Journal abstract)

17. 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, 1973, 29, 159-170.

The psychological effects of chronic heavy use of Cannabis sativa were studied in a population of normal adult Jamaican males. Users had been daily consumers of the drug for a minimum of 10 years; Controls were subjects who had neither current nor past experience with the drug. Subjects were matched for age, sex, social class, alcohol use, level of general information ("intelligence"), education, and modernity. Three groups of objective psychological tests were administered, in addition to a questionnaire. The first group of tests concerned physiological, sensory and perceptual motor functioning; the second group of tests measured concept formation and abstracting abilities; the third group was comprised of a number of tests of memory.

An initial study failed to discover any indications of User impairment. The data was studied for possible confounding factors including drug potency, literacy, motivation, and research design. A replication of the study using an improved research design led to a strong confirmation of the original findings.

It was suggested that heavy users of this drug did not show test performances indicating impairment of psychological functioning comparable to other types of organic cerebral dysfunction, nor did they show chronic changes on dimensions responsive to immediate intoxication. (Journal abstract)

18. Braden, W., Stillman, R. C., & Wyatt, R. J. Effects of marihuana on contingent negative variation and reaction time. Archives of General Psychiatry, 1974, 31, 537-541.

Contingent negative variation (CNV) and reaction time were measured in 12 subjects after they smoked placebo and marihuana cigarettes. Change in CNV amplitude after smoking marihuana was negatively

correlated (r = -.83) with subjects' ratings of their "high," and not significantly correlated with change in reaction time. The results suggest that the relationship of CNV amplitude to marihuana dose is probably in the form of an inverted U. The CNV amplitude may reflect attentional effort or level of interest rather than efficiency of attentional performance, as measured by reaction time. (Journal abstract)

19. Brill, N. Q. The marijuana problem in perspective. Military Medicine, 1973, 138, 205-210.

Views the pervasive problem of mood-influencing drugs, and specifically the epidemic-like explosion in marihuana use, against the background of related cultural changes. The epidemiology, legal aspects, and personality characteristics of chronic, occasional, and social users are delineated, with emphasis on motivation--boredom, curiosity, peer-group ties, rebellion against authority--and factors in the drug's increased use. Military and civilian studies have consistently proven that the problem lies in marihuana abusers, not in the drug itself. They have shown that the great majority of psychiatric casualties that occur with marihuana use are seen in those with pre-existing emotional disorders who concomitantly abuse other drugs. It is concluded that because the problem is inherently a part of the larger evolving cultural changes in society, it is society itself which eventually will decide what it will tolerate. (Psychological Abstracts, B. McLean)

20. Brown, B., Adams, A. J., Haegerstrom, G., Jones, R. T., & Flom, M. C. Effects of alcohol and marijuana on dynamic visual acuity: I. Threshold measurements. Perception & Psychophysics, 1975, 18, 441-446.

Alcohol and marijuana produce significant dose-related reductions in dynamic visual acuity. Ten subjects participated in a double-blind experiment involving three dose levels of each drug (including placebo). The reduction of DVA produced by alcohol (1.0 ml 95% ethanol/kg body weight) was greater than for marijuana (15 mg Δ-9-tetrahydrocannabinol), and we suggest that this difference was produced by differential oculomotor effects of the two drugs. We have speculated that reduction in DVA under alcohol may be a contributing factor in alcohol-related traffic accidents. (Journal abstract)

21. Brubaker, T. H. A synthesis of current research on marijuana. Journal of Drug Education, 1973, 3, 25-30.

This paper is a synthesis of the research which has been recently completed to ascertain the effects of the drug marijuana on human behavior. Since the isolation of the active component of marijuana (THC), studies have revealed various effects to the memory,

specific physiological effects, and definite visual effects to individuals while under the influence of marijuana. Furthermore, it has been noted that the sociological aspects of the drug are of great importance to the study of this drug. It appears that these sociological aspects may stimulate an individual into the use of this drug. The state of euphoria is cited as one of the factors which stimulate the usage of marijuana. It appears that an individual cannot participate normally in expected societal roles while under the influence of marijuana. (Journal abstract)

C

22. Caldwell, D. F., Myers, S. A., Domino, E. F., & Meriam, P. E. Auditory and visual threshold effects of marihuana in man. Perceptual & Motor Skills, 1969, 29, 755-759.

Auditory and visual thresholds were measured before and after smoking marihuana (Cannabis sativa L.) for 20 experienced subjects. Marihuana was administered until subject reported experiencing a "high." Results indicated no effect on visual acuity, whereas one of three auditory measurements differentiated between marihuana and control subjects. (Journal abstract)

23. Campbell, A. M. G., Evans, M., Thomson, J. L. G., & Williams, M. J. Cerebral atrophy in young cannabis smokers. Lancet, 1971, 2, 1219-1224.

Evidence of cerebral atrophy was demonstrated by air encephalography in ten patients with histories of consistent cannabis smoking over a period of 3-11 years. The average age of the patients was 22 years; all were males. Amphetamines and lysergide (L.S.D.) had also been taken, but in much smaller amounts. Measurements of the lateral and third ventricles were significantly different from those in thirteen controls of a similar age-group. (Journal abstract)

24. Campbell, D. R. The electroencephalogram in cannabis-associated psychosis. Canadian Psychiatric Association Journal, 1971, 16, 161-165.

Compared the EEGs of 4 groups of 16-22 yr. olds: (a) 11 patients with psychotic reactions after the use of cannabis; (b) 29 subjects admitted with a diagnosis of schizophrenia; (c) 10 subjects admitted for neurological considerations; and (d) 11 control cannabis users, with no apparent psychiatric implications, obtained from the community. It was found that there was a greater increase in the EEG abnormalities of both the psychotic-reaction and control cannabis users than in the other groups. Results suggest that the drug may be a factor in creating the EEG abnormalities as well as contributing to the observed psychotic reactions, especially when other factors which could create similar EEG abnormalities are ruled out. (Journal summary)

25. Cappell, H., & Pliner, P. Regulation of the self-administration of marihuana by psychological and pharmacological variables. Pscyhopharmacologia, 1974, 40, 65-76.

Investigated the roles of 3 variables as determinants of marihuana self-administration. Marihuana-use history was manipulated by

selecting 30 18-29 year old males at each of the 2 extremes of use frequency. To determine the possible contribution or learned smoking habits to consumption, subjects smoked either large or small cigarettes. Finally, cigarettes varying in concentration of Δ^9-tetrahydrocannabinol were used. Subjects were asked to smoke until they had attained a "nice high." Although there was some evidence of titration according to potency, subjects self-administrated more total tetrahydrocannabinol the more potent the material in attaining the same subjective endpoint of intoxication. More material was ingested in the form of large than small cigarettes. The latter variable accounted for nearly as much variance as did drug potency itself. This result illustrates the importance of an essentially cognitive variable as a determinant of drug intake. There was no difference in the amount required by frequent and infrequent users to attain the intoxication criterion. The latter result is in opposition to the assertion by G. H. Nahas (1973) that frequent exposure to cannabis will ultimately result in an increase in the amount required to produce the reinforcing effects of marihuana. (Journal abstract)

26. Cappell, H. D., and Pliner, P. L. Volitional control of marijuana intoxication: A study of the ability to "come down" on command. Journal of Abnormal Psychology, 1973, 82, 428-434.

Many marijuana users claim the ability to "come down" from a marijuana "high" as situational contingencies demand. However, the only evidence in support of volitional control of marijuana intoxication is personal testimony. The ability of experienced marijuana users to offset the behavioral consequences of marijuana smoking was studied using objective and subjective indices of intoxication. In a repeated test design, subjects smoked placebo or marijuana containing 1.2% tetrahydrocannabinol (THC). The dependent variables were subjective rating of intoxication, pulse rate, and several performance measures. In a high-motivation condition, subjects were instructed to try and overcome the effects of the drug, and in a low-motivation condition no special instructions were given. In comparison to the low-motivation group, high-motivation subjects compensated for intoxication in a time-estimation task but not in short-term memory. Subjective intoxication and pulse rate were not differentially affected. Although compensation was task specific, the results demonstrated that in principle the ability to come down exists. (Journal abstract)

27. Casswell, S., & Marks, D. Cannabis induced impairment of performance of a divided attention task. Nature, 1973, 241, 60-61.

Performance on a test of information processing under conditions of divided attention was diminished in human volunteers after smoking Cannabis. No significant difference was found between experi-

enced and naive subjects. The results are related to driving under Cannabis influence. (Coy W. Waller & others)

28. Casswell, S., & Marks, D. F. Cannabis and temporal disintegration in experienced and naive subjects. Science, 1973, 179, 803-805.

The effects of 3.3 and 6.6 milligrams of Δ^9-tetrahydrocannabinol and of placebo on performance of three cognitive tasks were compared for naive subjects and experienced cannabis smokers. No differences in performance or reported subjective effects were found between these two groups. A significant decrement was found following dosage at both levels, replicating earlier findings of temporal disintegration during cannabis intoxication. (Journal abstract)

29. Clark, L. D., Hughes, R., & Nakashima, E. N. Behavioral effects of marijuana: Experimental studies. Archives of General Psychiatry, 1970, 23, 193-198.

Evidence has been presented that marihuana intoxication has significant effects on complex reaction time (largely through sporadic impairment of vigilance), recent memory, recall and comprehension of written information, and accuracy of time estimation. Adverse effects of marihuana on recent memory have been recently confirmed by others in a series of interesting experiments.

Experimental data as well as introspective reports suggest that the processes involved in selective perception (and, conversely, habituation to irrelevant stimuli), immediate recall of preceding thoughts in order to keep on track, and capacity for goal-directed systematic thinking are particularly sensitive to relatively low doses of marihuana. It is likely that distortion of time sense is incident to these effects on perception, memory, and organization of thought. In any event, there appears to be sufficient evidence to justify focusing additional research on these mental processes in both short-term experiments and in the search for possible long-term impairment in habitual marihuana users. (Journal abstract)

30. Clark, L. D., & Nakashima, E. N. Experimental studies on marihuana. American Journal of Psychiatry, 1968, 125, 379-384.

A series of tests including reaction times, digit code memory tasks, depth perception, mirror pattern tracing and others was given in random order with subjects serving as their own controls. A high level of inter and intra subject variability in effects of marihuana occurred with wide oscillations in magnitude of dose effects. Effects on reaction time and on a digit code memory task were most consistently impaired, with the dose-effect relationship being a positively accelerating function. (W. H. Rickles, Jr. and others)

31. Clark, S. C. Marihuana and the cardiovascular system. Pharmacology, Biochemistry & Behavior, 1975, 3, 299-306.

Cites the actions of marihuana on the cardiovascular system in man as the most consistent physiological effects produced by acute administration. Significant tachycardia and conjunctival injection are well established effects. When the subject is upright, marihuana produces a fall in blood pressure; however, either no significant effect or a slight increase in blood pressure occurs when the subject is supine. Marihuana has been reported to increase limb blood flow and produce no significant effect on electrocardiogram of normal subjects. However, it interferes with the integrity of peripheral vascular reflex responses. Although the detailed mechanism of action has not been elucidated, there is evidence that marihuana produces both sympathetic nervous system stimulation and parasympathetic nervous system blockade. No data are available that indicate the acute administration of marihuana presents a significant hazard to the cardiovascular system of normal subjects. (Journal abstract)

32. Cohen, M. J., & Rickles, W. H. Marijuana influenced changes in GSR activation peaking during paired-associate learning. Pharmacology, Biochemistry & Behavior, 1975, 3, 195-200.

Activation Peaking (AP) refers to a patterned physiological response occurring during learning. Marihuana interfered with both paired-associate learning and phasic GSR [galvanic skin response] activity. A study was performed to assess the effects of marihuana intoxication on paired-associate learning and concomitant GSR AP. Two marihuana usage categories were employed--light and heavy usage subjects. Within each category 4 groups were run in a design to test state-dependent effects. Each subject was seen twice with a 7-day intersession interval. The groups were P-P, P-M, M-M and M-P with P = placebo and M = 14 mg Δ^9 THC [tetrahydrocannabinol]. At each session subject learned a 9-word paired-associate list to a criterion of one correct recitation, and then received 100 percent overlearning. No usage or group differences were found in level of basal conductance, except lights showed habituation over sessions and heavies did not. Magnitude of phasic GSR activation, aligned for AP, was significantly reduced for both heavy usage and marihuana intoxicated subjects. Also, only on placebo days was an AP effect evident. The results were discussed in terms of marihuana's effects on learning and physiology with emphasis on possible mechanisms of action. (Biological Abstracts)

33. Committee on Drugs (American Academy of Pediatrics). Effects of marihuana on man. Pediatrics, 1975, 56, 134-143.

The Committee on Drugs has reviewed the pharmacology of marihuana with special emphasis on effects in man because of the enormous

impact of this drug on society. Much of modern day society's reaction to and attitudes about this psychoactive agent does not reflect its pharmacology, and it is only recently that pertinent biologic facts about marihuana have become known. The Committee reports these facts here, in part, to inform the Academy membership of these facts and, in part, to provide a perspective with which to consider the various societal controls (i.e., laws) on the use of marihuana. (Journal abstract)

34. Committee on the Use of Human Subjects, Purdue University. Letter: Drugs, laws, Human Factors Society, and you. Human Factors Society Bulletin, 1975, 18(10), 6-7.

Denial of prior knowledge of study done by Salvendy & McCabe. (Ref. no. 158)

35. Crancer, A., Jr. Letter. Science, 1969, 166, 640.

Reply to critique by H. Kalant. (Ref. no. 83)

36. Crancer, A., Jr., Dille, J. M., Delay, J. C., Wallace, J. E., & Haykin, M. D. Comparison of the effects of marijuana on simulated driving performance. Science, 1969, 164, 851-854.

The effects of marihuana, alcohol, and no treatment on simulated driving performance were determined for experienced marihuana smokers. Subjects experiencing a "social marihuana high" accumulated significantly more speedometer errors than when under control conditions, whereas there were no significant differences in accelerator, brake, signal, steering, and total errors. The same subjects intoxicated from alcohol accumulated significantly more accelerator, brake, signal, speedometer, and total errors than under normal conditions, whereas there was no significant difference in steering errors. Impairment in simulated driving performance does not seem to be a function of increased marihuana dosage or inexperience with the drug. (Journal abstract)

D

37. Darley, C. F., Tinklenberg, J. R., Hollister, L. E., & Atkinson, R. C. Marihuana and retrieval from short term memory. Psychopharmacologia, 1973, 29, 231-238.

Twelve subjects received an oral dose of marihuana extract calibrated to 20 mg of Δ^1-tetrahydrocannabinol on Day 1 of the experiment and performed a short-term memory task before and after administration of the drug. The subjects were then split into two groups, receiving either marihuana or placebo on the evenings of Days 1 to 4 and between two memory test sessions on Day 5. Placebo subjects showed little change in performance between the two test sessions on Day 5; however, results from Day 1 for all subjects and Day 5 for the drug group showed that reaction time increased from before- to after-challenge sessions. This increase in time under marihuana was explained as a change in encoding and/or response processes, rather than processes involved in the search of the memory store. (Journal abstract)

38. Darley, C. F., Tinklenberg, J. R., Roth, W. T., & Atkinson, R. C. The nature of storage deficits and state-dependent retrieval under marihuana. Psychopharmacologia, 1974, 37, 139-149.

To explore the nature of the storage deficit produced by marihuana intoxication and to determine if retrieval is state dependent for this drug, 48 subjects were presented ten 20-word lists before receiving an oral dose of marihuana and another 10 lists following drug administration. Subjects studied half of each set of 10 pre-drug and 10 post-drug lists using an overt fixed-rehearsal procedure and half using their normal covert free-rehearsal procedure. On Day 1 of the experiment an immediate-recall test followed each of the 20 lists presented. The marihuana-induced deficit in immediate-recall performance on Day 1 for free-rehearsal lists was not eliminated when the fixed-rehearsal procedure was used. Thus, marihuana intoxication impaired the storage of information even when overt rehearsal in the drug and no-drug states was equated. Three days later (Day 4) subjects returned, half receiving marihuana (Drug Group) and half-receiving placebo (Placebo Group). All subjects were then administered delayed recall, recognition, and order tests on the words presented on Day 1. Delayed recall performance was asymmetrically state dependent, whereas delayed recognition performance was not state dependent. (Journal abstract)

39. Darley, C. F., Tinklenberg, J. R., Roth, W. T., Hollister, L. E., & Atkinson, R. C. Influence of marihuana on storage and retrieval processes in memory. Memory & Cognition, 1973, 1, 196-200.

Following presentation and immediate free recall testing of 10 20-word lists, 48 subjects were divided into two groups, one of which received an oral dose of marihuana extract calibrated to 20 mg of Δ^9-THC and one of which received placebo. One hour later, all subjects were administered delayed recall, recognition, and order tests on the first set of words. Presentation of another set of 10 lists followed, and there were immediate recall and delayed recall, recognition, and order tests on these words. Performance of drug and placebo subjects on immediate recall, delayed recall, and delayed recognition of the second set of lists. We concluded that retrieval of information relevant to the occurrence or nonoccurrence of an event was not affected by marihuana intoxication. Storage difficulties probably account for memory deficits due to the drug, and these difficulties appear to occur in the process of transferring information from short-term to long-term memory. (Journal abstract)

40. Delizannakis, E., Panagopoulos, C., & Huott, A. D. The influence of hashish on human EEG. Clinical Electroencephalography, 1970, 1, 128-140.

The EEG's of twenty-seven hashish addicts were recorded at rest and during various combinations of tobacco and tobacco-hashish mixtures. In seven out of twenty-five cases who smoked hashish there was no change in the EEG noticed. In three there was an alpha rhythm stabilization and amplitude increase; in eleven short or long lasting basic rhythm blocking with or without amplitude decrease and disorganization of the tracing; in four a decrease or even a disappearance of pre-existing abundant (and in three of them asymmetric) temporal and posterior slow waves in the resting EEG. Tobacco caused qualitatively similar changes but it was of less intensity and shorter duration.

There was a significant correlation between clinical and EEG manifestations.

Six of the seven patients who manifested delusions and hallucinations are included in the group which showed EEG disorganization or tendency to it. Two who manifested confusion are included in the group which showed stabilization and amplitude increase of the basic rhythm.

The findings were considered as non-specific and are attributed mainly to the stimulating or sometimes, depressive effect on the cerebral cortex of hashish and/or to the psychologic dependence of the addict on the drug. (Author's summary)

41. Dittrick, A., Battig, K., & von Zeppelin, I. Effects of (-) Δ^9-trans-tetrahydrocannabinol (Δ^9-THC) on memory, attention and subjective state: A double blind study. Psychopharmacologia, 1973, 33, 369-376.

In a double blind study, cross-over design, on 37 volunteers several effects of an orally administered dosage of 15 mgs (-)-Δ^9-trans-tetrahydrocannabinol (Δ^9-THC) were assessed. The results did bear out the hypotheses of this experiment that the impairment of attention and information storage in the long-term memory as well as depersonalization and temporal disintegration phenomena induced by Δ^9-THC are interrelated. Furthermore, the sequence of information retrieval from memory was found to be changed by Δ^9-THC. (Journal abstract)

42. Dittrich, A., & Woggon, B. Subjective changes in volunteers without prior experience of cannabis induced by (-) Δ^9-trans-tetrahydrocannabinol. International Pharmacopsychiatry, 1974, 9, 138-151.

Students [36], with no prior experience of Cannabis, received either 350 µg/kg Δ^9-tetrahydrocannabinol [Δ^9-THC] or placebo, orally, in a double-blind study, to assess the high dosage effect of Δ^9-THC. Δ^9-THC caused profound depersonalization and derealization syndromes. Anxious-depressive and euphoric-stimulated states occasionally appeared during 1 intoxication, at approximately the same time, and/or at different times. Some subjects, with their eyes closed, had optical hallucinations which could be influenced by suggestion. The tests used, and the behavior observation of the subjects, showed a great inter- and intra-individual variability of the intensity of Δ^9-THC effects. Two hours after application of the drug, the following subjective side effects were observed: weariness and feebleness, heaviness of the legs, dizziness and hypersensitivity against cold. While no difference between Δ^9-THC and placebo was found in the self-assessed changes of the ability to concentrate, the test results show a significant decrease of performance under Δ^9-THC. (Biological Abstracts, J. G. S.)

43. Dornbush, R. L., Clare, G., Zaks, A., Crown, P., Volavka, J., & Fink, M. 21-day administration of marijuana in male volunteers. In M. F. Lewis (Ed.), Current research in marijuana. New York: Academic Press, 1972.

Studied effects of chronic administration of marihuana in 6 first and second year medical and graduate students. Changes in the retention intervals on a short-term memory task were significant ($p < .01$). Heart rate increased significantly immediately after smoking, then decreased consistently. There were no EEG adnormalities or effects on a digit symbol substitution test. (Psychological Abstracts)

44. Dornbush, R. L., Fink, M., & Freedman, A. M. Marijuana, memory, and perception. American Journal of Psychiatry, 1971, 128, 194-197.

The effect of high and low doses of marijuana on behavioral and physiological responses was studied in male medical school volunteers. Short-term memory, reaction time, EEG, and heart rate were significantly affected by the higher dose; time estimation and blood sugar were not differentially affected by either dose. (Journal abstract)

E

45. Ellingstad, V. S., McFarling, L. H., & Struckman, D. L. Alcohol, marijuana and risk-taking (Final report, Contract No. DOT-HS-191-2-301). University of South Dakota, Department of Psychology, Human Factors Laboratory, Vermillion, South Dakota, April 1973.

The performance of six groups of 16 subjects each (marijuana user control, non-user control, .05 BAC alcohol, .10 BAC alcohol, low dose marijuana, and high dose marijuana) were compared on two laboratory analogs of the automobile passing task. Analysis of the data utilized a multiple discriminant analysis, producing statistically significant discrimination between the six groups. The first dimension of discrimination was related to "judgmental accuracy" and was capable of distinguishing the two marijuana treatment groups from the remaining four groups. The marijuana subjects tended to overestimate time required to complete passes, and showed considerable variability in their estimates. The second discriminant function dimension was labelled "riskiness/decisiveness" and appeared capable of distinguishing the alcohol groups from the remaining subjects. The alcohol group subjects tended to exhibit patterns of psychomotor performance suggesting a tendency to make "snap decisions" which were subsequently over-ridden. No dose responses were found for either alcohol or marijuana. (Authors' abstract)

46. Evans, M. A., Martz, R., Brown, D. J., Rodda, B. E., Kiplinger, G. F., Lemberger, L., & Forney, R. B. Impairment of performance with low doses of marihuana. Clinical Pharmacology & Therapeutics, 1973, 14, 936-940.

Eight volunteers smoked marihuana cigarettes under controlled laboratory conditions on 4 separate occasions. The cigarettes were calibrated to deliver doses of 0, 3, 6, and 9 µg per kilogram of delta-9-tetrahydrocannabinol (THC). The experimental design was a double-blind random block with a 1 week interval between sessions. Analysis of variance revealed a significant linear decrease in stability with increase in dose of THC. The tracking scores with Pursuit Meter (PM) demonstrated a significant increase above control for all three doses of THC. Mental performance, as evaluated by Delayed Auditory Feedback (DAF), and subjective evaluation revealed no consistent change with dose. (Journal abstract)

F

47. Fischer, R. Letter: Marihuana. Science, 1969, 163, 1144.

Critique of A. T. Weil & others. (Ref. no. 196)

48. Flom, M. C., Adams, A. J., & Jones, R. T. Marijuana-smoking and reduced pressure in human eyes: Drug action or epiphenomenon? Investigative Opthalmology, 1975, 14, 52-55.

Normal pressure within the human eye was reduced after smoking a socially relevant dose of marijuana (12 mg. Δ^9-tetrahydrocannabinol), but only for light to moderate users who experienced a substantial "high" and a state of peaceful relaxation from the experimental dose. Analysis suggests an indirect effect of the drug associated with relaxation--a psychophysiologic state that can be produced by drug and nondrug means. (Journal abstract)

G

49. Gagnon, M. A., & Elié, R. [Marijuana and dextroamphetamine: Dose-effect relationship on some neurophysiological and cardio-respiratory variables in man] (Fren). Toxicomanies, 1973, 6 305-331.

Cigarettes of marihuana containing 5, 10 and 15 mg of Δ^9-THC, were compared to d-amphetamine tablets for their effects on some physiological variables. Half the sample of 12 young male volunteers received active marihuana with a d-amphetamine placebo; the other half had the opposite combination. After initial measurement the tablets were administered one hour and a half before cigarette smoking and two hours before response measurement.

This double-blind experiment was controlled by random allocation of subjects to groups and of dose sequence to subjects, by standardization of the experimental conditions and by preliminary practice. Drug administration, absorption and residual effects were also controlled. Statistical comparisons were performed with the analysis of convariance on response data using the initial measurement as the covariate.

The dose increment with both drugs produced a significant rise in heart rate (mainly due to Δ^9-THC 15 mg). A clear increase of systolic blood pressure was found to be dose-related with both substances while respiration rate was not. The only significant differences between marihuana and d-amphetamine were shown in the patellar reflex variables: the movement amplitude is greater during the first phase of leg extension and the duration of this phase and that of the next phase (return to initial position) are shorter with marihuana, while leg oscillations are more numerous with d-amphetamine. With 5 mg of the latter, time variables as well as EMG suggest, for the same reflex, a predominant stimulation of agonist muscles and, with the higher doses, an approximately equal and simultaneous stimulation of both agonists and antagonists. The marihuana dose-increment effects are smaller but seem to be somewhat similar. A significant dose-related diminution of performance was found with amphetamine on both the simple reaction time to a visual stimulus and the duration of the simple following movement. Only the energy required for the latter movement was significantly increased by the marihuana dose increment. (Journal abstract)

50. Galanter, M., Weingartner, H., Vaughn, T. B., Roth, W. T., & Wyatt, R. J. Δ^9-transtetrahydrocannabinol and natural marihuana: A controlled comparison. Archives of General Psychiatry, 1973, 28, 278-281.

Twelve long-term marihuana users were studied after smoking natural marihuana, synthetic Δ^9-transtetrahydrocannabinol (Δ^9-THC),

and placebo cigarettes. The subjective, cognitive, and physiologic changes tended to be greater for marihuana than for Δ^9-THC, although the syndromes produced were very similar. There was also a marked placebo effect on subjective measures that is suggestive of the importance of learning in the marihuana subjective syndrome. The apparent deficit in memory produced by marihuana appeared to be due to an attentional decrement rather than one of longer-term information storage. Reaction time, both unrewarded and with a monetary incentive, was unaffected by the drugs. (Journal abstract)

51. Galanter, M., Wyatt, R. J., Lemberger, L., Weingartner, H., Vaughn, T. B., & Roth, W. T. Effects on humans of Δ^9-tetrahydrocannabinol administered by smoking. Science, 1972, 176, 934-936.

Twelve chronic marijuana users received Δ^9-tetrahydrocannabinol by smoking. The magnitude of their pulse increment was highly correlated with their subjective experiences. Three of the 12 subjects subsequently received Δ^9-tetrahydrocannabinol labeled with carbon-14; the time course of its concentration in plasma was highly correlated with the pulse increment. Subjective symptoms, however, appeared later and dissipated more slowly. (Journal abstract)

52. Gaskill, H. S. Marihuana, an intoxicant. American Journal of Psychiatry, 1945, 102, 202-204.

Marihuana does not produce addiction in the sense that opium and its derivatives do. Tolerance is not established and withdrawal symptoms do not occur. It is an intoxicant which temporarily produces euphoria, distortion of time perception and impairment of intellectual and moral judgment.

Its habitual users are largely emotionally immature individuals who are constantly frustrated in their attempts to find adequate instinctual expression. The fundamental problem is the abnormal personality.

Marihuana smoking creates an important problem since it often acts as the determining factor, turning the balance in the direction of asocial behavior rather than permitting the poorly integrated social conscience of such an individual to remain in control. (Journal summary)

53. Goodwin, D. W. Letter: Marihuana. Science, 1969, 163, 114.

Critique of A. T. Weil & others. (Ref. no. 196)

54. Greden, J. F., & Morgan, D. W. Patterns of drug use and attitudes toward treatment in a military population. Archives of General Psychiatry, 1972, 26, 113-117.

A population of 747 functioning military personnel was surveyed at an army installation in the United States to determine previous use of illicit drugs and associated attitudes toward treatment. Based on self-reported drug use, seven subgroups with distinct patterns were delineated and statistically compared. Demographic distinctions among these subgroups were frequently pronounced, as were prevailing attitudes toward traditional medical and psychiatric treatment of drug abuse. These distinctions have obvious implications in planning and conducting drug abuse prevention, treatment, and educational programs. (Journal abstract)

55. Greden, J. F., Morgan, D. W., & Frenkel, S. I. The changing drug scene: 1970-1972. American Journal of Psychiatry, 1974, 131, 77-81.

Using the same questionnaire, the authors surveyed drug use at a military installation in 1970, 1971, and 1972. Over the three years, the total percentage of respondents reporting previous drug use increased; the amount of use and number of current users also increased. For most drug types, the increases occurred between 1970 and 1971; heroin use, however, increased each year. The authors question the usefulness of specialized short-term drug treatment programs. (Journal abstract)

56. Green, K. Marihuana and the eye. Investigative Ophthalmology, 1975, 14, 261-262.

The reduction in ocular pressure pulse seen in man, together with studies in rabbit which show an increased blood-aqueous barrier permeability (measured directly in vitro and by increased aqueous protein in vivo) concurrent with the intraocular pressure fall, suggest that the action of the cannabinoids is a vasoconstriction of the afferent vessels of the ciliary body causing a pressure fall in the capillaries. This effect occurs concurrently and paradoxically with an engorgement of conjunctival vessels by a mechanism which is not yet understood. Whether the inhibition of prostaglandin synthesis by Δ^9-tetrahydrocannabinol is of importance in the nonstimulated eye remains to be determined; tetrahydrocannabinol inhibits the formation of prostaglandin from arachidonic acid when the latter is given in large quantities to the eye. With regard to treatment for the reduction of intraocular pressure in man, the most advantageous route is topical administration. Some compounds which reduce intraocular pressure when applied topically to the rabbit eye have little or no central effects, if there is systemic absorption. Fewer side effects are desirable and necessary. (Biological Abstracts, J. G. S.)

57. Grinspoon, L. Marijuana and brain damage: A criticism of the study by A. M. G. Campbell et al. Contemporary Drug Problems, 1972(Fall), 1, 811-814.

Criticizes as inadequate a study by A. M. G. Campbell [ref. no. 23] which concluded that chronic marihuana use can lead to brain damage. The bias of the investigators is noted, and they are reproached for their failure to use a control group of psychiatric patients who did not use marihuana for comparison. Also criticized is the lack of attention given to the fact that all of the patients studied used other drugs. The research is compared to a study which purported to show that liver damage is linked to marihuana use. It is suggested that the linkage of brain damage and marihuana not be accepted until properly controlled studies are done. (Psychological Abstracts, R. Johnson)

58. Grinspoon, L. Marihuana reconsidered. Cambridge, Massachuetts: Harvard University Press, 1971. (443 pages, $15.00)

This book is aimed at the nonspecialist reader with the exception of Chapter 3 which "was included as part of an overall effort to provide a reasonably comprehensive view of the current state of knowledge of cannabis and its derivatives." Chapter titles are as follows: (1) History of marihuana in the United States; (2) From plant to intoxication; (3) Chemistry and pharmacology; (4) Acute intoxication: Literary and other reports; (5) Acute intoxication: Its properties; (6) Motivation of user; (7) Turning on; (8) Place of cannabis in medicine; (9) Addiction, dependence, and the "stepping stone" hypothesis; (10) Psychoses, adverse reactions, and personality deterioration; (11) Crime and sexual excess; (12) Campaign against marihuana; and (13) Question of legalization. (M. L. Pagel)

H

59. Haertzen, C. A. Development of scales based on patterns of drug effects, using the Addiction Research Center Inventory (ARCI). Psychological Reports, 1966, 18, 163-194.

A series of scales were developed on the basis of the pattern of change of responses on Addiction Research Inventory items produced by drugs including morphine, pentobarbital, chlorpromazine, alcohol, LSD, pyrahexyl, and amphetamine in post addicts. The pattern scales were compared with empirically developed scales that measure the effects of each drug as contrasted with placebo. It was found that the empirical scales show a greater sensitivity to general or non-specific drug effects than pattern scales, i.e., all drugs in the series produced significant elevations on empirical scales. Because of this characteristic, less differentiation between drugs is possible with empirical scales. On scales which reflect patterns of drug actions, greater differentiation between drugs was shown. Higher doses produced more specific drug effects than lower doses. The difference was produced probably by a relatively greater contribution of non-specific drug effects for lower doses. Significant reliability coefficients were obtained for all scales. Reliability of scales across conditions was related to the type of scale and similarity of conditions. As indicated by several findings, condition-similarity has implications for relating personality to drug effects. (Journal abstract)

60. Hauschild, T. B. Marijuana. Military Medicine, 1971, 136, 105-109.

The Expert Committee (World Health Organization, 1964) has defined drug dependence of cannabis type very clearly as habit-forming. A review of studies on marijuana shows that it is an euphoriant, a powerful intoxicant and has psychotomimetic properties. Because it distorts time, space and body image and because it interferes with thought processes, it can precipitate mental illness in the predisposed. Excess use provokes an acute brain syndrome. Chronic use produces lethargy and apathy.

It is not an aphrodisiac, does not enhance creativity, does not solve mental or emotional problems and, although it may produce a vivid inner sensory experience, its interference with ego functions and ego integration actually constricts mental functioning.

The fact that marijuana abuse is intimately associated with multiple drug abuse shows that seeking drug effect is part of a larger problem. Finally, although the American Psychiatric Association has not published a position statement, the American Medical Association has: that the drug is dangerous and as such is a public health concern. (Journal summary)

61. Hepler, R. S., & Frank, I. M. Letter: Marijuana and intraocular pressure. Journal of the American Medical Association, 1971, 217, 1392.

Intraocular pressure was substantially decreased in most subjects one hour after smoking marihuana. (Coy W. Waller & others)

62. Hepler, R. S., Frank, I. M., & Underleider, J. T. Pupillary constriction after marijuana smoking. American Journal of Opthalmology, 1973, 74, 1185-1190.

Ocular effects of the use of marijuana were determined by examination of 21 healthy adults before and after smoking marijuana. The use of marijuana was associated with decrease in pupillary size (but preservation of normal responsiveness to light), decrease in tear secretion, decrease in intraocular pressure, and conjunctival hypermia. Results of visual function tests indicated that central visula acuity, refraction, peripheral visual fields, binocular fusion, and color vision were not altered significantly by marijuana smoking. (Journal summary)

63. Hollister, L. E. Clinical pharmacology of marihuana. In R. J. Gibbons, Y. Israel, H. Kalant, R. E. Popham, W. Schmidt, & R. T. Smart (Eds.), Research advances in alcohol and drug problems. (vol. 1). New York: John Wiley & Sons, 1974.

Presents a review of marihuana research with human subjects. Topics discussed included methodological problems (e.g., dosages); constituents, metabolites, and monologs; pharmacokinetics; clinical syndromes; physiological, biochemical, and psychological effects, therapeutic uses; adverse effects; and comparisons of marihuana with other drugs. (Psychological Abstracts)

64. Hollister, L. E. Marihuana in man: Three years later. Science, 1971, 172, 21-29.

The past 3 years of renewed research on the effects of marihuana in man has added little not previously known about the clinical syndromes produced by the drug. The major advance has been a quantification of dose in relation to clinical phenomena, and a beginning of an understanding of the drug's metabolism. The crucial clinical experiments in regard to the social questions about marihuana, such as the possible deleterious effects from chronic use, cannot be answered by laboratory experiments. These must be settled by close observations made on those who experiment on themselves. It should be possible, within a relatively short-time, to determine whether marihuana has any medical utility, but the future would appear to be no more promising than the past in this regard. The mechanisms by which marihuana alters mental functions are

not likely to be answered in man, nor even answered soon by animal studies. As marihuana may be unique among drugs in that more experimentation has been accomplished in man than in animals, it may be necessary to look to additional animal studies to provide leads for pertinent future studies in man. (Author's summary)

65. Hollister, L. E., Overall, J. E., & Gerber, M. L. Marihuana and setting. Archives of General Psychiatry, 1975, 32, 798-801.

Marihuana or placebo cigarettes were smoked by 12 subjects in two environments, one "favorable" and one "neutral." The object was to determine the contribution of setting to the effects reported from the drug. Two quantifiable self-report measurements, the linear euphoriant scale and the card-sort version of the Addiction Research Center Inventory (marihuana and hallucinogen scales), were the major reporting criteria.

Analyses of variance consistently demonstrated strong effects for subjects and drug but not for the environmental conditions. Reports of marihuana effects may be assumed to be highly colored by psychological differences in the mental set of subjects, or biological variations in their responses to the drug. The actual environment in which the drug is taken seems to play little, if any, role. (Journal abstract)

66. Hollister, L. E., Richards, R. K., & Gillespie, H. K. Comparison of tetrahydrocannabinol and synhexyl in man. Clinical Pharmacology & Therapeutics, 1968, 9, 783-791.

The clinical effects of tetrahydrocannabinol and synhexyl, a THC-type compound, were studied and compared to the clinical effects of LSD. Self-reports, questionnaires, the Clyde Mood Scale and several physiological and psychological measurements were used to evaluate the drug experience. (W. H. Rickles, Jr. & others)

67. Hollister, L. E., & Tinklenberg ,J. R. Subchronic oral doses of marihuana extract. Psychopharmacologia, 1973, 29, 247-252.

Conducted a test in which subchronic oral doses of marihuana administered to 9 male casual users of the drug revealed no evidence of sensitization to the effects of 2 test doses of drug. Comparisons were made with 10 matched subjects who received interval treatment with placebo. Slight evidence of tolerance to dizziness and tachycardia from the drug was noted, but not necessarily as a function of the amount of intervening drug exposure. (Journal abstract)

68. Holm, V. M. Marijuana and the naval aviator. In M. F. Lewis (Ed.), Current research in marijuana. New York Academic Press, 1972.

Discusses the implications for naval aviation of the widespread general use of marihuana by young people, including possible pilot candidates. The possible impairment of perception and performance which might be dangerous in flying and the problem of screening pilot candidates are considered. (Psychological Abstracts)

69. Hosko, M. J., Kochar, M. S., & Wang, R. I. H. Effects of orally administered delta-9-tetrahydrocannabinol in man. Clinical Pharmacology & Therapeutics, 1973, 14, 344-352.

The effects of delta^9-tetrahydrocannabinol (delta^9-THC) administered orally at dose levels were studied in a group of 7 healthy young adult males. Each subject was studied for 7 nights (2 drug, 5 placebo). Vital signs, subjective feelings, deep tendon reflexes, ECG, EEG(s), visual evoked responses, postural responses, time estimation and reaction time and sleep patterns were studied. At the doses studied, delta^9-THC increased pulse rate, altered subjective feelings and caused hyperreflexia and upset postural responses in the absence of visual cues. Some subjects also exhibited lowered oral temperature, changes in averaged visual evoked response and alteration of sleep patterns. (Biological Abstracts)

70. Isbell, H., Gorodetzsky, C. W., Jasinski, D., Claussen, U., Spulak, F. v., & Korte, F. Effects of (-) Δ^9-trans-tetrahydrocannabinol in man. Psychopharmacologia, 1967, 11, 184-188.

The authors report that delta^9-THC has marihuana-like activity in man. Also reported is that the relative potencies of tetrahyrocannabinols can be assayed quantitatively in man and that delta^9-THC is more potent when smoked than when taken orally.

"Regardless of the route of administration, delta^9-THC caused no significant changes in pupillary size, respiratory rate, systolic and diastolic blood pressures or threshold for elicitation of the knee jerk. Pulse rates at rest were consistently elevated. Patients developed injection of the conjunctivae after larger doses. Changes in mood, usually euphoric, were consistently reported. Other changes included alterations in sense of time and in visual and auditory perception (usually described as keener)." (W. H. Rickles, Jr. & others)

71. Isbell, H., & Jasinski, D. R. A comparison of LSD-25 with (-)-Δ^9-trans-tetrahydrocannabinol (THC) and attempted cross tolerance between LSD and THC. Psychopharmacologia, 1969, 14, 115-123.

The objective and subjective effects of 0.5 and 1.5 mcg/kg of LSD intramuscularly were compared with those of 75 and 225 mcg/kg of (-)-Δ^9-trans-tetrahydrocannabinol by smoking in the same eight subjects.

The objective effects of LSD and THC differed markedly. LSD increased body temperature, systolic and diastolic blood pressure, lowered the threshold for the knee-jerk, and dilated the pupils. THC had none of these effects but caused more marked tachycardia than did LSD.

The subjective effects of the two drugs could not be readily distinguished by the methods used. Both LSD and THC are psychotomimetic drugs.

Patients tolerant to LSD were not cross-tolerant to THC, indicating that the mental effects of the two drugs are probably mediated by different mechanisms. (Authors' summary)

J

72. Jampolsky, A., Flom, M. C., Adams, A. J., & Jones, R. T. Objective testing of marijuana induced vision changes (Final report, Contract No. DADA17-72-C-2083). Optical Sciences Group, Visual Sciences Division, San Rafael, California, April 1973.

Nine vision functions were measured by objective methods in a study sample of 19 experienced, male, marijuana users who smoked a 0.8 gram natural marijuana cigarette containing 1.5 percent (12 milligrams) of delta-9-tetrahydrocannabinol (Δ^9-THC). Placebo cigarettes were smoked as a control. The experiments were carried out double-blind with a cross-over design. Six related functions were also measured. Some of the subjects were also given 22 mg THC, alcohol, or Librium in separate experiments.

The chief results are: a) a reduction in glare recovery time with marijuana; b) a decrease in intraocular pressure with marijuana, alcohol, or Librium; c) a deterioration of tracking eye movements with alcohol; d) a rapid rise in pulse rate at the start of smoking marijuana followed by a rapid fall within minutes after smoking; e) a correlation between specific subjective symptoms and objectively measured decrease in intraocular pressure; and f) a correlation between the subjects' high ratings and the intraocular pressure drop.

Some additional and incomplete results are: g) no significant change in heterophoria with marijuana, alcohol, or Librium; h) a possible reduction in amplitude, frequency, and regularity of optokinetic nystagmus with marijuana; i) no change in simple reaction time with marijuana; j) a possible increase in saccadic eye movement rhythm with marijuana; k) a decrease in time production and increase in time estimation which are consistent with a "speeding up" of the internal clock after smoking marijuana; l) a suggested small decrease in pupil size after marijuana, and placebo; m) consistent conjunctival injection with marijuana; and n) suggested lid edema after smoking marijuana leading to pseudoptosis (lid droop). (Authors' abstract)

73. Jampolsky, A. J., Flom, M. C., Adams, A. J., & Jones, R. T. Influence of socially used drugs on vision and vision performance (Preliminary annual report, Contract No. DADA17-73-C-3106). Optical Sciences Group, Visual Sciences Division, San Rafael, California, July 1974. (U.S. Army Tech. Report No. 741)

In a study sample of 19 experienced, male marijuana users, seven vision functions were measured under the influence of alcohol or marijuana. Experiments were performed with placebo controls in a double-blind fashion with a cross-over design.

The experimentally obtained results are: (a) Intraocular pressure (IOP) was reduced slightly by alcohol and more by marijuana for "equivalent" levels of intoxication. For 5 concentrations of tetrahydrocannabinol (THC) up to 22 mg THC, a typical dose relationship curve was established for IOP drop and marijuana (THC) dose. For both alcohol and marijuana, IOP drop seems to be related to the extent of drug-induced relaxation; (b) Phoria consistently shifts in a convergent (eso-ward) direction after either alcohol or marijuana. Free-space compared to stereoscope instrument measurements indicate a change in instrument-induced (proximal) vergence after alcohol and possibly after marijuana; (c) Optokinetic nystagmus (OKN), induced by vertical black bars moving horizontally across a 100 degree-wide field, was assessed qualitatively to have decreased saccadic frequency and amplitude, and to become less regular after alcohol intoxication; (d) Sinusoidal pursuit eye movements were limited in their high frequency response after alcohol; marijuana, however, did not reduce this maximum velocity function; (e) Sinusoidal pursuit eye movements deteriorated markedly after alcohol and slightly after marijuana for intermittently-seen targets; (f) Glare recovery time (GRT) was affected in the same general way by alcohol and marijuana: GRT was reduced (i.e., improved) for high contrast stripes, and increased for low contrast stripes; (g) Visual acuity measured psychometrically with 4-position Landolt rings and with variable contrast spots did not change after alcohol or marijuana intoxication; (h) Spot luminance thresholds 25 degrees in the retinal periphery were unaffected by alcohol and were slightly increased by marijuana in a dose-related fashion. (Authors' abstract)

74. Janowsky, D. S., Meacham, M. P., Blaine, J. D., Schoor, M., & Bozzetti, L. P. Marijuana smoking and simulated flying performance. Paper presented at the annual meeting of the American Psychiatric Association, Anaheim, California, 1975.

Studied seven professional and three private, male pilots who were social users of marijuana. Flight simulation tests were given before and after smoking. All subjects showed a significant increase in pilot errors related to heading, altitude and deviation from pattern when tested 30 minutes after smoking. Performance did not return to normal until four hours after the drug was taken. "The deficiencies noted in pilot performance probably reflect marijuana's ability to affect memory, skill, concentration, time and orientation in three-dimensional space as well as the performance of multiple complex tasks," said Janowsky. "At times," he said, "subjects exhibited a complete loss of orientation with respect to navigational fix, resulting in grossly unpredictable flight performances." They seemed to concentrate on some variables to the exclusion of others. The pilots did report, however, that flying was a much more challenging task while high. (Science News)

75. Janowsky, D. S., Meacham, M. P., Blaine, J. D., Schoor, M., & Bozzetti, L. P. Simulated flying performance after marihuana intoxication. Aviation Space & Environmental Medicine, 1976, 47, 124-128.

Ten pilots smoked, in counterbalanced order on a double blind basis, a social dose of marihuana (.09 mg/kg delta-9-tetrahydrocannabinol) and a matched placebo after being trained to fly a specific flight sequence on an ATC-510 flight simulator. In contrast to placebo, marihuana caused a gross decrement in flying performance, with increased prevalence of major errors, minor errors, altitude deviations, heading deviations, and radio navigation errors. These effects of active marihuana persisted for at least 2 hours and generally had disappeared by 4 to 6 hours after marihuana administration. (Journal abstract)

76. Johnstone, R. E., Lief, P. L., Kulp, R. A., & Smith, T. C. Combination of Δ^9-tetrahydrocannabinol with oxymorphone or pentobartital: Effects on ventilatory control and cardiovascular dynamics. Anesthesiology, 1975, 42, 674-684.

Marijuana is widely used, yet few data concerning its actions combined with other drugs exist. Psychologic, respiratory and cardiovascular effects of Δ^9-tetrahydrocannabinol (THC), the active component of marijuana, combined with oxymorphone (OXM) or with pentobarbital (PBL), were studied in 15 healthy volunteers.

Oxymorphone, 1.0 mg/70 kg, iv, caused sedation and ventilatory depression (minute ventilation: 24.9 ± 11.9 SD to 14.1 ± 4.9 l/min with PET_{CO_2} held at 50 torr) in eight volunteers. THC (27, 40, 60, 90, and 134 µg/kg, iv) increased sedation and further decreased ventilation with each THC dose to 6.6 ± 3.7 l/min after 134 µg/kg. The combination of OXM and THC decreased the CO_2-ventilation slope from 2.23 to 0.88 l/min/torr. When THC, 134 µg/kg, was added to OXM, which alone caused no significant cardiovascular change, cardiac index (4.1 ± 1.3 to 5.9 ± 2.2 l/min/m^2 and heart rate (66 ± 12 to 107 ± 31 beats/min significantly increased and total peripheral resistance (1,030 ± 260 to 660 ± 200 dynes·sec/cm^5) decreased. Heart rates exceeded 150 beats/min in two subjects after 27 and 134 µg/kg.

Pentobarbital alone, 100 mg/kg, iv, caused no significant ventilatory or cardiovascular change. THC, after PBL pretreatment, induced hallucinations and anxiety in five of seven volunteers; four failed to complete all five doses of THC because of the severe psychologic effects. The combination of PBL and 40 to 134 µg/kg THC did not affect ventilation significantly. After PBL pretreatment, THC significantly increased heart rate (76 ± 17 to 130 ± 32 beats/min). Cardiac index also increased (3.8 ± 0.7 to 5.6 ± 1.9 l/min/m^2) and total peripheral resistance decreased (1,070 ± 240 to 720 ± 300 dynes·sec/cm^5). Three subjects developed heart rates exceeding 150 beats/min after 27, 27, and 90 µg/kg THC; in all three, heart rates fell from maximal value with a further dose of THC. (Journal abstract)

77. Jones, R. T. Biological effects of cannabis: 1972 literature. In Drug use in America: Problem in perspective (Second report of the National Commission on Marihuana & Drug Abuse), Washington, D.C.: U.S. Government Printing Office, 1973.

Reviews the reported biological effects of cannabis on humans in the literature from October 1971 through October 1972. (Author's abstract)

78. Jones, R. T. Marihuana induced "high": Influence of expectation, setting and previous drug experience. Pharmacological Reviews, 1971, 23, 359-369.

In summary, these data suggest that marihuana when smoked at what was, for our subject population, a socially relevant dose, a level of intoxication is produced that allows the attitude of the subject, his set and expectations, the setting and his past experience to interact in a complex way to determine how the subjective state will be labeled and reported. Such findings should not be surprising and certainly suggest nothing pharmacologically unique about marihuana. Evaluations of the effects of low or modest doses of any psychoactive drug have to deal with these issues. The situation with marihuana is a bit different in that so many people have uncritically accepted the belief that the drug has specific effects on behavior and experience and that these can be readily identified. Such an erroneous model has been accepted by both users and professionals and is continually reinforced by the media. Although at high doses such a model may be valid, at the doses most youthful drug users are discussing there is ample evidence that the effects of psychoactive drugs on behavior and experience are often to a great extent independent of the drugs' pharmacological effects.

The investigator who depends on a subject reaching a certain "social high" does so at the risk of studying behavior in a non-specific psychological state rather than the pharmacological effects of a given dose of marihuana. Moreover, in addition to the important and complex problems associated with specifying the delivered doses of THC the researcher must also in a sense quantify the dose of "interpersonal stimulation" and the dose of "subject expectation" if he is going to relate in any meaningful way marihuana induced physiological changes to a given subjective state. (Author's summary)

79. Jones, R. T. The marihuana induced "social high": A note of caution. Proceedings of the Western Pharmacology Society, 1971, 14, 21-25.

The attitude and expectations of the subject, and the social setting are important determinants of the subjective effects produced by marijuana. This report describes two experiments on the effects of these

factors. The first experiment involved 100 experienced marijuana smokers, mainly students, aged 21-30 years. Previous marijuana use varied from having smoked a total of 5 cigarettes to smoking 5 cigarettes/day with a mean of 4/month. Subjects were tested on 2 occasions. They smoked marijuana on one occasion and placebo on the other. They were told they might be given inactive marijuana. The treatments were assigned in a double-blind balanced order. The marijuana was from the California Bureau of Narcotic Enforcement, grown in Western Mexico. (Journal abstract)

80. Jones, R. T. Tetrahydrocannabinol and the marijuana-induced social "high," or the effects of mind on marijuana. Annals of the New York Academy of Sciences, 1971, 191, 155-165.

For abstract, see ref. no. 78.

81. Jones, R. T., & Stone, G. C. Psychological Studies of marijuana and alcohol in man. Psychopharmacologia, 1970, 18, 108-117.

Regular users of marijuana (cannabis sativa) were given smoked and orally administered marijuana, a placebo, or alcohol. They were unable to distinguish between smoked marijuana and the tetrahydrocannabinol-free placebo. The oral administration of tincture of cannabis produced primarily dysphoric symptoms and was similar to alcohol in this respect. The smoked marijuana altered pulse rate, time estimation, and EEG, but had no effect on a measure of field dependence or on a digit symbol substitution task. Both drugs appeared to be mild intoxicants in a laboratory setting. Consideration of the dose, prior experience with drugs, setting, and possible cross tolerance of marijuana and alcohol are important in evaluating the significance of the clinical effects. (Journal abstract)

82. Joubert, L. Letter: Marihuana. Science, 1969, 163, 1144-1145.

Critique of A. T. Weil & others. (Ref. no. 196)

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83. Kalant, H. Letter: Marijuana and simulated driving. Science. 1969, 166, 640.

Critique of A. Crancer, Jr. & others. (Ref. no. 36)

84. Kalant, O. J. An interim guide to the cannabis (marijuana) literature. Toronto: Addiction Research Foundation, 1968. (18 references, $3.50)

Thoroughly and critically annotated, but limited in scope, this bibliography covers 11 books and 7 review articles written during the period 1900-1966. The introduction is a synopsis of the history of the cannabis plant, derivation of its name, history of its use, presumed known effects, and sociologic versus psychophysiologic interpretations of its use. This precedes a novel section on the history of cannabis literature. The author concludes, "Despite the periodic upsurges of concern in the literature, it should be stressed that both the quantity and quality of studies of Cannabis are far below other drugs of similar type. This is especially noteworthy when its long standing use by the peoples of many countries is considered." The more well-known references included are: Hemp-drug addiction in India (Chopra & Chopra, 1939); The marijuana problem in the city of New York (Mayor's Committee on Marijuana, 1944); and The marijuana papers (Solomon, 1966). Of the total number of references, two are French, one is German, and one is Spanish--with only this last having been translated into English. Includes a combined subject-author index. (M. L. Pagel)

85. Keeler, M. H. Adverse reaction to marihuana. American Journal of Psychiatry, 1967, 124, 674-677.

Case reports of panic, gross confusion, depersonalization, depression, and paranoia following the use of marihuana in a student population are presented. These reports of adverse reaction are interpreted in the light of the expected reaction to the drug, other reports of adverse reaction, and the nature of the populations studied.

All but two of the 11 individuals reporting adverse reactions considered the benefits to far outweigh the unfortunate aspects and planned to continue use of the drug. (Journal abstract)

86. Keeler, M. H. Marihuana induced hallucinations. Diseases of the Nervous System, 1968, 29, 314-315. (a)

Of 56 marihuana users interviewed, six reported that during the drug syndrome they experienced hallucinations of color, design, or marked changes in perspective with their eyes open. Nineteen of the 56

reported some type of visual imagery with their eyes closed.

The literature cited and the case reports presented suggest that marihuana can evoke the type of hallucination usually associated with LSD and mescaline. (W. H. Rickles, Jr. & others)

87. Keeler, M. H. Motivation for marihuana use: A correlate of adverse reaction. American Journal of Psychiatry, 1968, 125, 386-390. (b)

Curiosity and conformity were cited as the principal reasons for initial marihuana use by 54 users interviewed. Twenty-six of the 40 who became regular users sought an experience combining tension relief with mild stimulation of thought. Fourteen of the 40 continuing users desired some type of psychotomimetic experience. Desire for psychotomimetic experience was correlated with higher dosage and higher incidence of psychopathology. (Journal abstract)

88. Keeler, M. H., Reifler, C. B., Liptzin, M. B. Spontaneous recurrence of marihuana effect. American Journal of Psychiatry, 1968, 125, 384-386.

Four individuals reported the recurrence, in a drug-free state, of unusual visual or somatic sensations previously experienced during marihuana reaction. Two of the four were distressed by these recurrences. Such events should be distinguished from the recurrence of clinical psychopathology first experienced during marihuana reaction and from reports of nonspecific heightening of perception subsequent to marihuana use. (Journal abstract)

89. Keup, W. Letter: Marihuana. Science, 1969, 163, 1144.

Critique of A. T. Weil & others. (Ref. no. 196)

90. Kielhotz, P., Hobi, V., Ladewig, D., Miest, P., & Richter, R. An experimental investigation about the effect of cannabis on car driving behaviour. Pharmakopsychiatrie Neuropsychopharmakologie, 1973, 6, 91-103.

By a double-blind test 54 volunteers were tested for their car driving capacity before and after taking delta-9-tetrahydrocannabinol at doses of 350, 400 or 450 micrograms per kilogram bodyweight and a placebo. The medical examination of those in the THC-group revealed injected conjunctival vessels, increased pain sensitivity as well as an increase of pulse rate and a rise in diastolic blood pressure. Five effects were especially prominent in the self-assessment of the THC-group: (1) an increase of psychosomatic complaints; (2) a definite inward turning followed by an impairment of attention and concentration

capacities; (3) change in motor functions, co-ordination and associations; (4) resulting from a discrete alienation experience, an impaired "coming to terms" with the environmental situation; (5) as well dysphoric as euphoric experience reactions.

These self-assessments agreed with the results of experimental studies of a number of variables in driving and personality features. The study demonstrates that THC, because of its inhibiting as well as stimulating effects, influences psychological and physiological functions important for driving in a manner different from alcohol. It changes and worsens adaptability as the mentioned aspects of driving behaviour, especially if there is simultaneous stress. At times when rapid decisions and actions are required, prolongation of reaction time and an increased frequency of wrong and inadequate responses were observed. The smooth automatism, which is so important in car driving, was disturbed. The degree of impairment depended on the initial personality structure and individual effects of the drug on basic mood and attitude. The intensity of THC was still measureable five to six hours after intake. The subjects still noticed a definite effect eight to ten hours after intake, 24 hours later still a discrete after-effect. (Journal abstract)

91. King, A. B., & Cowen, D. L. Effect of intravenous injection of marihuana. Journal of the American Medical Association, 1969, 210, 724-725.

Two cases of severe illness occurred following the intravenous injection of marihuana. Injection produces immediate severe body tremors with tachycardia, nausea, vomiting, and diarrhea. Diffuse aching pains, hypotension, non-oliguric renal failure, thrombocytopenia, and leukopenia follow. In the cases we saw, all changes have been reversible. (Journal abstract)

92. Kiplinger, G. F. Manno, J. E., Rodda, B. E., & Forney, R. Dose-response analysis of the effects of tetrahydrocannabinol in man. Clinical Pharmacology & Therapeutics, 1971, 12, 650-657.

Motor and mental performance, as measured by an extensive battery of tests, were impaired in a dose-dependent fashion. Increases in pulse rate, conjunctival injection, and ratings on subjective questionnaires of mood and sensation were also dose-dependent. (Coy W. Waller & others)

93. Klonoff, H. Marijuana and driving in real-life situations. Science, 1974, 186, 317-324.

It is evident that the smoking of marijuana by human subjects does have a detrimental effect on their driving skills and performance in a restricted driving area, and that this effect is even greater under normal conditions of driving on city streets. The effect of marijuana

on driving is not uniform for all subjects, however, but is in fact bi-directional: whether or not a significant decline occurs in driving ability is dependent both on the subject's capacity to compensate and on the dose of marijuana. For those subjects who improved their performance, the explanation may lie in overcompensation and possibly the sedative effect of the drug.

Whereas the street portion of this study approximated normal driving conditions, it should be emphasized that the context of the driving experience even on city streets was experimental. The design of this study provided maximal safeguards in terms of a dual control vehicle and a driver observer; in addition, the subjects were professionally screened and, with rare exception, they were emotionally stable. Given the experimental setting and set, the safeguards, and the nature of the study sample, idiosyncratic behavior that might occur under normal driving conditions would be less likely to occur in a study such as this.

Other identified factors might lead to more stringent conclusions regarding the effects of marijuana on driving. The first is night driving, which may be more stressful. But an even more important unanswered question is the cumulative effect of alcohol and marijuana on driving (64 percent of the study sample reported using alcohol in combination with marijuana before driving). Third, the doses of marijuana used in this study were within the range of social marijuana usage; more heroic doses might be taken before driving. Fourth, the effect of marijuana on reactions and decisions during high speed is still another unknown.

What are the recommendations that emerge from this study? Driving under the influence of marijuana should be avoided as much as should driving under the influence of alcohol. More investigation is urgently required--and high priority should be given to studies that approximate normal conditions of driving and in which alcohol and marijuana are administered to the same subjects. (Author's summary)

94. Kochar, M. S., & Hosko, M. J. Electrocardiographic effects of marihuana. Journal of the American Medical Association, 1973, 225, 25-27.

The electrocardiograms of seven young men were studied to determine the effects of Δ-9-tetrahydrocannabinol (THC), the most psychoactive component of marihuana. Two doses of THC, 200 μg/kg of body weight and 300 μg/kg, were given orally to each subject at a three-day interval, and placebo was administered between the two doses of THC. After the small dose of THC, only two of the seven subjects showed electrocardiographic changes, but after the large dose, six manifested increased heart rate, two developed S-T-segment and T-wave changes, and one had premature ventricular contractions. No electrocardiographic changes occurred after the placebo was administered. Marihuana may affect the heart, and its repeated use may have a cumulative effect. (Journal abstract)

95. Kurke, M. I. Letter: Drugs, laws, Human Factors Society, & you. Human Factors Society Bulletin, 1975, 18(10), 5.

Critique of study done by Salvendy & Mc Cabe as professionally and ethically questionable. (Ref. no. 158)

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96. Le Dain, G., Campbell, I. L., Lehmann, H., Stein, J. P., Bertrand, M. A. (Eds.). Cannabis: A report of the commission of inquiry into the non-medical use of drugs. Ottawa: Information Canada, 1972, (426 pages, $3.00)

A report submitted to the Minister of National Health and Welfare by the Commission of Inquiry into the Non-Medical Use of Drugs. It offers a thorough discussion of Cannabis and its effects with a twenty page section on experiments on Cannabis and alcohol; legal and illegal sources and distribution; patterns and extent of use; the constitutional and international framework of the law on Cannabis, legislation and law enforcement; and conclusions and recommendations. An extensive listing of references and bibliographies is given along with an index. (Coy W. Waller & others)

97. Le Dain, G., Campbell, I. L., Lehmann, H., Stein, J. P., Bertrand, M. A. (Eds.). Final report of the commission of inquiry into the non-medical use of drugs. Ottawa: Information Canada, 1973. (1148 pages, $7.95)

An impressive culmination of four years of research effort,

The Commission's research program consisted of some 120 projects.... In addition, there was a variety of miscellaneous investigations which were not formally classified as separate projects. The areas covered by the research program include: chemical and botanical factors; physiological, psychological and behavioural effects; extent and patterns of use; motivation and related factors; social context; mass media; legal and illegal sources and distribution; legal controls; law enforcement and the correctional system; medical treatment and related services; innovative services; information and education; prevention and alternatives to drug use; and the response of various institutions, including government, to non-medical drug use. The methods employed in our research include critical review of technical and scientific literature and current investigations, surveys and interviews, participant observation, human pharmacological experiments, and chemical analysis of illicit drugs.... Since a separate final report was devoted to cannabis, the present report has concentrated on the other psychotropic drugs, and in particular, on the opiate narcotics, the amphetamines and the strong hallucinogens. There has also, however, been considerable emphasis on other psychotropic drugs which are the subject of non-medical use, and in particular, on alcohol and tobacco. We have not attempted to carry the discussion of cannabis, in any significant degree, beyond the Cannabis Report, which must remain our final word on that subject. (Commission's introduction, partial)

98. Lemberger, L., Crabtree, R., Rowe, H., & Clemens, J. Tetrahydrocannabinols and serum prolactin levels in man. Life Sciences, 1975, 16, 1339-1343.

Administered Δ^9-tetrahydrocannabinol (THC), 11-OH-Δ^9-THC, or placebo to 6 casual marihuana smokers in a double-blind, crossover study. Δ^9-THC and 11-OH-Δ^9-THC produced marked pharmacologic and psychologic effects (tachycardia, increased symptom score, and psychologic high). In contrast to effects produced by many other centrally acting drugs, the acute administration of these cannabinoids was devoid of any significant effect on prolactin secretion as determined by monitoring changes in serum prolactin levels. (Journal abstract)

99. Lemberger, L., Silberstein, S. D., Axelrod, J., & Kopin, I. J. Marihuana: Studies on the disposition and metabolism of delta-9-tetrahydrocannabinol in man. Science, 1970, 170, 1320-1322.

Δ^9-Tetrahydrocannabinol (the major active component of marihuana) administered intravenously to normal human volunteers persists in plasma for more than 3 days (half-life = 56 hours). Its metabolites appear in plasma within 10 minutes after administration and persist along with the precursor compound. Δ^9-Tetrahydrocannabinol is completely metabolized in man, and the radioactive metabolites are excreted in urine and feces for more than 8 days. (Journal abstract)

100. Lemberger, L., Tamarkin, N. R., Axelrod, J., & Kopin, I. J. Delta-9-tetrahydrocannabinol: Metabolism and disposition in long-term marihuana smokers. Science, 1971, 173, 72-74.

Radioactively labeled delta-9-tetrahydrocannabinol (Δ^9-THC) administered intravenously to chronic marihuana smokers disappeared from the blood plasma with a half-life of 28 hours as compared to 57 hours for nonusers of marihuana. Apparent volumes of distribution did not significantly differ between the two groups. Within 10 minutes after administration of Δ^9-THC, 11-hydroxy-Δ^9-THC is present in the plasma of nonusers and chronic users. This metabolite was also present in urine and feces of nonusers and long-term marihuana smokers. In addition, polar metabolites were excreted in urine and feces of both groups for more than 1 week. (Journal abstract)

101. Lemberger, L,. Weiss, J. L., Watanabe, A. M., Galanter, I. M., Wyatt, R. J., & Cardon, P. V. Δ^9-tetrahydrocannabinol: Temporal correlation of the psychological effects and blood levels after various routes of administration. New England Journal of Medicine, 1972, 286, 685-688.

^{14}C-delta-tetrahydrocannabinol (^{14}C-Δ^9-THC) was administered to 12 long-term marihuana smokers intravenously, orally or by inhalation, and the drug's disposition, excretion and psychologic effects compared. Over 90 per cent of the dose was absorbed after oral administration, the psychologic effects and plasma levels of metabolites of Δ^9-THC peaked at three hours. After inhalation, the peak psychologic "high" ranged from 10 to 140 minutes (average peak "high" of 70 minutes), correlating well with the peak plasma levels of metabolites of Δ^9-THC. The percentage of administered radioactive dose excreted in urine during the first day was similar after oral and intravenous routes, but the proportion of radioactivity recovered from feces (seven days) exceeded that in the one-day urine output.

The fact that the psychologic effects in response to pharmacologic doses of ingested or inhaled ^{14}C- Δ^9-THC were temporally correlated with plasma levels of the metabolites of the drug supports the hypothesis that these metabolites are active compounds. (Journal abstract)

102. Lewis, E. G., Dustman, R. E., Peters, B. A., & Beck, E. C. The influence of Δ^1-tetrahydrocannabinol on human visual evoked response. Newsletter for Research in Mental & Behavioral Sciences, 1973, 15, 43-46. (a)

Examined the effects of known oral dose levels of tetrahydrocannabinol (THC) on the visual evoked response of frequent and occasional marihuana smokers. Recordings were made from 10 male and 10 female 21-34 year olds, equally divided into groups of those who reported smoking marihuana at least 3 times/week (frequent) and those who used it not more than 2 times/month (occasional) in the past 3-4 years. Results indicate that marihuana produced significant changes in the electrical activity of the brain but only at high doses. It is concluded that the efficiency of the nervous system is reduced by THC. (Psychological Abstracts, R. S. Albin)

103. Lewis, E. G., Dustman, R. E., Peters, B. A., & Beck, E. C. The effects of varying doses of Δ^9-THC on the human visual and somatosensory evoked response. Electroencephalography & Clinical Neurophysiology, 1973, 35, 347-354. (b)

Orally administered Δ^9-tetrahydrocannabinol (Δ^9-THC) to 21-34 year olds who reported using marihuana occasionally or frequently (N = 10 males and 10 females). All subjects received .2, .4 and .6mg/kg Δ^9-THC and a placebo in a randomized sequence. Visual and somatosensory evoked responses were recorded from frontal, central, and occipital scalp 4 hours after drug administration. No consistent evoked response differences were found between the frequent and occasional user groups. The most prominent finding was the consistency with which Δ^9-THC slowed the latency of evoked response waves while producing relatively little

change in amplitude. It was thus hypothesized that Δ^9-THC acts to increase the threshold of cortical and subcortical neurons or neural networks involved in producing the evoked response rather than to selectively inhibit brain stem centers. Δ^9-THC produced no evidence of an excitatory action on the CNS. In those infrequent instances in which Δ^9-THC did produce a change in evoked response amplitude it was always a decrease. Unlike alcohol, Δ^9-THC did not alter hemispheric asymmetry. (Journal summary)

104. Lewis, M. F., & Ferraro, D. P. Flying high: The aeromedical aspects of marihuana (Report No. FAA-AM-73-12). Federal Aviation Administration, Office of Aviation Medicine, Department of Transportation, Washington, D.C., December 1973. (NTIS No. AD-775 889)

A summary of the discussions from the CAMI Symposium on Aeromedical Aspects of Marihuana is presented. The invited panel discussed the legal aspects of marihuana use and aviation, the experiences of military aviation, and the acute and chronic effects of the drug. For civil aviation, the panel proposed: (1) a 12-16 hour period between marihuana use and work in aviation, (2) no radical changes in FAA policy towards marihuana use, and (3) additional research on aeromedical aspects of marihuana. (Authors' abstract)

105. Lieberman, C. M., & Lieberman, B. W. Marihuana: A medical review. New England Journal of Medicine, 1971, 284, 88-90.

Reviews the history of marihuana use and the characteristics of the cannabis plant. Marihuana is analyzed chemically, and physiological effects discussed. The acute physical effects of marihuana intoxication in man include conjunctival injection, tachycardia, and minor oscillations in blood pressure. The acute psychic effects of a marihuana "high" represent, for most smokers, a benign, ego-syntonic experience. Sufficiently high doses could cause a temporary psychotic reaction in almost anyone. Although neither tolerance nor withdrawal symptoms result from chronic recourse to marihuana in humans, psychologic dependence has been reported. (Psychological Abstracts, S. R. Diamond)

106. Linton, P. H., Kuechenmeister, C. A., White, H. B., & Travis, R. P. Marijuana: Heart rate and EEG response. Research Communications in Chemical Pathology and Pharmacology, 1975, 10, 201-214.

Changes in heart rate (HR) and EEG under different doses of marihuana, Δ^9THC [delta-9-tetrahydrocannabinol], were examined. The experimental design differed from earlier investigation in that the human subjects were kept constantly alert by being involved in problem-solving tasks. HR and EEG recordings were analyzed by time-locked evoked

averaging techniques. The presentation of each problem task was under computer control and depended on the subjects' return to base-line level of physiological functioning. EEG and HR patterns were significantly related to dose levels and to the different tasks being performed. Marihuana interfered very little with cognitive functions except for impairing short-term memory at all dose levels of marihuana. The procedure described for the measurement of subjects' HR and EEG changes while they were alert as they responded to various perceptual stimuli, and for the analyses of these changes, offered a particularly powerful technique for looking at subtle drug treatment effects not only of marihuana but also of other drugs. (Biological Abstracts)

107. Lomonaco, T. [Use of drugs by flight personnel during a flight] (Ital). Minerva Medica, 1973, 64, 940-945.

Many drugs are now in common use, both with and without the backing of a prescription. Aeronautical physicians must assess the side-effects of such drugs with reference to their influence on aircrew. The side-effects of commonly ingested drugs are described and their negative influence on the physical activity of crew members is assessed. In-flight prohibition of such drugs is urged. (Journal abstract)

M

108. Malit, L. A., Johnstone, R. E., Bourke, D. L., Kulp, R. A., Klein, V., & Smith, T. C. Intravenous Δ^9-tetrahydrocannabinol: Effects on ventilatory control and cardiovascular dynamics. Anesthesiology, 1975, 42, 666-673.

Δ^9-Tetrahydrocannabinol (THC), the active component of marijuana, was studied to determine whether it might be used for preanesthetic medication. Ten healthy subjects received THC intravenously in logarithmically spaced incremental doses. Four subjects received a total cumulative dose of 135 µg/kg and four others, 201 µg/kg. Two of the ten subjects discontinued the study because of anxiety reactions. Ventilatory minute volume at a controlled elevated CO_2 tension, 48 ± 22 (SD) torr, changed minimally with THC, -0.49 l/min/50 percent increase in dose. THC shifted the ventilatory response to CO_2 2.7 torr dextrad at 20 l/min without a change in slope. Dose-related tachycardia was the most marked cardiovascular effect. Heart rates increased to more than 100/min in five of six subjects. Cardiac index increased from 4.04 ± 0.62 l/min/m^2 before THC to 6.92 ± 2.34 l/min/m^2 after 134 µg/kg. Mean arterial pressure increased slightly, and total peripheral resistance fell. The cardiovascular changes suggest beta-adrenergic stimulation. Intense mental effects and anxiety prohibited higher THC doses. (Journal abstract)

109. Manno, J. E., Kiplinger, G. F., Haine, S. E., Bennett, I. F., & Forney, R. B. Comparative effects of smoking marihuana or placebo on human motor and mental performance. Clinical Pharmacology & Therapeutics, 1970, 11, 808-815.

Motor and mental performance was tested after smoking a placebo cigarette and after smoking a marihuana cigarette calibrated to deliver 5 mg. of delta-9-tetrahydrocannabinol. A significant decrement in all motor performance tests and in five of nine mental performance tests was observed after the marihuana cigarette. We were not able to detect any cannabinols in the blood or urine of subjects who smoked the marihuana. (Journal abstract)

110. Manno, J. E., Kiplinger, G. F., Scholz, N., & Forney, R. B. The influence of alcohol and marihuana on motor and mental performance. Clinical Pharmacology & Therapeutics, 1971, 12, 202-211.

Twelve healthy male volunteers smoked marihuana cigarettes calibrated to deliver 0, 2.5, or 5 mg. of delta-9-tetrahydrocannabinol (THC) either alone or in combination with either a plain fruit-flavored beverage or the same beverage containing 15 ml. of alcohol per 50 pounds

of body weight. Each subject received all 6 possible combinations in a double-blind randomized block experiment. The parameters measured were four pursuit meter tests (motor performance), nine delayed auditory feedback tests (mental performance), pulse rate, conjunctival injection, and subjective effects (Cornell Medical Index). It was found that the high dose of THC produced significant impairment in performance of both mental and motor tasks and that alcohol induced an additional effect. There was little difference between the response to 2.5 and 5.0 mg. of THC on these parameters. Conjunctival injection, pulse rate, and subjective effects were dose dependent and alcohol was additive. (Journal abstract)

111. Martz, R., Sonday, F. L., Rodda, B. E., Brown, D. J., Kiplinger, G. F., & Forney, R. B. The effect of marihuana on auditory thresholds. Journal of Auditory Research, 1972, 12, 146-148.

Eight men aged 21-26 years in an experimental study smoked either placebo marihuana cigarettes or marihuana cigarettes prepared to deliver 50 μg/kg Δ-9-THC. Significant increases from control were found in both heart rate and positive responses on the Cornell Medical Index. Although 7 subjects felt that their hearing acuity was improved, changes in Bekesy thresholds from .125-8 Kc/s could not be clearly demonstrated. (Journal abstract)

112. Maugh, T. H., II. Marihuana: Does it damage the brain? Science, 1974, 185, 775-776. (a)

Examines the literature concerning the controversial possibility that marihuana may be a health hazard. Two objective conclusions may be reached from data accumulated over 5 years of research: (a) there is probably little or no damage associated with a single or a few uses of marihuana and (b) there is evidence that suggests danger from long-term heavy use of the drug. Concerning the latter, empirical data show that the psychoactive constituent of cannabis, tetrahydrocannabinol (THC), has a high affinity for brain and lipophilic tissue and will be absorbed and stored by them for long periods. It is contended that continued presence of THC in the brain produces the "amotivational syndrome": apathy and sluggishness in mental and phyical responses, flattening of affect, loss of interest in personal appearance, physical exhaustion, loss of time sense, difficulty with recent memory, and mental confusion. These symptoms have persisted in some individuals for as long as 24 months after withdrawal of the drug, and investigators have suggested that these individuals may have suffered irreversible brain damage. Observation of larger samples of heavy marihuana users is urged since the adverse effects are manifested in only a fraction of susceptible users. (Psychological Abstracts, B. McLean)

113. Maugh, T. H., II. Marihuana: The grass may no longer be greener. Science, 1974, 185, 683-685. (b)

Reports that research since 1969 has produced a growing body of evidence suggesting that the effects of marihuana use are cumulative and dose-related. It is stated that prolonged heavy use of marihuana (or less frequent use of hashish) is associated with 6 different types of potential hazard, including possible chromosome damage. (Psychological Abstracts)

114. Major's Committee on Marijuana. The marijuana problem in the city of New York. In D. Solomon (Ed.), The marihuana papers. Indianapolis: Bobbs-Merril, 1966. (Originally published, 1944)

An extensive report on the sociological, medical, psychological, and pharmacological aspects of marihuana. Although issued in 1944, this report still remains as one of the most impressive collections of factual finding in the whole body of scientific literature on marihuana. The report is presented in two sections as follows:

(1) A sociological study dealing with the extent of marihuana smoking and the methods by which the drug is obtained; in what districts and among what races, classes, or types of persons the use is most prevalent; whether certain social conditions are factors in its use; and what relation there is between its use and criminal or anti-social acts.

(2) A clinical study to determine by means of controlled experiments the physiological and psychological effects of marihuana on different types of persons; the question as to whether it causes physical or mental deterioration; and its possible therapeutic effects in the treatment of disease or of other drug addictions. (W. H. Rickles Jr. & others)

115. McCabe, G. P. Letter: Drugs, laws, Human Factors Society, & you. Human Factors Society Bulletin, 1975, 18(10), 6.

Author denies any professional or ethical misconduct on his part in study done with Salvendy (ref. no. 158). For criticisms of this study, see ref. nos. 34, 95, 119, & 166.

116. McCauley, C. R. Letter: Marihuana effects amid great expectations. Science, 1969, 165, 204.

A letter to the editor criticizing the experiment by Weil, et al. [ref. no. 196] because marihuana users were able to distinguish marihuana from placebo not only on the basis of taste but on the basis of the physiological reaction, the onset of which occurs rapidly and before the administration of the drug by smoking is completed. Weil answers the letter by acknowledging the shortcomings of the procedure and

discussing the difficulties of finding a placebo and then stating that regardless of the set of user subjects, the experiment showed that they were able to compensate fully for whatever marihuana does to brain function--at least in the tests used. (W. H. Rickles, Jr. & others)

117. McGlothlin, W. H., & West, L. J. The marihuana problem: An overview. American Journal of Psychiatry, 1968, 125, 370-378. (Also in H. Gadlin & B. E. Garskof (Eds.), The uptight society: A book of readings. Belmont, California: Brooks/Cole, 1970.)

Current knowledge of the use of marihuana, its physical and mental effects, and its relation to crime and to other drug use are reviewed. The authors feel that a re-appraisal of the social and legal policies regarding marihuana use is needed to resolve the crisis brought about by the rapid increase in its use, despite the severe penalties prescribed for violation of the marihuana laws. (Journal abstract)

118. Meacham, M. P., Janowsky, D. S., Blaine, J. D., Bozzetti, L. P., Jr., & Schorr, M. Letter: Effects of marihuana on flying ability. Journal of the American Medical Association, 1974, 230, 1258.

In a letter to the editor, Meacham reports on the preliminary findings of D. S. Janowsky & others (see ref. nos. 74 & 75).

119. Meister, D. Letter: Drugs, laws, Human Factors Society, & you. Human Factors Society Bulletin, 1975, 18(10), 6.

As Human Factors Society President, Meister addresses the questions of ethical responsibility raised by Kurke in a critique of the study done by Salvendy & McCabe. (Ref. no. 158)

120. Melges, F. T., Tinklenberg, J. R., Hollister, L. E., & Gillespie, H. K. Marihuana and temporal disintegration. Science, 1970, 168, 1118-1120.

High oral doses of marihuana extract, calibrated for content of 1(-)-delta-1 tetrahydrocannabinol, significantly impaired the serial coordination of cognitive operations during a task that required sequential adjustments in reaching a goal. This disintegration of sequential thought is related to impaired immediate memory. (Journal abstract)

121. Melges, F. T., Tinklenberg, J. R., Hollister, L. E., & Gillespie, H. K. Temporal disintegration and depersonalization during marihuana intoxication. Archives of General Psychiatry, 1970, 23, 204-210.

In an experiment using double-blind controls, 8 normal men were given a placebo and 20-, 40-, and 60-mg marihuana extract calibrated for content of tetrahydrocannabinol. On a cognitive task and a subjective inventory it was found that the oral doses of marihuana extract induced subjects to confuse past, present, and future and to lose their goal-directedness. This temporal disintegration was related to increases in depersonalization for all 8 subjects. For each subject studied separately, changes in temporal disintegration correlated positively with changes in depersonalization, indicating that these processes were dynamically interrelated. Overall findings indicate that the fragmentation of temporal experience and the accompanying depersonalization were euphorigenic. Euphoria often took place when subjects felt less concerned about future outcomes relevant to maintaining their usual sense self. (Journal summary)

122. Mendelson, J. H. Behavioral and biological concomitants of chronic marihuana use (Final report, Contract No. DADA17-73-C-3082). McLean Hospital, Belmont, Massachusetts, August 1974. (NTIS No. AD-A009 083/7GA)

The behavioral and biological concomitants of chronic marihuana use were studied in a group of heavy and casual users under controlled research ward conditions. Assessments of operant work performance revealed that most subjects showed no impairment in motivation to work for money reinforcement even when they smoked a large number of marihuana cigarettes. Some dose-related decrement in performance was noted following days of heavy marihuana smoking; however, these decrements were probably not biologically significant. No significant changes were observed in a large series of physical and laboratory assessments following marihuana smoking. The only significant changes were those related to vital capacity (lung function) and these changes may be more closely related to the processes of smoking per se than to the pharmacological actions of marihuana. (Government Reports abstract)

123. Mendelson, J. H., Rossi, A. M., & Meyer, R. E. (Eds.). The use of marihuana: A psychological and physiological inquiry. New York: Plenum Publishing Corp., 1974. (202 pages, $14.95)

Reporting on the first controlled research ward study of marihuana acquisition and chronic use in man, this multidisciplinary volume presents new experimental data on the physiological and psychological effects of marihuana. In controlled laboratory situations, leading research workers examine the effects of marihuana on motivation, aggression, group interaction, problem-solving, mood states, memory and time estimation, and psychological reactions. (Publisher's abstract)

124. Miller, L.L. (Ed.). Marijuana: Effects on human behavior. New York: Academic Press, 1974. (406 pages, $29.50)

Contributors to this publication are prominent marijuana researchers. The 14 chapters are: (1) The logistics of marijuana research: Methodological, legal, and societal (H. Klonoff); (2) The marijuana controversy (A. Wikler); (3) Motor and mental performance with marijuana: Relationship to administered dose of Δ^9-tetrahydrocannabinol and its interaction with alcohol (J. E. Manno, B. R. Manno, G. F. Kiplinger, & R. B. Forney); (4) Marijuana and memory (C. F. Darley & J. R. Tinklenberg); (5) A model of attention describing the cognitive effects of marijuana (F. L. De Long & B. I.Levy); (6) Psychological and neurophysiological effects of marijuana in man: An interaction model (H. Klonoff & M. D. Low); (7) Cannabis: Neural mechanisms and behavior (L. L. Miller & W. G. Drew); (8) Marihuana and behavior: Human and infrahuman comparisons (L. L. Miller); (9) The long term effects of cannabis use (R. L. Dornbush); (10) Cannabis intoxication: The role of pharmacological and psychological variables (H. Cappell & P. Pliner); (11) Marijuana use and psychiatric illness (J. A. Halikas); (12) Marijuana use and the progression to dangerous drugs (E. Goode); (13) Marijuana and human aggression (J. R. Tinklenberg); and (14) Effects of marijuana on driving in a restricted area and on city streets: Driving performance and physiological changes (H. Klonoff).

Each chapter is outlined with the outline appearing in the table of contents as well as on the first page of each chapter--and includes a list of references. The book is indexed by subject. (M. L. Pagel)

125. Miller, L. L., & Drew, W. G. Marihuana (M)-induced impairment of recent memory (RM) and mental set shifting (MSS). Federal Proceedings, 1972, 31, 551. (Summary)

Twelve paid male volunteers were randomly assigned to smoke either placebo marihuana or M cigarettes calibrated to deliver 25 µg/kg Δ^9-THC. Cognitive testing was conducted in a 10 minute period starting 30 minutes after smoking began. M impaired certain aspects of RM functioning as measured by the Babcock Story recall-immediate recall, especially the total number of distortions. MSS was measured by the time required to complete a modified version of the Trail Making test. In Form A (Tm A), numbers, randomly distributed on the sheet, were serially connected with a blunt stylus, while in form B (Tm B), consecutively progressive numbers and letters (e.g. 1-A-2-B...) were connected. The Tm B - Tm A difference, in seconds, is taken as a measure of MSS. Tm B - Tm A differences were increased by M indicating difficulty in MSS. It is concluded that the Babcock Story recall, as a measure of RM, and the modified version of the Trail Making test, as a measure of MSS, are sensitive to the effects of very low doses of M.

126. Milstein, S. L., MacCannell, K., Karr, G., & Clark, S. Marijuana-produced changes in pain tolerance: Experienced and non-experienced subjects. International Pharmacopsychiatry, 1975, 10, 177-182.

The effect of marihuana and placebo on pain tolerance was compared in cannabis-experienced and naive subjects. A statistically significant increase in tolerance was observed after smoking marihuana. Although there was no statistically significant interaction between the drug effect and having had previous cannabis experience, there was a definite trend towards a greater increase in tolerance for the experienced (16%) compared to the naive group (8%). (Biological Abstracts)

127. Mirin, S. M., & McKenna, G. J. Combat zone adjustment: The role of marihuana use. Military Medicine, 1975, 140, 482-485.

Discusses the use of marihuana by American troops in Southeast Asia from the perspective of more recent clinical and laboratory data and the authors' 1971 visits to the Far East and Southeast Asia. Contrary to popular belief, the extent and pattern of use generally paralleled that seen in comparable civilian populations. Adverse consequences, in terms of both performance and psychological state, were relatively infrequent. Marihuana was often regarded and used as an external means of coping with anxiety and aggressive feelings. The drug was also used in part as an antidepressant and social lubricant. Its utility in this regard is examined from both a psychodynamic and psychosocial perspective. (Journal summary)

128. Mohan, H., Sood, G. C. Conjugate deviation of the eyes after Cannabis indica intoxication. British Journal of Ophthalmology, 1964, 48, 160-161.

An 18-year-old Hindu boy was examined. His eyes had become fixed in a dextroverted position and ocular movements were absent although fundi were normal. It is assumed that conjugate deviation of his eyes resulted from Cannabis indica intoxication and the effects of the drug lasted for 6 weeks. (W. H. Rickles, Jr. & others)

129. Moore, L. A., Jr. Marihuana (cannabis) bibliography, 1960-1968. Los Angeles: Bruin Humanist Forum, 1969. (825 references)

This non-annotated bibliography cites references on marijuana, hashish, LSD, alcohol, and various other drugs. A large number of the references are from foreign publications--not all of these are translated into English. Topic areas covered by the bibliography include a large number of articles on college student use and abuse of drugs; social aspects of drug usage; addiction, drug legislation; drug-

related crime; philosophical treatises on drug use--i.e. Huxley, Laing, Leary; the pharmacology of marijuana; United Nations and United States government reports on drugs; marijuana as a medicant; reviews, overviews and other available sources for references. (M. L. Pagel)

130. Moskowitz, H., & McGlothlin, W. Effects of marihuana on auditory signal detection. Psychopharmacologia, 1974, 40, 137-145.

Twenty-three male subjects were tested for auditory signal detection under a no-treatment condition, and smoke marihuana conditions containing 0, 50, 100 and 200 μg Δ^9-THC per kg body weight. Signal detection was measured under conditions of concentrated attention, in which the subject reported the presence or absence of a tone in a 3-second noise burst; and divided attention, where the subject also repeated a series of six digits which were presented simultaneously with the noise burst. No differences were found between the no-treatment and placebo conditions. Significant dose-dependent impairment of signal detection resulted for the marihuana conditions under both concentrated and divided attention. Application of signal detection theory indicated that impaired performance was due to a decline in sensitivity (d'), independent of changes in subject criteria (beta). There was also some indication of change in criteria--a greater tendency for erroneous reporting of a signal when it was not present. (Journal abstract)

131. Moskowitz, H., Sharma, S., & McGlothin, W. Effect of marihuana upon peripheral vision as a function of the information processing demands in central vision. Perceptual & Motor Skills, 1972, 35, 875-882.

Examined detection of peripheral light stimuli with 12 males under 4 treatment levels of smoked marihuana (0, 50, 100, and 200 μg/kg). Marihuana severely impaired detection performance and the decrement was linearly related to dose. Information-processing demands from the central fixation light did not affect the degree of impairment. (Journal abstract)

132. Moskowitz, H., Sharma, S., & Schapero, M. Comparison of the effects of marijuana and alcohol on visual functions. In M. F. Lewis (Ed.), Current research in marijuana. New York: Academic Press, 1972.

This paper reports three sets of experiments designed to compare alcohol and marijuana effects on visual functions. The first set of experiments examined drug influences on the detection of peripheral lights under three levels of central visual information processing demands. The second set studied drug effects on autokinesis and the third set examined drug effects on visual acuity, dark adaptation and ocular motor control. (Authors' abstract)

133. Moskowitz, H., Shea, R., & Burns, M. Effect of marihuana on the psychological refractory period. Perceptual & Motor Skills, 1974, 38, 959-962.

Reaction times to an auditory stimulus (RT_1) and a subsequent visual stimulus (RT_2) were measured for 12 subjects under three levels of smoked marihuana. Marihuana impaired responses; effect was larger on RT_2 than on RT_1. However, delays on RT_2 are longer than would be predicted in terms of the psychological refractory period. (Journal abstract)

134. Myers, S. A., & Caldwell, D. F. The effects of marihuana on auditory and visual sensation: A preliminary report. The New Physician, 1969, 18, 212-215.

Problems of setting up pharmacological experiments for marihuana are discussed. The clinicians preferred to study marihuana in social context rather than in pharmacological context, i.e., use marihuana cigarettes rather than pure THC, allow subjects to select end point and smoke as they normally would. Data showed no significant difference in performance after drug intake. (Coy W. Waller & others)

N

135. Nahas, G. G. When friends or patients ask about marihuana. Journal of the American Medical Association, 1975, 233, 79-80.

Author reviews briefly several studies on marijuana and calls for more thorough and complete research. "Because of these scientific findings, even those who claimed that marihuana was harmless are now heeding the danger signals. They are calling for longitudinal, epidemiological studies of marihuana similar to those that took 40 years to ascertain the damaging effects of tobacco.... In any event, the idea that marihuana is harmless must be reviewed. For too long, with a near-total lack of scientific evidence, this notion has enjoyed a high degree of acceptance, with a complete disregard for both history and preventive medicine." (M. L. Pagel)

136. National Commission on Marijuana and Drug Abuse. Marijuana: A signal of misunderstanding. New York: New American Library, 1972. (233 pages, $1.25)

History, patterns of use, and degree of social acceptance in different countries are reviewed; psychological and social effects depend partly on the attitude of society. In the U.S. marihuana use may be leveling off, particularly in adolescents; peer use is the strongest correlate of use. Behavioral, physiological and neurochemical effects in animals and metabolic and toxicological findings are reviewed. Questions of an amotivational syndrome, teratogenicity, and brain damage have not been resolved, but clinical results indicate impaired driving ability, decreased intraocular pressure, activity in metabolites, and respiratory problems. (Coy W. Waller & others)

137. National Institute on Drug Abuse. Marihuana and health: Third annual report to Congress from the Secretary of Health, Education, and Welfare (DHEW. Pub. No. (ADM) 75-132). Washington, D.C.: U.S. Government Printing Office, 1974. (89 references, $2.00)

Presents the 1973 report on the health consequences of cannabis use. Topics include the extent, patterns, and social context of use in the US; marihuana use in other countries; preclinical research; effects in man; and future research directions. (Psychological Abstracts)

138. Negrete, J. C. Psychological adverse effects of cannabis smoking: A tentative classification. Canadian Medical Association Journal, 1973, 108, 195-202.

This paper stresses the need for an early definition and description of the "deviant" cannabis smoker in North America. Attention is called to the fact that on this continent heavy smokers have not yet been separated as "problem" users for other smokers.

A comprehensive review of possible psychological adverse effects of the drug is made. The following classification is suggested: (a) Severe intoxication, (b) Pathological intoxications, (c) Acute cannabis psychoses, (d) Subacute and chronic cannabis psychoses, and (e) Residual conditions. (Author's summary)

139. Negrete, J. C. Relative value of various etiological factors in short lasting, adverse psychological reactions to cannabis smoking. British Journal of Addiction, 1973, 68, 221-229.

This study concerns short-lasting, severe emotional disturbances experienced while smoking moderate doses of Cannabis. An attempt of nosologic classification and a description of the most frequently mentioned etiological factors are made. A group of Adverse Reaction cases was compared with Normal Reaction controls; the results indicate that individual psychological vulnerability is the most important item accounting for such reactions. (Author's summary)

P

140. Paton, W. D. M. Cannabis and its problems. Proceedings of the Royal Society of Medicine, 1973, 66, 718-721.

For medical practice, it is the habitual user of cannabis, in whom effects build up, who is likely to present the main problem. Unfortunately it is not yet possible to define what rate of consumption represents 'habitual' use. Possible impairment of liver microsomes prompts caution in drug dosage. The possibility of postural hypotension should be understood, as also the irritant effects of the smoke. The tachycardia has been insufficiently explored; since in resting subjects it may reach 160/minute, and is (anecdotally) stated to increase with exercise, study of habitual users under mild physical stress is desirable. In all studies of cannabis, the slowness of its kinetics must be taken into account; the characteristic changes take time to develop, and on ceasing to take the drug an equivalent time is required before visual effects, time sense, 'muddliness' and concentration return to normal. If it is desired to try to treat the habit, it is useful to suggest that the subject should try to abandon the drug just for a limited period; but the period should be 2-3 months. (Author's summary)

141. Paton, W. D. M. Pharmacology of marijuana. Annual Review of Pharmacology, 1975, 15, 191-220.

Reviews specific literature since 1972 covering the main new studies of the biochemistry of cannabis metabolites, of their cellular and toxicological effects, and effects on the human organism. (Psychological Abstracts)

142. Payne, R. J., & Brand, S. N. The toxicity of intravenously used marihuana. Journal of the American Medical Association, 1975, 233, 351-354.

While no unanimity of opinion exist regarding the risk to physical health from smoking marihuana, we have seen four cases that demonstrate clearly that intravenous usage is hazardous. The severity of the multisystemic involvement is dose-related. On initial examination, signs of most severe overdosage included fulminant gastroenteritis, hypoalbuminemia, toxic hepatitis confirmed by serial biopsy, acute renal failure, electrolyte disturbances, leukocytosis, anemia, and a relative thrombocytopenia. In three patients who shared a common needle, gingivostomatitis also developed. (Journal abstract)

143. Perez-Reyes, M., Timmons, M. C., & Wall, M. E. Long-term use of marihuana and the development of tolerance or sensitivity to tetrahydrocannabinol. Archives of General Psychiatry, 1974, 31, 89-91.

A group of 15 subjects who have used marihuana infrequently and a group of 15 subjects who have used the drug frequently were intravenously infused with Δ^9-tetrahydrocannabinol.

In spite of the marked differences in marihuana use, the groups did not differ significantly in the amount of Δ^9-THC necessary for its effects to be perceived, to accelerate the heart 25% above the base line levels, the total dose administered, the maximum level of "high," the maximum heart rate acceleration, and the heart rate acceleration observed 15 minutes after the beginning of the infusion.

This is evidence that marihuana, as currently used by young Americans does not produce tolerance or sensitivity to its effects. (Journal abstract)

144. Pillard, R. C., McNair, D. M., & Fisher, S. Does marijuana enhance experimentally induced anxiety? Psychopharmacologia, 1974, 40, 205-210.

Two experiments tested whether laboratory stressors induce greater or more variable anxiety in marijuana-intoxicated subjects. In experiment 1, marijuana and placebo subjects were shown a motion picture film depicting dental procedures. In experiment 2, they were subjected to the stress of giving a short videotaped speech. We found no significant difference between marijuana and placebo subjects in anxiety response to these two stressors, as measured by a mood adjective rating scale. (Journal abstract)

R

145. Rafaelsen, L., Christrup, H., Bech, P., & Rafaelsen, O. J. Effects of cannabis and alcohol on psychological tests. Nature, 1973, 242, 117-118.

This report deals with tests of attention and short-term memory, and of subjective and objective ratings of degree and kind of intoxication. Part of a combined study. (See ref. no. 146)

146. Rafaelsen, O. J., Bech, P., Christiansen, J., Christrup, H., Nyboe, J., & Rafaelsen, L. Cannabis and alcohol: Effects on simulated driving. Science, 1973, 173, 920-923.

The effects of cannabis and alcohol on simulated car driving were studied. Cannabis resin containing 4 percent Δ^1-tetrahydrocannabinol was administered orally in three doses equivalent to 8, 12, and 16 milligrams of that component. Alcohol was given orally in one standard dose of 70 grams. Both cannabis and alcohol increased the time required to brake and start, whereas alcohol increased while cannabis decreased the number of gear changes. An effect of dosage on response was observed with cannabis. (Journal abstract)

147. Renault, P. F., Schuster, C. R., Freedman, D. X., Sikie, B., de Mello, D. N., & Halaris, A. Repeat administration of marihuana smoke to humans. Archives of General Psychiatry, 1974, 31, 95-102.

Tolerance to marihuana was investigated in two experiments. Four men were given smoke from 435 mg of marihuana (1.5 Δ-9-tetrahydrocannabinol [THC]) twice a day for ten days preceded and followed by three days of a placebo twice a day; three additional men were given a higher dose (2.8% THC).

Time estimation was disrupted on the higher dose and gradually improved. Heart rate increase did not show tolerance. Enhancement of postural cardiovascular responses, when present, decreased in duration in three subjects. One developed a brief toxic psychosis, another pneumonitis of uncertain etiology. Dysphoric and psychotoxic effects were evident as a cumulative effect of the high dose.

Three additional men were given the low dosage once a week for six to eight weeks, and time estimation and heart rate changes were similar to those seen with frequent administration at that dose. Tolerance, recently reported in man, probably requires more frequent administration or a different dosage than the schedules employed here. (Journal abstract)

148. Renault, P. F., Schuster, C. R., Heinrich, R., & Freeman, D. X. Marijuana: Standardized smoke administration and dose effect curves on heart rate in humans. Science, 1971, 174, 589-591.

A spirometer was used to deliver marihuana and placebo smoke to human subjects. This procedure produced linear dose-effect curves on heart rate and replicable dose effects in individual subjects. No differences were observed between experienced and inexperienced smokers in responsiveness to heart rate increases produced by marihuana. (Journal abstract)

149. Rickles, W. H., Jr., Chatoff, B., & Whitaker, C. Marijuana: A selective bibliography, 1924-1970. Los Angeles: Brain Research Institute Publications, 1970. (192 references)

This annotated bibliography is divided into six major catagories: (1) Cannabis and its origin, (2) Pharmacological effects, (3) Clinical studies and case reports, (4) Therapeutic assessment, (5) Sociological and legal issues, and (6) Reviews and overviews.

In the first section, authors and titles are listed alphabetically under each relevant subject area with a reference number to the main bibliographic list. The second section is the complete alphabetical listing of all references. (M. L. Pagel)

150. Rickles, W. H., Jr., Cohen, M. J., Whitaker, C. A., & McIntyre, K. E. Marijuana induced state-dependent verbal learning. Psychopharmacologica, 1973, 30, 349-354.

Human, male subjects from our light marijuana usage category were given paired associate learning under either placebo or marijuana intoxication. A 2 X 2 experimental design used to test for dissociation effects. Marijuana intoxicated subjects needed significantly more trials to reach criterion learning than subjects under placebo. Testing of recall, ten days later, demonstrated a significant state-dependent effect. The results were discussed in terms of state-dependent theory and the effects of central nervous system active drugs on learning models. (Journal abstract)

151. Rodin, E. A., Domino, E. F., & Porzak, J. P. The marihuana-induced "social high": Neurological and electroencephalographic concomitants. Journal of the American Medical Association, 1970, 213, 1300-1302.

Ten healthy freshman medical students who had previous extensive experience with marihuana smoking were allowed to inhale the compound in the laboratory until they had reached their usual "high." The observed overall effects were mild or miminal. In the electro-

encephalogram, there occurred a slight but statistically significant shift toward slower α-frequencies. There were no significant changes in cerebral evoked responses. Results of the neurological examination remained normal. Vibratory sense appreciation improved slightly. Mental status examination showed a slight decrease in intellectual efficiency, some excess jocularity, and a slight loosening of associations. Bender-Gestalt drawings were executed slightly more poorly after drug inhalation than before. It is concluded that the subjective pleasure and relaxation which are experienced as a result of marihuana smoking are accompanied by a very slight decrease in highest cortical functions. (Journal abstract)

152. Roffman, R. A., & Sapol, E. Marijuana in Vietnam: A survey of use among Army enlisted men in the two southern corps. International Journal of the Addictions, 1970, 5, 1-42.

An anonymous, multiple-choice questionnaire was administered to 628 Army enlisted men (ranks E-2 through E-6) selected indiscriminately at a replacement center where they were processing for return to the United States. Forty-four incomplete or admittedly falsified questionnaires were discarded resulting in a remaining sample of 584 respondents. The majority of the respondents indicated that they had never smoked marijuana. Of the 31.7% (N = 185) who had, 61.1% (N = 113) first smoked marijuana after coming to Vietnam. Approximately three-quarters of the users (N = 141) only experimented with the drug; one-quarter (N = 44) were considered to be heavy marijuana users. Marijuana smoking was considered as experimental or "casual" when it occurred on 20 or fewer occasions. "Heavy" use was manifested by smoking on 21 or more occasions. These findings, when compared with the results of civilian studies performed in the same time period, reveal that marijuana use occurred to no greater extent in the specific military population studied than in many civilian university communities or among the comparable age group in the general population of San Francisco.

The heavy marijuana user was unique in terms of his being younger, of less rank, and being more likely to have close friends who use marijuana than the casual user. He is further differentiated by being more likely to have used marijuana before coming to Vietnam, using it earlier in his tour in Vietnam, being more likely to use other drugs illicitly, having been the subject of at least one minor disciplinary action, and intending to use marijuana in the future.

The soldier who first used marijuana before coming to Vietnam is distinguished by virtue of his being more likely to have been reared in a large city, having more Negroes among his numbers, having less rank, being more likely to use other drugs illicitly, using marijuana earlier in his tour, and intending to use marijuana in the future.

Corroboration of the findings of other studies occurred with reference to incidence of use, frequency of use, race, marital status, religion, and use of alcohol. (Journal abstract)

153. Rossi, A. M. Marijuana effects on short-term memory and time estimation. Proceedings of the 81st Annual Convention of the American Psychological Association, 1973, 8, 1029-1030. (Summary)

A unique aspect of the design of this study made it possible to obtain marijuana related assessments both when subjects were and were not aware that their performance would be related directly to acute marijuana use. A comparison of "aware" (special) and "unaware" (daily) marijuana related assessments indicated subjects displayed less impairment on a short-term memory task when they were aware that their performance would be related to marijuana. This indicates that the reported acute deleterious effect of marijuana on short-term memory may not be a reflection of direct impairment of neuronal memory systems, but rather a reflection of what a person chooses to attend to while under the influence of the drug. Evidence that attention can be maintained under the influence of marijuana is provided by the results of several studies.

Both casual and heavy users made significantly shorter estimates of time while under the influence of marihuana than at other times. These results provided experimental confirmation of a frequently reported effect of the drug. A finding in the present study that has not been reported previously is that nonmarijuana related time estimations progressively increased over the extended marijuana smoking period. This change in time estimates was in opposite direction from the acute effect of the drug suggesting that the change represents a compensating or rebound reaction to the acute effect. Compensatory reactions commonly occur as a result of induced changes in neuronal activity levels. Thus, the indications of a compensatory reaction in the present results suggest that the acute effect of marijuana on time perception is produced by direct action of delta 9 THC within the central nervous system.

No significant differences occurred in time estimations made during "aware" and "unaware" marijuana related assessments. This similarity in performance under both conditions is consistent with the interpretation that the acute effect of the drug on time perception is brought about by direct action on neuronal systems.

154. Roth, W. T., Galanter, M., Weingartner, H., Vaughan, T. B., & Wyatt, R. J. Marijuana and synthetic Δ^9-trans-tetrahydrocannabinol: Some effects on the auditory evoked response and background EEG in humans. Biological Psychiatry, 1973, 6, 221-233.

Studied the effects of smoking cigarettes containing marihuana, placebo, or synthetic Δ^9-trans-tetrahydrocannabinol (THC) on the auditory evoked responses (AER's) and background EEG's of 12 young male chronic users. Components of the AER to both frequent and infrequent sound bursts were decreased in amplitude with marihuana, especially in

the first few minutes of the stimulation period. There was also initially more alpha power in the EEG with marihuana. A 10-mg dose of the THC showed effects intermediate between placebo and marihuana, although the marihuana cigarettes contained an equal amount of THC. Several parameters of spontaneous activity, measured after stimulation by Fourier analysis of occipital and vertex leads, failed to differentiate the 3 conditions. (Journal abstract)

155. Roth, W. T., Tinklenberg, J. R., Kopell, B. S., & Hollister, L. E. Continuous electrocardiographic monitoring during marihuana intoxication. Clinical Pharmacology & Therapeutics, 1973, 14, 533-540.

The EKG was continuously recorded in 10 normal subjects during marihuana and placebo administration. NIMH marihuana was administered in cigarettes calibrated to a delta-9-tetrahyrocannabinol content of 20 mg. Automated methods of data analysis were used to scan the EKG records for cardiac arrhythmias and to plot graphs of pulse rate and average T wave amplitude computed every 20 seconds over sessions lasting from 2 to 4 hours. Only 5 ventricular premature contractions occurred in all of the sessions; they were not related to marihuana intoxication. The marihuana-induced tachycardia had a mean of 127.6 beats per minute with a latency of 17.8 minutes from the onset of smoking to maximum tachycardia. T wave changes were slight and did not correspond to other effects of marihuana. We suggest that syncopal episodes associated with marihuana intoxication are not associated with cardiac arrhythmias, but rather with orthostatic or vasovagal reactions combined with inhibition of compensatory vascular reflexes. (Journal abstract)

156. Roth, W. T., Tinklenberg, J. R., Whitaker, C. A., Darley, C. F., Koppell, B. S., & Hollister, L. E. The effect of marihuana on tracking task performance. Psychopharmacologia, 1973, 33, 259-265.

Gave 37 18-22 year old males a 5-minute paced contour tracking task before and after receiving brownies containing either placebo or marihuana calibrated to a Δ^9-tetrahydrocannabinol content of 20 mg. The error patterns of placebo subjects and marihuana subjects were compared. After marihuana there was an increase in total errors as measured by the standard deviation ($p < .01$) and the mean deviation ($p < .02$) error scores. Although marihuana is reputed to create a fluctuating effect, under the conditions of this experiment the variability of error scores between successive 15-second time periods in the marihuana group was not significantly greater than in the placebo group. In addition the marihuana deficit did not show significant time trends during the task. (Journal abstract)

S

157. Salvendy, G. Letter: Drugs, laws, Human Factors Society, & you. Human Factors Society Bulletin, 1975, 18(10), 6.

Senior author defends his study (ref. no. 158). For criticisms, see ref. nos. 34, 95, 119, & 166.

158. Salvendy, G., & McCabe, G. P., Jr. Marijuana and human performance. Human Factors, 1975, 17, 229-235.

Four groups of 10 subjects each, representing different levels of marijuana usage, performed two different psychomotor tasks. One group had never smoked marijuana; one group had smoked marijuana previously but had stopped. The other two groups consisted of habitual smokers of marijuana--one smoked a placebo, and the other smoked marijuana just prior to performing the psychomotor tasks. Consistent patterns of inferior performance were found for the marijuana users on both manipulative and coordination skills. (Journal abstract)

159. Salvendy, G., & McCabe, G. P., Jr. Marijuana and human productivity. Proceedings of the 17th Annual Meeting of the Human Factors Society. Santa Monica, California: Human Factors Society, October 16-18, 1973. (Summary)

Four groups (nonsmokers, previous smokers, habitual smokers--placebo and habitual smokers of marijuana) of 10 subjects each, performed three psychomotor tasks (one-hole test, rotary pursuit and hand dynamometer). The results indicate a consistent pattern of inferior performance for the marijuana users on manipulative and coordination skills but not for strength attributes.

160. Schaefer, C. F., Gunn, C. G., & Dubowski, K. M. Letter: Marihuana dosage control through heart rate. New England Journal of Medicine, 1975, 293, 101.

Expands upon the concept of using the heart rate response as a means of marihuana dosage control and suggests using the rise in heart rate to same end by first establishing a subject's baseline heart rate and then monitoring the rise in rate while smoking marihuana to a predetermined increment, i.e., 20 per cent above baseline. (M. L. Pagel)

161. Scher, J. Letter: The marihuana habit. Journal of the American Medical Association, 1970, 214, 1120.

Medical comment based solely on author's observation of patients he has seen clinically. Describes similarities of these patients in terms of symptoms, length of use prior to seeking assistance, general characteristics, and motivation of use. (M. L. Pagel)

162. Shafer, R. P. Marihuana: A signal of misunderstanding. New York: New American Library, 1972. (233 pages, $1.25)

Official report of the National Commission on Marihuana and Drug Abuse. For abstract, see ref. no. 136.

163. Sharma, S., & Moskowitz, H. Effect of marihuana on the visual autokinetic phenomenon. Perceptual & Motor Skills, 1972, 35, 891-894.

The effects of 4 dose levels of marihuana upon the visual autokinetic phenomenon were examined in 12 subjects. The amount of apparent movement was greatly increased under the two highest doses. Possible hazards associated with vehicle operation at night under marihuana are noted. (Journal abstract)

164. Sharma, S., & Moskowitz, H. Effects of two levels of attention demand on vigilance performance under marihuana. Perceptual & Motor Skills, 1974, 38, 967-970.

Twelve subjects under marihuana performed a modified version of the Mackworth clock-vigilance task with two levels of attention and response demands. Similar continuous declines in signal detections over time were found for both experimental conditions indicating that the vigilance decrements induced by marihuana (200 mcg/Kg. B.W.) are unrelated to arousal level. (Journal summary)

165. Sharma, S., & Moskowitz, H. Marijuana dose study of vigilance performance. Proceedings of the 81st Annual Convention of the American Psychological Association, 1973, 8, 1031-1032. (Summary)

In a recent visual signal detection study, Moskowitz, Sharma, and McGlothlin (1972) found that errors in peripheral light detections were significantly greater in the second half of a 1-hour session than in the first half. This suggests that there may be vigilance related decrements under marijuana. Typically, investigations of vigilance involve the ability of a subject to detect changes in stimulus events over relatively long periods of sustained attention (Frankmann & Adams, 1962). While many studies have shown decrements in perceptual performance under marijuana, there appears to be insufficient examination of the interactions of marijuana and vigilance.

This study tested the effects of marijuana on a sustained attentional task using a modified Mackworth "Clock" technique (Mackworth, 1961). Both overall differences between three levels of active marijuana and a placebo treatment, as well as effects on time-related changes in performance, were examined.

166. Snyder, H. L. Letter: Drugs, laws, Human Factors Society, & you. Human Factors Society Bulletin, 1975, 18(10), 5-6.

As Human Factors Society Journal Editor, Snyder addresses the questions of ethical responsibility raised by Kurke in a critique of the study done by Salvendy & McCabe. (Ref. no. 158)

167. Solomon, D. (Ed.). The marihuana papers. Indianapolis: Bobbs-Merrill, 1966; also, New York: Signet, 1968.

An extensive and comprehensive book covering the many questions concerning cannabis. The book contains numerous articles by many authors and is divided into three parts as follows: (1) Historical, sociological, and cutural papers; (2) Literary and imaginative papers; and (3) Scientific papers. (W. H. Rickles, Jr. & others)

168. Spector, M. Acute vestibular effects of marijuana. Journal of Clinical Pharmacology, 1973, 13, 214-217.

The objective of this study was to define any vestibular dysfunction resulting from the acute use of marijuana. Electronystagmography was utilized to record gaze nystagmus, tracking a pendulum, spontaneous nystagmus, positional nystagmus, and rotation of the torsion swing. Results were compared between heavy users and infrequent users, conducting the study in a double-blind fashion and demonstrating the effects of a placebo, an ordinary dose of marijuana, and a heavy dose. Results indicated no vestibular effect. (Author's summary)

169. Spector, M. Chronic vestibular and auditory effects of marijuana. Laryngoscope, 1974, 84, 816-820.

The objective of this study was to ascertain vestibular dysfunction and impaired hearing resulting from the chronic use of marijuana. Electronystagmography was utilized to record gaze nystagmus, tracking a pendulum, spontaneous nystagmus, positional nystagmus, and rotation on the torsion swing. Pure tone thresholds were also obtained. The results of these tests, for normals and heavy marijuana users, were then compared. The comparison of these results showed significant changes in vestibular functions for chronic marijuana users in: (a) decrease in maximum amplitude on torsion swing; (b) increase in incidence of nystagmus in two or more supine positions; and (c) decrease in speed of slow component on caloric tests. (Author's summary)

T

170. Talbott, J. A., & Teague, J. W. Marihuana psychosis. Journal of the American Medical Association, 1969, 210, 299-302.

A clinical syndrome of acute psychosis associated with Cannabis derivatives and environmental stress has been observed in 12 soldiers seen in Vietnam. Each case was characteristic of acute toxic psychosis with organic features and ten cases had paranoid features as well. Factors unique to Vietnam and combat situations seem pertinent; treatment was conservative and supportive. (Journal abstract)

171. Tart, C. T. Marihuana intoxication: Common experiences. Nature, 1970, 226, 701-704.

As a guide to future experiments, the chief experiential effects of marijuana have been elucidated with the help of a detailed questionnaire given to seasoned marijuana users whose experiences, it seems, are almost entirely pleasant. (Journal abstract)

172. Tart, C. T. On being stoned: A psychological study of marijuana intoxication. Palo Alto: Science & Behavior Books, 1971. (333 pages, $7.95)

This book describes what people actually feel when they smoke marijuana--the effects on vision and hearing, social interaction and sexuality, perception of time and space, thinking processes and memory, spiritual experiences and ESP, and many other effects. (Author's summary)

173. Tart, C. T., & Kvstensky, E. Marijuana intoxication: Feasibility of experimental scaling of level. Journal of Altered States of Consciousness, 1973, 1, 15-21.

Experienced users report psychological factors can markedly alter their response to marijuana, so quantity of drug ingested may not be an adequate measure of the psychological construct of the "level of intoxication" of the altered state of consciousness produced by marijuana. Users show a highly reliable set of experiential criteria for scaling level, suggesting the usefulness of this psychological approach as an alternative and/or supplement to a pharmacological approach. (Journal abstract)

174. Tashkin, D. P., Shapiro, B. J., & Frank, I. M. Acute pulmonary physiologic effects of smoked marijuana and oral Δ^9-tetrahydrocannabinol in healthy young men. New England Journal of Medicine, 1973, 289, 336-341.

Acute pulmonary physiologic effects of smoked marijuana and oral Δ^9-tetrahydrocannabinol were investigated in 32 healthy, experienced male marijuana smokers. After smoking of marijuana assayed at either 1 or 2 percent Δ^9-tetrahydrocannabinol, specific airway conductance increased immediately, reached peak levels at 15 minutes and was still significantly elevated at 60 minutes. In contrast, specific airway conductance decreased after both tobacco smoking and deep-breathing maneuvers that simulated marijuana smoking. Inhalation of 1250 µg of isoproterenol caused specific conductance to rise to less than 60 per cent of the average peak increase observed after 2 per cent marijuana. After ingestion of 10, 15 and 20 mg of Δ^9-tetrahydrocannabinol in 12 subjects, specific airway conductance rose significantly as compared with placebo, attained peak levels three hours after ingestion and remained elevated for four to six hours. These findings indicate that both smoked marijuana and oral Δ^9-tetrahydrocannabinol cause definite dilation of the airways lasting as long as 60 minutes and six hours, respectively. (Journal abstract)

175. Thaler, S., Fass, P., & Fitzpatrick, D. Marihuana and hearing. Canadian Journal of Otholaryngology, 1973, 2, 291-295.

Many users of marihuana have reported an astonishing heightening of their subjective auditory acuity. In a pilot study, five volunteers--all with prior experience of marihuana--were subjected to a battery of audiometric tests in a normal state and during a marihuana "high." When tested for speech discrimination using a W-22 word list by live voice at 10dB SL, their pre-drug average was 65.1 per cent and their post-drug average was 92 per cent. With another W-22 word list, presented with ipsilateral white noise having a signal to noise ratio of -20dB, the pre-drug average discrimination ability was 31.6 per cent, the post-drug average 90.6 per cent.

A follow-up controlled study showed similar improvement in speech discrimination scores. A patient with abnormal discrimination scores was tested and also demonstrated improvement in post-drug scores. Further proposed studies are outlined. (Journal abstract)

176. Thomas, K. Flying high! Private Pilot, 1975, 10(12), 46-47.

Reviews the findings of the FAA symposium on the aeromedical aspects of marijuana (see ref. no. 104).

176. Thurlow, H. J. On drive state and cannabis: A clinical observation. Canadian Psychiatric Association Journal, 1971, 16, 181.

On the basis of these clinical observations, the following hypotheses were entertained: (1) that the lack of initiative was a relatively long-term effect of the excessive use of cannabis; (2) that other hallucinogens were producing these symptoms, and it is conceivable

that the student reporting use of cannabis alone had in fact had this agent 'cut' or mixed with other agents, without his knowledge; (3) that the above two hypotheses were misconstructions from the clinical data, and these symptoms were related to the use of hallucinogenic drugs only by coincidence.

Further research, rather than case-by-case clinical observation, would be of value in assessing the role of antidepressant medication generally in the management of lack of initiative without other stigmata of depression and in evaluating a possible amotivational syndrome resulting from the use of cannabis and/or other hallucinogenic drugs. (Journal summary)

178. Tinklenberg, J. R., Kopell, B. S., Melges, F. T., & Hollister, L. E. Marihuana and alcohol: Time production and memory functions. Archives of General Psychiatry, 1972, 27, 812-815.

In a double-blind study, time production tasks and clinical tests of memory function were performed by 15 normal subjects given placebo and "social" doses of alcohol (ethyl alcohol) and marihuana, calibrated to (-)-Δ^1-tetrahydrocannabinol. Using subjects as their own controls, it was found that, compared to alcohol and placebo, marihuana induced a significant under production of time intervals suggesting an acceleration of the internal clock. At these dose levels, there were no significant changes in memory funtion, but during marihuana intoxication some consistent trends toward greater impairment of tracking information over time were noted. (Journal abstract)

179. Tinklenberg, J. R., Melges, F. T., Hollister, L. E., & Gillespie, H. K. Marijuana and immediate memory. Nature, 1970, 226, 1171-1172.

Studies were made on subjects who had previously smoked marijuana to record effects of varying doses of marijuana on the immediate memory. The testing involved digit span tasks, requiring the subjects to repeat, forward or backward, a series of random digits. Results showed that smaller doses of THC impaired immediate memory and that larger doses do not significantly augment the impairment. The impairments on memory are brief and not always under volitional control. (Coy W. Waller & others)

180. Triesman, D. Logical problems in contemporary cannabis research. International Journal of the Addictions, 1973, 8, 667-682.

Discusses 4 error typologies in research studies of the effects of marihuana, the relationship of marihuana to further drug use, and the personality characteristics of users--nosological, nomological, psychological, and sociopathological. Problems in what defines use, outcome measures, and theoretically inappropriate sample populations are discussed. (Psychological Abstracts)

181. Truitt, E. B., Jr., & Braude, M. C. Preclinical pharmacology of marihuana. In R. J. Gibbins, Y. Israel, H. Dalant, R. E. Popham, W. Schmidt, & R. T. Smart. (Eds.), Research advances in alcohol and drug problems (vol. 1). New York: John Wiley & Sons, 1974.

Summarizing the current status of preclinical marihuana research is a particularly difficult task. Some persons active in the general field of drug abuse have watched this area hopefully looking for "solutions" to the problem of marihuana abuse based upon data indicative of possible dangers to health. Others knowledgeable in the difficulties of extrapolating animal data to humans have been less optimistic and more critical.

An extensive amount of data has now been acquired concerning the cannabinoid chemical constituents of the plant and its variability. The principal components of marihuana smoke have been identified and quantitated. Although much work is in progress on the characterization of other noncannabinoid smoke components, the publication of these data must be awaited.

The metabolic fate of the cannabinoids has now been traced through three or four stages of enzymatic reaction. The large number of metabolites now identified make it difficult to select any one in particular as characteristic of cannabis use, but a group of products with a carboxyl derivative at position 9 appearing in the urine and feces in free or conjugated states may form the basis of tests for detection of marihuana consumption. The hypothesis that 11-hydroxy-THC metabolites represent the active species within the body has been strengthened by recent evidence.

Acute and subacute studies have shown Δ^9-THC to be a drug with relatively low physical risk, and its effects on operant behavior and pharmacological functions have been found to be reversible.

Tolerance to some pharmacologic actions of THC has been demonstrated, but it is not yet known whether this is metabolic (distributional) or functional (neural change). Many pharmacological effects of THC have been identified; these include analgesic, anticonvulsant, hypotensive, antiglaucomic and antiasthmatic actions. However, none of these has received adequate therapeutic evaluation in animals or humans in comparison to standard therapy. (Authors' summary)

182. Turner, C. E., & Hadley, K. Preservation of cannabis. Journal of the American Medical Association, 1973, 223, 1043-1044.

Rebuttal to E. A. Rodin & others on the quality of marijuana supplied by the National Institute of Mental Health (NIMH) to experimenters.

U

183. United Nations Commission on Narcotic Drugs. The question of cannabis: Cannabis bibliography. (U.N. Document No. E/CN. 7/479) New York: United Nations, Sales Section, Publishing Service, 1965. (1860 references)

This bibliography covers a broad scope of the marijuana literature and research up to and including 1965. The bibliographies of Coy W. Waller and others (see ref. nos. 188, 189, 190 & 191) are intended to continue from where this bibliography ended. (M. L Pagel)

184. United States Government, The President's Commission on Law Enforcement and Administration of Justice. Task force report: Narcotics and drug abuse. Washington, D.C.: U.S. Government Printing Office, 1967.

An extensive review of drugs, drug abuse, existing laws and regulations, educational programs, and extent of current research. Among other things, the Commission recommends further research:

"The research should identify existing gaps in our knowledge of marihuana. A systematic review of the literature will be necessary. The plan should provide for an intensive examination of the important medical and social aspects of marihuana use. It should provide for surveys of the extent of marihuana use and of the nature of such use, i.e., occasional, periodic, or habitual. It should provide for studies of the pharmacology of marihuana and of its immediate and long-term effects." (W. H. Rickles, Jr. & others)

V

185. Vachon. L., Sulkowski, A., & Rich, E. Marihuana effects on learning, attention and time estimation. Psychopharmacologia, 1974, 39, 1-11.

Ten young, healthy male volunteers smoked a marihuana cigarette with 2.5% Δ^9-THC and a THC-exhausted placebo cigarette. The marihuana administration was associated with an increase in heart rate, elevation of systolic blood pressure, conjunctival reddening and specific airway conductance increase; time perception and Automated Digit Symbol Substitution Test performance were impaired. Diastolic blood pressure and attention measured by the Continuous Performance Task were not affected.

The placebo preparation produced a subjective pleasant "high" but no physiologic effects nor performance change. The "high" induced by the active preparation was often rated as unpleasant. (Journal abstract)

186. Volavka, J., Crown, P., Dornbush, R., Feldstein, S., & Fink, M. EEG, heart rate and mood change ("high") after cannabis. Psychopharmacologia, 1973, 32, 11-25.

Fourteen experienced marijuana users smoked marijuana, hashish, Δ^9-THC, and placebo. EEG, ECG and ratings of subjective feelings of "high" and pleasantness were recorded. EEG's were processed by period analysis.

In EEG, marijuana and Δ^9-THC increased the amount of alpha activity, and the three cannabis preparations decreased the amount of beta activity. The average frequency of alpha activity was decreased by 0.15-0.20 c/sec after marijuana, hashish and Δ^9-THC. The peak EEG effect occurred during the first 10 minutes after smoking; most of the changes disappeared after 40 minutes. Heart rate was increased by all the three drugs, and the effect persisted for the entire observation period (50 minutes).

Feelings of "high" were elicited by each cannabis preparation. This was not true of the pleasantness of the experience: only marijuana and hashish were perceived as more pleasant than placebo. Intensity of "high" increased with the amount of alpha activity, and decreased with the average alpha frequency. Pleasantness was unrelated to the EEG.

The "high" showed a linear increase with heart rate, whereas pleasantness of the experience was an inverted U-function of heart rate. (Journal abstract)

187. Volavka, J., Dornbush, R., Feldstein, S., Clare, G., Zaks, A., Fink, M., Freedman, A. M. Marijuana, EEG, and behavior. Annals of the New York Academy of Sciences, 1971, 191, 206-215.

Chronic and acute doses of marijuana were smoked by male subjects, and EEG, behavioral, and cardiovasular changes noted. Heart rate increased, psychomotor performance was impaired, and an increase in alpha activity associated with a reduction in theta and beta bands were found. Both physiological and behavioral responses were dose related. (Coy W. Waller & others)

W

188. Waller, C. W., & Denny, J. J. Annotated bibliography of marihuana, 1964-1970. University of Mississippi, School of Pharmacy, Research Institute of Pharmaceutical Sciences, University, Mississippi, 1971. (1112 references)

This annotated bibliography was designed to continue where the United Nations' The question of cannabis: Cannabis bibliography (ref. no. 183) ended. It contains entries in many different languages and is indexed by author and subject. Arranged alphabetically by senior author with editorials and certain other reports listed under "Anonymous," this bibliography lists--in a comprehensive manner--articles published in recognized scientific journals. (M. L. Pagel)

189. Waller, C. W., Denny, J. J., & Walz, M. A. Annotated bibliography of marihuana, 1971 supplement. University of Mississippi, School of Pharmacy, Research Institute of Pharmaceutical Sciences, University, Mississippi, 1972. (467 references)

Supplement to Coy W. Waller & others (ref. no. 188). Identical format.

190. Waller, C. W., Denny, J. J., Walz, M. A., Buelke, J., Guinn, M. M., & Turner, C. E. Annotated bibliography of marihuana, 1973 supplement. University of Mississippi, School of Pharmacy, Research Institute of Pharmaceutical Sciences, University, Mississippi, 1974. (523 references)

Supplement of Coy W. Waller & others (ref. nos. 188, 189, & 191). Identical format.

191. Waller, C. W., Denny, J. J., Walz, M. A., Buelke, J., & Turner, C. E. Annotated bibliography of marihuana, 1972 supplement. University of Mississippi, School of Pharmacy, Research Institute of Pharmaceutical Sciences, University, Mississippi, 1974. (457 references)

Supplement of Coy W. Waller & others (ref. nos. 188 & 189). Identical format.

192. Waskow, I. E., Olsson, J. E., Salzman, C., & Katz, M. M. Psychological effects of tetrahydrocannabinol. Archives of General Psychiatry, 1970, 22, 97-107.

Twenty milligrams of I-Δ^1-3, 4 trans-tetrahydrocannabinol, when administered to prisoner subjects in a neutral, controlled setting, resulted in a number of subjective effects. Drug subjects, as compared to placebo controls, tended to feel considerable somatic discomfort, some feelings of dizziness and weirdness, and being in a dreamlike floating state. They also reported feeling sleepy and "high." They felt that they were cognitively impaired, that they had experienced some visual changes, and that their time sense was altered.

Changes were also obtained on several physiological measures, with drug subjects showing an increased pulse rate, a slight but consistent drop in temperature, and a small drop in blood pressure. Several simple cognitive measures revealed little or no difference due to drug per se.

Many of the subjective effects were similar to those commonly attributed to marihuana. A major difference between the subjective effects in this study and those in previous studies of marihuana and THC was in the comparatively minor role played by feelings of elation and euphoria in the present study. Some of the variables that might account for this difference were considered, including subject population, nature of THC as compared to natural marihuana, subject expectations and drug history, and individual differences in personality and physiology. The setting variable investigated in the present study--the use of music--did not result in any significant effects. (Authors' summary)

193. Weil, A. T. Adverse reactions to marihuana: Classification and suggested treatment. New England Journal of Medicine, 1970, 282, 997-1000.

Adverse acute reactions to marihuana are infrequent, but physicians will see more of them as use of the drug increases and reaches new areas of society. Several very distinct types of reactions occur. In persons without a history of mental disorder who have never taken hallucinogenic drugs, marihuana may cause simple depressive reactions, panic reactions (most common) and toxic psychoses. In persons who have previously taken hallucinogens, marihuana may also trigger recurrences of hallucinogenic effects and may occasionally precipitate delayed psychotic reactions. Finally, in ambulatory schizophrenics, marihuana can cause atypical reactions, frequently marked by derealization. Most of these reactions are self-limited and benign but can be worsened by improper medical management. A few require psychiatric and psychopharmacologic intervention. (Journal abstract)

194. Weil, A. T. Letter: Marihuana. Science, 1969, 163, 1145.

Author replies to letters critical of his study. (ref. no. 196). For critiques, see ref. nos. 47, 53, 82, 89, & 116.

195. Weil, A. T., & Zinberg, N. E. Acute effects of marihuana on speech. Nature, 1969, 222, 434-437.

Persons high on marihuana have subtle difficulties in speech, primarily in remembering from moment to moment the logical thread of what is being said. Marihuana may interfere with retrieval of information from immediate memory storage in the brain. (Journal abstract)

196. Weil, A. T., Zinberg, N. E., & Nelsen, J. M. Clinical and psychological effects of marihuana in man. Science, 1969, 162, 1234-1242.

(1) It is feasible and safe to study the effects of marihuana on human volunteers who smoke it in a laboratory; (2) In a neutral setting persons who are naive to marihuana do not have strong subjective experiences after smoking low or high doses of the drug, and the effects they do report are not the same as those described by regular users of marihuana who take the drug in the same neutral setting; (3) Marihuana-naive persons do demonstrate impaired performance on simple intellectual and psychomotor tests after smoking marihuana; the impairment is dose-related in some cases; (4) Regular users of marihuana do get high after smoking marihuana in a neutral setting but do not show the same degree of impairment of performance on the tests as do naive subjects. In some cases, their performance even appears to improve slightly after smoking marihuana; (5) Marihuana increases heart rate moderately; (6) No change in respiratory rate follows administration of marihuana by inhalation; (7) No change in pupil size occurs in short term exposure to marihuana; (8) Marihuana administration causes dilation of conjunctival blood vessels; (9) Marihuana treatment produces no change in blood sugar levels; and (10) In a neutral setting the physiological and psychological effects of a single, inhaled dose of marihuana appear to reach maximum intensity within one-half hour of inhalation, to be diminished after 1 hour, and to be completely dissipated by 3 hours. (Authors' summary)

197. Wikler, A. Clinical and social aspects of marihuana intoxication. Archives of General Psychiatry, 1970, 23, 320-325.

Discusses the objective and observable aspects of the acute marihuana intoxication syndrome with reference to recent studies reported in the literature. A detailed description by W. Bromberg in 1934 of the progression of emotional and behavioral reactions during intoxication is quoted. Difficulties in identifying a uniform response pattern are attributed to 2 factors: (a) low concentrations of tetrahydrocannabinols in marihuana available in the United States, and (b) a number of predisposing conditions including personality make-up, expectations of the smoker, and the environmental setting. Failure to obtain cross-tolerance between tetrahydrocannabinol and LSD suggest that their site of action in

the brain is not the same. Reports of chronic intoxication and unrestricted smoking of marihuana under experimental conditions are reported. Public health and ideological aspects are considered. (Psychological Abstracts, P. McMillan)

198. Wolfson, E. A., & Louria, D. B. Marijuana: Tempest over pot. Contemporary Drug Problems, 1972, 1, 225-243.

Discusses various issues surrounding the use of marihuana. It is noted that cannabis has been used either as a medicine, as a psychedelic, or as hemp for about 3,000 yrs. Its source is a ubiquitous plant, Cannabis sativa, that grows under almost any climatic or soil conditions. Evidence indicates that marihuana causes some temporary impairment of coordination for complex motor activities, and that there is a distortion of depth and time perception. Although the incidence of psychotic or significant adverse reactions is small, there are some reports describing various mental abnormalities resulting from use of cannabis. The loss of motivation to marihuana habitues is probably related to psychological dependence on a mind-altering substance. Driving performance may be altered while under the influence of the drug. The crux of the public marihuana polemic rests on the issue of escalation from marihuana to more potent drugs. Options for public policy include (a) maintaining the present restrictions, (b) removing all restrictions, and (c) initiating a new system. (Psychological Abstracts, C. Kokkinis)

199. Woody, G. E. Visual disturbances experienced by hallucinogenic drug abusers while driving. American Journal of Psychiatry, 1970, 127, 683-686.

The author presents three case reports of young men with histories of hallucinogen usage who experienced visual disturbances while driving. None was "high" at the time of the experience. It is likely that the disturbances were due to recurrences of the acute effects of one or more hallucinogens. The author believes that use of these drugs may be introducing a new driving hazard. (Journal abstract)