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Effects of Tetrahydrocannabinol Content on Marijuana Smoking Behavior, Subjective Reports, and Performance

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HEISHMAN, S J, M L STITZER AND J E YINGLING *Effects of tetrahydrocannabinol content on marijuana smoking behavior, subjective reports, and performance* PHARMACOL BIOCHEM BEHAV 34(1) 173–179, 1989 —This study investigated the smoking topography of marijuana and its effect on heart rate, subjective reports, and cognitive/psychomotor task performance Male subjects (N = 12) with histories of moderate marijuana use smoked ad lib one cigarette containing 0, 1 3, or 2 7% Δ^9-THC on separate days Smoking topography measures revealed smaller puff and inhalation volumes and shorter puff duration for the high marijuana dose compared to the low dose No other smoking behavior differed between the active doses Heart rate was increased dose dependently over placebo levels Active marijuana also increased subjective reports of drug effect over placebo, but not dose dependently Significant memory impairment was observed on a forward and reverse digit span task, and performance was impaired on the digit symbol substitution task by the high, but not low, dose of marijuana Performance on a divided attention task was not affected by marijuana Thus, although subjects adjusted their smoking of cigarettes varying in THC content, dose-related effects of marijuana were obtained on several measures The observed differences and individual variation in smoking topography measures suggest that precise control of smoking behavior would improve the accuracy of marijuana dose delivery

Marijuana THC Smoking topography Subjective effects Performance effects Cognitive tasks Psychomotor tasks Human behavioral pharmacology

MARIJUANA is, by far, the most widely used illicit drug in the United States Estimates indicate that 62 million Americans have used marijuana at least once, and 18 million are current users (27) Virtually all of this marijuana use is by smoking. In studying the behavioral and subjective effects of marijuana, it is important to accurately control dosage. This is difficult with inhaled drugs because individual differences in smoking styles and/or attempts to adjust smoke inhalation can produce a wide range of delivered doses and thus make experimental results difficult to interpret

The most common means of manipulating marijuana dosage in experimental studies has been through the use of cigarettes varying in Δ^9-tetrahydrocannabinol (THC) content, typically from 1 to 4%, and placebo marijuana cigarettes from which the active cannabinoids have been chemically extracted The majority of studies investigating the effects of marijuana have allowed subjects to smoke the cigarettes ad lib or until a desired "high " Some of these studies reported orderly dose-related effects (2, 19, 24, 32), but others have not observed significant differentiation between active marijuana doses (25,34) In an attempt to standardize the dosing procedure, other studies have adopted a paced smoking procedure in which number of puffs, breath hold duration, or interpuff interval were controlled by the experimenter (5, 11, 13, 16, 30) Although these studies reported significant differences between active and placebo marijuana on a variety of physiological and behavioral measures, again, consistent orderly differentiation was not seen among the active marijuana doses

A possible explanation for this lack of dose differentiation is that individuals may adjust their smoking behavior according to the potency of the marijuana cigarette similar to that observed with ad lib smoking of tobacco cigarettes varying in nicotine yield (12,15) To our knowledge only three studies have examined the adjustment of smoking behavior by directly measuring the smoking topography of multiple active marijuana doses Cappell *et al* (3) found no significant differences in duration of lung exposure, puff number, puff duration, and interpuff interval between cigarettes containing 0 2, 0 4, and 0.8% THC. Perez-Reyes *et al* (31) also found no evidence for smoking adjustment using marijuana with greater THC concentrations (1.32, 1 97, and 2.54% THC). In contrast, Herning *et al* (14) reported that subjects took more puffs and inhaled greater volumes of air, a measure not assessed by the former studies, while smoking a 3.9% compared to a 1 2% THC cigarette The increased inhalation volume was interpreted as an

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attempt to dilute the marijuana smoke from the more potent cigarette However, slower burn characteristics of the high potency cigarette and the lack of standard instructions regarding when to puff and inhale during the breathing cycle may have confounded their results Thus, the issue of behavioral adjustment during marijuana smoking remains equivocal

We have begun to investigate the smoking of marijuana cigarettes using a detailed topographical assessment, which measures puff duration, puff volume, lung exposure duration, inhalation volume, and other behavioral aspects of smoking The purpose of this study was to examine smoking behavior across multiple doses of marijuana in order to characterize potential behavioral adjustments This study improved on previous studies by incorporating more topography measures, by using marijuana cigarettes that had similar burn characteristics, and by standardizing instructions to subjects concerning puff initiation during the breathing cycle In addition to measuring smoking topography, dose and time course effects of marijuana on heart rate, subjective reports, and cognitive/psychomotor tasks were assessed

METHOD

Subjects

Participants were 12 healthy, male community volunteers who were recruited through newspaper advertisements and ranged in age from 23 to 43 (mean = 31 1, SD = 5 8) Prior to participation, subjects were medically screened, provided a drug-free urine specimen, and gave written informed consent about the study and its risks They were paid $5 .0 per hour of participation At intake interview, subjects gave a detailed history of past and current drug use All reported past use of various illicit drugs, however, the majority of participants reported current use (within the past month) of four drugs caffeine (100% of subjects), alcohol (92%), marijuana (83%), and nicotine (67%) One subject reported infrequent current use of sedative/hypnotics, tranquilizers, and opiates (codeine) No one reported current use of amphetamines, inhalants, LSD, or PCP, and none of the subjects reported ever being treated for alcohol or drug abuse In terms of marijuana experience, all subjects reported previous use, and the 83% current users reported using it an average of 7 8 times per month, smoking an average of 2 1 joints on each occasion

Marijuana Cigarettes

Marijuana cigarettes were supplied by the National Institute on Drug Abuse (NIDA) Research Technology Branch Each cigarette was approximately 85 mm in length × 25 mm in circumference and weighed an average of 835 mg. As assayed by NIDA, cigarettes contained either 0 (placebo), 1 3, or 2 7% THC The 1 3 and 2 7% THC cigarettes were estimated to contain 12 and 21 mg THC, respectively To determine burn characteristics, five cigarettes from each of the three potencies were mechanically smoked in an apparatus providing continuous draw The length of time for 70 mm of plant material to burn was recorded Burn times (mean seconds ± S E M) were 683 ± 61, 683 ± 60, and 657 ± 43 for 0, 1 3, and 2 7% THC cigarettes, respectively There was no difference in burn time between the three potencies, $F(2,12) = 0\ 093$, n s The moisture content of the cigarettes was raised by humidification at room temperature over a saturated sodium chloride solution in a closed humidifier at least 12 hours before machine and human smoking

Experimental Procedures

Subjects were informed that the purpose of the study was to investigate how people smoke marijuana cigarettes and the effects of smoked marijuana on physiological responses, mood, and performance Before the first experimental session, subjects were trained in the smoking procedure to begin a puff at the end of an exhalation and to inhale immediately after each puff This served to standardize puffing and inhalation patterns across subjects and allowed valid and reliable measurement of puff and inhalation volumes. Subjects also practiced the computerized tasks until a stable level of performance was reached This smoking and task practice usually involved 2–4 hours over two days Subjects then participated in three experimental sessions from 9 00–11 00 a m , which were separated by at least 48 hours During each session, subjects smoked one cigarette containing either 0, 1 3, or 2 7% THC Doses of marijuana were administered in counterbalanced order according to a 3 × 3 Latin Square design under double-blind conditions Subjects remained at the laboratory until any residual drug effects had dissipated before they were released Subjects were instructed not to use drugs or alcohol within 24 hours, not to smoke marijuana within 48 hours, and not to smoke tobacco cigarettes within 1 hour of experimental sessions A breathalyzer and urine specimen were obtained before each session to assess and encourage compliance with these rules

Experimental sessions began by connecting subjects to the smoking topography measurement system and heart rate (HR) monitoring equipment Subjects then completed a 10-minute computerized battery of subjective reports and performance tasks The topography system was calibrated, followed by a 5-minute baseline HR measurement Immediately before smoking, the first of two expired air carbon monoxide (CO) samples was taken Subjects then smoked ad lib a single marijuana cigarette, they were stopped after the eighth puff was exhaled This resulted in complete or nearly complete pyrolysis of each cigarette Number of puffs was standardized in order to increase the probability of detecting compensatory adjustments on other topography measures The second expired air CO sample was obtained 2 minutes after smoking ended The battery of subjective reports and performance tasks was repeated at 5, 25, 45, and 65 minutes postmarijuana

Smoking Topography

The smoking topography system has been described in detail previously (35,36) Briefly, an Apple IIe microcomputer displayed and measured puffing and respiratory topography parameters in real time by simultaneously sampling at high rates the analog output of two peripheral systems a flowmeter cigarette holder modeled after an ADL Smoke Dosimeter (Arthur D Little, Inc , Cambridge, MA) and a respiratory inductive plethysmograph (Respitrace, Non-Invasive Monitoring Systems, Inc . Ardsley, NY)

Five puffing topography parameters were measured 1) interpuff interval, 2) puff duration, 3) puff volume, 4) maximum flow rate/puff, and 5) average flow rate/puff The flowmeter mouthpiece was connected to a pressure-sensitive switch that signaled puff onset and offset, the microcomputer timed the interval between switch onset and offset for the puff duration measure and the interval between switch offset and subsequent onset for interpuff interval A differential pressure transducer also connected to the flowmeter detected pressure changes during puffing, which were proportional to the rate of smoke flow through the flowmeter The computer integrated these flow rates over the duration of the puff to yield puff volume Puff volume measurement was calibrated each day by drawing 50 ml of air from an unlit cigarette with a syringe If puff volumes deviated from 50 ml by more than 6%, the system was adjusted The highest flow rate

during each puff was selected by the computer as the maximum flow measure. Average flow rate/puff was calculated by dividing puff volume by puff duration. In addition to these puffing topography parameters, the duration of smoking each cigarette was measured.

Inhalation volume and lung exposure duration were the two respiratory topography parameters measured. Two elastic cloth bands containing folds of multistrand wire were placed around the subject's thoracic and abdominal regions. The Respitrace system monitored the changing electrical signal produced by movement of the bands as subjects breathed and measured inhalation volume directly by comparing signal changes with those obtained during a presmoking calibration procedure using a known 800-ml volume of air. To control for differences in lung size, inhalation volumes were expressed as percent of vital capacity, a measure of lung size. Vital capacity (VC) was measured for each subject at the beginning of experimental sessions by having them take three deep breaths and exhaling as much as possible of the third breath into a water spirometer (Vitalometer; W. E. Collins, Inc., Braintree, MA). Mean VC for the 12 subjects was 4375 ml, ranging from 3075 ml to 6000 ml. Lung exposure duration was measured by the computer as the temporal interval from puff offset to the trough of the electrical signal generated by the end of the following exhalation.

TABLE 1

MARIJUANA SMOKING TOPOGRAPHY MEASURES*

	Placebo	1.3% THC	2.7% THC
General Characteristics			
Smoking duration (min)	5.9 (0.5)	6.9 (0.5)	6.6 (0.5)
Harshness rating†	4.4 (1.0)	5.8 (0.6)	6.8 (0.7)
Carbon monoxide (ppm)	14.6 (1.3)	14.7 (1.5)	13.0 (1.3)
Puffing Parameters			
Interpuff interval (sec)	52.3 (5.2)	56.5 (4.4)	54.2 (4.5)
Puff duration (sec)	1.9 (0.2)	2.1 (0.2)	1.7 (0.1)‡
Puff volume (ml)	63.9 (6.2)	67.9 (7.3)	59.1 (6.8)‡
Maximum flow rate (ml/sec)	45.4 (4.6)	48.5 (6.2)	48.0 (5.6)
Average flow rate (ml/sec)	34.2 (3.0)	33.6 (3.2)	34.8 (3.1)
Respiratory Parameters			
Inhalation volume (% VC)§	23.8 (2.8)	29.5 (4.4)	23.9 (3.5)‡
Lung exposure duration (sec)	11.2 (1.0)	11.3 (0.9)	10.4 (0.9)

*Data are means (N = 12) with 1 S.E.M. in parentheses. Carbon monoxide data are postsmoking minus presmoking differences.
†Response range was 0 to 10.
‡$p < 0.05$ versus 1.3% THC dose.
§VC = vital capacity.

Physiological Measures

Heart rate was measured throughout experimental sessions using an EKG amplifier (3 leads) and Schmitt trigger, which measured the temporal interval between successive R-waves to give an average HR each minute. Continuously updated HR values were displayed in real time on the video monitor during baseline, smoking, and nontask periods. Expired air CO samples were obtained by having subjects fully exhale, inhale and hold their breath for 20 seconds, and then exhale successively into two 1-liter polyvinyl bags. The CO content of the second bag, which contained alveolar air, was measured directly in parts per million using an Ecolyzer 2000 (Energetics Science, Inc., Elmsford, NY).

Subjective Report Measures

Nine subjective report questions appeared individually on the video monitor. Subjects answered the questions by using a joystick to move a pointer along a 15-cm visual analog line scaled from 0 (not at all) to 100 (extremely). The questions assessed the following: drug high, stoned, impaired performance, energetic, clear-headed, anxious, sluggish, confused, and relaxed. Immediately following smoking, subjects (N = 9) were asked to verbally rate the harshness of the marijuana cigarette on a scale from 0 (not harsh at all) to 10 (extremely harsh).

Performance Task Battery

Three computerized cognitive/psychomotor tasks were presented in the following order: digit span, divided attention, and digit-symbol substitution task (DSST). The digit span task was adapted from the Wechsler Adult Intelligence Scale (WAIS) and is a test of memory. On the video monitor, subjects were first presented a series of seven digit spans, beginning with a span of three digits and increasing by one to a span of nine digits. The randomly selected digits were presented one at a time at 1-second intervals. Immediately following the last digit of each span, subjects were given 15 seconds to enter the span of digits in the correct order of presentation using a numeric keypad. This was the forward component of the task. The reverse component involved presentation of another seven spans, beginning with two digits and increasing to eight, which subjects attempted to enter in reverse order. In each component, the number of correct spans and the longest correct span before an error was made were recorded.

The 2-minute divided attention task involved a pursuit tracking component located in the upper half of the video monitor and a visual search component in the lower half. In the tracking component, a diamond-shaped target (9-mm tall, 9-mm wide) moved randomly along a horizontal line. Subjects attempted to track it as closely as possible with a plus-sign cursor (7 × 7 mm), which they controlled with a joystick. The average distance off target was measured in pixels. Simultaneously, in the visual search component, subjects were required to search four numbers, which changed at random intervals, for a target number. Each of the four numbers was positioned at one corner of a 3 × 16.5-cm rectangle; the target number was positioned in the center and displayed continuously throughout the task. Each time the target number was identified, subjects pressed a button on the joystick manipulandum. The number of correct responses and the latency to respond were recorded.

The automated DSST, also adapted from the WAIS, has been described previously (20) and is considered a measure of associative and motor ability. Briefly, randomly selected digits appeared in the center of the video monitor. Subjects used a numeric keypad to reproduce a geometric pattern associated with the digit by using the digit-symbol code presented continuously at the top of the video screen. Each digit-symbol association constituted one response. The number of correct responses was recorded during the 2-minute task.

Data Analysis

The following smoking behaviors were analyzed using one-way analysis of variance: five puffing parameters (interpuff interval, puff duration, puff volume, maximum flow rate/puff, and average flow rate/puff), two respiratory parameters (inhalation volume and lung exposure duration), smoking duration, harshness rating, and CO boost. Puffing and respiratory parameters were

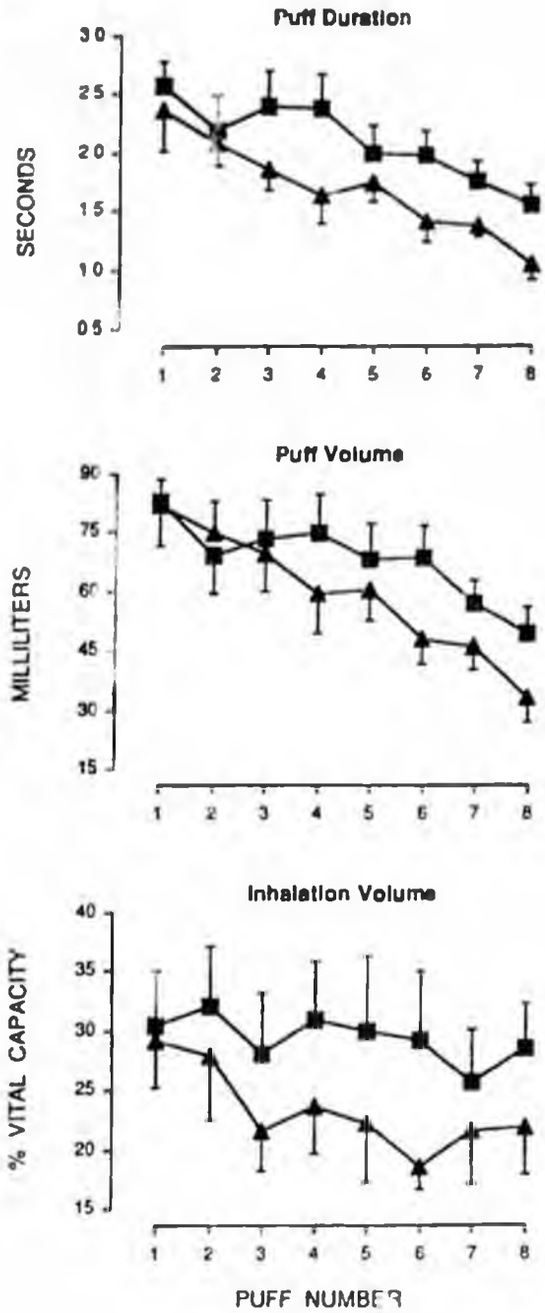

FIG 1 Mean smoking topography parameters that differed significantly between 1 3% THC marijuana (squares) and 2 7% THC marijuana (triangles) as a function of successive puff number Each data point represents the mean of 12 subjects ± 1 S E M

averaged over the eight puffs of each cigarette The difference in expired air CO levels from presmoking to 2 minutes postsmoking was used as the measure of CO boost To assess whether smoking behavior changed as a function of THC concentration, planned comparisons were conducted between the two active marijuana doses on the above smoking measures The placebo condition was included primarily as a control for subjective, performance, and HR data Visual analog subjective report, task performance, and HR data were analyzed using two-way, repeated measures analysis

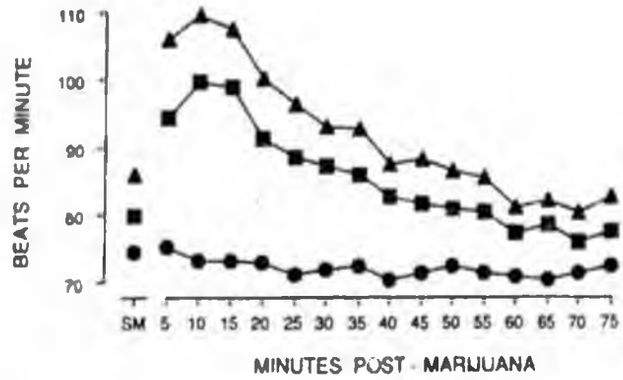

FIG 2 Effect of placebo marijuana (circles), 1 3% THC marijuana (squares), and 2 7% THC marijuana (triangles) on heart rate averaged over the smoking period (SM) and in 5-minute intervals during the session Data points are adjusted for premarijuana baseline values and represent means of 12 subjects

of covariance with marijuana dose and time postmarijuana as the factors The premarijuana baseline value was used as the covariate for each measure For continuously recorded HR, the baseline value was the average of the 5-minute premarijuana resting HR, postmarijuana HR data were averaged in 5-minute blocks of time Huynh-Feldt adjustments of repeated measures degrees of freedom were used to correct for violations of the sphericity assumption Post hoc analysis of subjective, performance, and HR data was made using the Tukey method with scores averaged over the postmarijuana session For all statistical tests, effects were considered significant if $p<0.05$

RESULTS

Smoking Topography

Mean smoking parameter values for the three marijuana doses are shown in Table 1 Planned comparisons indicated no significant difference between the active doses in smoking duration, harshness rating, and CO boost In terms of puffing parameters, there were no significant differences in interpuff interval and maximum and average flow rate However, puff duration and puff volume were significantly less for the 2 7% compared to the 1 3% THC dose Lung exposure duration also did not differ between the active doses, but inhalation volume was significantly less for the 2 7% dose

Figure 1 illustrates these differences between the 1 3% and 2 7% THC doses by showing mean puff duration, puff volume, and inhalation volume as a function of successive puff number The first puff from both cigarettes was about 83 ml in volume and 2 5 seconds in duration, subjects inhaled to about 30% VC Beginning with the third or fourth puff, puff duration and volume of the 2.7% THC cigarette became less than that of the 1 3%, and both then declined in parallel over the rest of the cigarette Inhalation volume of the 1 3% dose remained at about 30% VC over successive puffs However, beginning with the third puff, inhalation volume of the 2 7% dose shifted to a lower range (18–24% VC), which remained relatively constant for the remainder of the cigarette

Heart Rate

Figure 2 displays mean HR values for each marijuana dose averaged over the smoking period and in 5-minute intervals

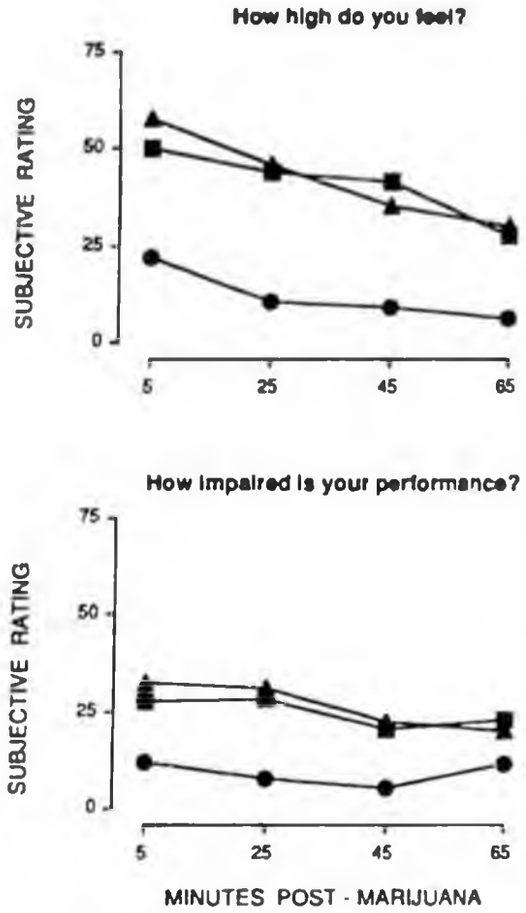

FIG 3 Effect of placebo marijuana (circles), 1 3% THC marijuana (squares), and 2 7% THC marijuana (triangles) on visual analog ratings of two subjective report questions as a function of time postmarijuana Data points are adjusted for premarijuana baseline values and represent means of 12 subjects

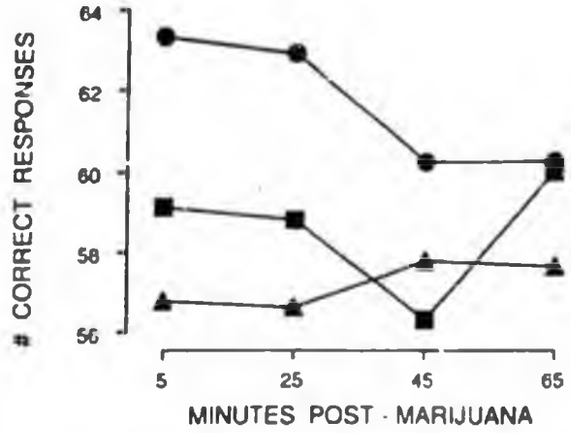

FIG 4 Effect of placebo marijuana (circles), 1 3% THC marijuana (squares), and 2 7% THC marijuana (triangles) on number of correct responses on the DSST as a function of time postmarijuana Data points are adjusted for premarijuana baseline values and represent means of 12 subjects

postmarijuana Active marijuana clearly increased HR over placebo levels, as indicated by a significant dose × time interaction, $F(30,330) = 12\ 47$, $p<0\ 001$ Post hoc analysis revealed that both active doses were significantly elevated over placebo and that the active doses were significantly different from each other, producing an orderly dose-dependent effect. This dose dependency was already evident during the smoking of the cigarette Peak increases of 35 beats per minute for the 2 7% THC dose and 25 beats per minute for the 1 3% dose occurred 10 minutes after smoking and declined gradually during the experimental session.

Subjective Measures

Average subjective ratings on two of the visual analog questions are shown in Fig 3 for each marijuana dose as a function of time postmarijuana Significant dose effects were observed for drug high, $F(2,21) = 9\ 83$, $p<0\ 001$, and impaired performance, $F(2,21) = 6\ 07$, $p<0\ 01$ Post hoc analysis indicated that for both questions, both active marijuana doses produced ratings significantly different from placebo, but not from each other Maximal ratings of drug high occurred at 5 minutes postsmoking and declined gradually toward placebo levels during the session, whereas ratings of impaired performance remained consistently elevated throughout the session Subjective responses for stoned revealed a significant dose effect, $F(2,21) = 12\ 96$, $p<0\ 001$, and were identical in time course to ratings for drug high Scores on clear-headed were significantly decreased by active marijuana relative to placebo, $F(2,21) = 3\ 72$, $p<0\ 05$ No other questions were significantly affected by marijuana.

Performance Measures

Table 2 shows scores on the digit span task averaged over the session for each marijuana dose In the forward component, significant dose effects were observed for number of correct spans, $F(2,21) = 4\ 62$, $p<0\ 05$ and longest correct span before an error was made, $F(2,21) = 5\ 72$, $p<0\ 01$ Post hoc analysis indicated that for both measures, recall was significantly impaired only with the 1 3% THC dose Similarly, in the reverse component, significant dose effects were seen for number of correct spans, $F(2,21) = 10\ 70$, $p<0\ 001$ and longest correct span before an error, $F(2,21) = 8\ 14$, $p<0\ 01$ Post hoc analysis revealed that only the 2 7% dose significantly impaired recall compared to placebo on both measures. Time course data (not shown) indicated that, in both components, recall memory was most impaired at the 5- and 25-minute assessments, recovering to placebo levels by the end of the experimental session.

TABLE 2

EFFECTS OF MARIJUANA ON DIGIT SPAN TASK*

	Placebo	1 3% THC	2 7% THC
Forward Component			
Number of correct spans	4 9	4 2†	4 7
Longest correct span before error	6 0	4 6†	5 8
Reverse Component			
Number of correct spans	5 0	4 6	4 0†
Longest correct span before error	5 5	5 0	4 3†

*Data are adjusted for predrug baseline values and represent means of 12 subjects

†$p<0\ 01$ versus placebo

Mean number of correct responses on the DSST for each marijuana dose as a function of time postmarijuana are shown in Fig 4 Active marijuana significantly decreased scores compared to placebo. $F(2,21) = 5\ 09$, $p<0\ 05$ Post hoc analysis indicated that only the 2 7% dose significantly impaired performance relative to placebo Performance was impaired at 5 minutes postsmoking and remained relatively unchanged throughout the session Marijuana had no effect on the divided attention task Mean scores of distance off the target in the tracking component were 9 8, 9 0, and 10 2 for 0, 1 3, and 2 7% THC, respectively In the visual search component, mean number of correct responses was 11 6, 11 9, and 11 5 out of a possible 12, and latency to respond was 1 4, 1 5, and 1 5 seconds for 0, 1 3, and 2 7% THC, respectively

DISCUSSION

This study demonstrated that subjects adjusted their smoking of marijuana cigarettes differing in THC content On average, subjects took puffs from the high potency cigarette (2 7% THC) that were smaller in volume and shorter in duration, and inhaled a smaller volume of air with each puff compared to the low potency cigarette (1 3% THC) Carbon monoxide boost, an indirect measure of amount of smoke inhalation, was not significantly different between the two potencies, although the trend of a lower CO boost for the high dose of marijuana was consistent with the significantly lower puff and inhalation volumes

This finding of differences in smoking topography conflicts with previous studies reporting no evidence of behavioral adjustments while subjects smoked active marijuana varying in potency (3,31) However, these latter studies did not measure puff and inhalation volume, which were the primary topographical components that differed in the present study Herning *et al* (14) found evidence for adjustment of smoking behavior, reporting that subjects inhaled a 46% greater volume of air from high (3 9% THC) versus low (1 2% THC) potency marijuana cigarettes This contrasts with our finding that subjects inhaled about 23% less air while smoking the high compared to the low potency cigarette This discrepancy may be explained by the fact that their subjects were allowed to puff and inhale at any point in their normal breathing cycle (R I Herning, personal communication) With no control over the timing of a puff and subsequent inhalation during the breathing cycle (and thus no control over volume of lung air at the beginning of an inhalation), data concerning inhalation volume as a measure of smoking topography are difficult to interpret

Previous studies of smoking topography have reported that puff duration decreased progressively over successive puffs from marijuana (30) and tobacco (8, 28, 29) cigarettes The present study replicated this finding regarding puff duration and extended it to puff volume There was a close correspondence between the decline in puff duration and puff volume across successive puffs of the low ($r = 96$) and high ($r = 99$) potency THC cigarettes In contrast, inhalation volume remained relatively constant after the second puff from both potencies

Although average puff and inhalation volume differed between the two marijuana doses, the range of values for each measure was large Puff volumes ranged from 29 to 117 ml for the low dose and 26 to 115 ml for the high dose of marijuana Inhalation volumes ranged from 14 to 64% VC and 14 to 53% VC for the low and high doses, respectively These large individual differences during ad lib smoking argue strongly for experimental control over smoking parameters if uniform dose delivery of smoked marijuana is desired The extent of each subject's adjustment in smoking behavior basically reflected the mean data For most subjects, smoking topography values of one dose were predictive of the other dose, as indicated by positive correlations between the two THC potencies for puff volume ($r = 84$) and inhalation volume ($r = 81$) However, three subjects took puffs or inhalations from the high potency cigarette that were equal to or larger than those from the low potency cigarette

It is possible that the observed differences in smoking behavior were due to the THC content of the cigarettes Chait *et al* (6) reported that subjects were able to discriminate between active and placebo marijuana cigarettes after only two puffs based on the characteristic marijuana "high" Interestingly, in the present study, topography measures of the active doses began to diverge after the second or third puff (Fig 1) However, the general lack of subjective discriminability between active marijuana doses observed in this and other (9, 13, 16, 30, 31) studies suggests that nonpharmacological factors are also involved in smoking adjustments In this study, harshness ratings tended to increase with increasing THC dose Cigarette harshness or other sensory cues potentially correlated with THC potency (e g , heat, draw, or taste) may have contributed to the observed differences in smoking topography

In spite of behavioral adjustments in smoking, we obtained dose-dependent effects on several measures, particularly heart rate, a measure that has been shown by many investigators to reflect dose-related effects of acute marijuana exposure (2, 13, 19, 24, 32) Marijuana also increased subjective ratings of drug high and stoned compared to placebo values, however, no differences between 1 3% and 2 7% THC marijuana were observed An absence of dose-related subjective effects has also been reported in studies testing a comparable range of marijuana doses in which subjects smoked marijuana either ad lib (9,31) or by following an experimenter-controlled paced smoking procedure (13, 16, 30) This suggests that subjective effects within this dose range of marijuana are difficult to discriminate This possibility is supported by the human drug discrimination work of Chait *et al* (6) They successfully trained subjects to discriminate 2 7% THC marijuana from placebo and found that cigarettes containing 1 4% THC substituted completely for the 2 7% THC training dose, whereas 0 9% THC marijuana produced placebo-appropriate responding Thus, subjects experienced the stimulus effects of 1 4% and 2 7% THC marijuana as subjectively similar

The most consistently reported behavioral effect of marijuana in humans is a disruption of memory processes (23) In the present study, marijuana impaired immediate recall as measured by the digit span task, although effects were related in an orderly way to increasing marijuana dose only for the reverse component of the task This disruption in memory is consistent with numerous past studies reporting marijuana-induced impairment in immediate or delayed recall of digit spans (22,33), short stories (17), and word lists (4, 7, 24, 26) In the present study, marijuana also impaired associative ability and psychomotor skills as assessed by the DSST This finding agrees with most previous research (2, 13, 34) Two studies reporting that smoked marijuana did not impair DSST performance (7,18) used the traditional paper and pencil DSST, which may be less sensitive to the performance-impairing effects of marijuana than the automated version, and one (18) tested a relatively low dose of marijuana (0 9% THC) in subjects with a heavy history of marijuana use In the present study, DSST was the task most sensitive to marijuana dose effects Finally, performance on a divided attention task was not affected by marijuana in the present study This contrasts with previous reports of marijuana-induced impairment on divided attention tasks involving tracking and visual search components (1,11) or dual visual search components (5,21) It is likely that the divided attention tasks used in these studies were more difficult than the one reported here Complex tasks requiring rapid, decisional responses are most sensitive to the behavioral effects of marijuana (10) Our subjects also reported that they enjoyed the divided

attention task the most of the three performance tasks, which may have increased their motivation to perform well

In conclusion, this study found that moderate marijuana users smoked a 2 7% THC cigarette less vigorously than a 1.3% THC cigarette by taking smaller and shorter puffs and inhaling less air with each puff. Studies of tobacco smoking topography have reported similar dose-related compensatory changes during ad lib smoking of cigarettes varying in nicotine yield (12,15) In spite of adjustments in smoking behavior, dose-related effects of marijuana were observed, particularly on heart rate, whereas differences between effects of the low and high dose were less apparent on subjective report and performance measures The dose-related differences in puffing and inhalation parameters and the large intersubject variability in puff and inhalation volume support the need for precise methods of control over marijuana smoking patterns to improve the accuracy of dosage delivery

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Effects of Varying Marijuana Potency on Deposition of Tar and Δ^9-THC in the Lung During Smoking

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MATTHIAS, P., D. P. TASHKIN, J. A. MARQUES-MAGALLANES, J. N. WILKINS AND M. S. SIMMONS. *Effects of varying marijuana potency on deposition of tar and Δ^9-THC in the lung during smoking.* PHARMACOL BIOCHEM BEHAV 58(4) 1145–1150, 1997.—To determine whether smoking more, compared to less, potent marijuana (MJ) cigarettes to a desired level of intoxication ("high") reduces pulmonary exposure to noxious smoke components, in 10 habitual smokers of MJ, we measured respiratory delivery and deposition of tar and Δ^9-tetrahydrocannabinol (THC), carboxyhemoglobin (COHb) boost, smoking topography, including cumulative puff volume (CPV) and breathholding time, change in heart rate (ΔHR) and "high" during ad lib smoking of 0, 1.77, and 3.95% MJ cigarettes on 3 separate days. At each session, subjects had access to only a single MJ cigarette. On average, smoking topography and COHb boost did not differ across the different strengths of MJ, while THC delivery, as well as HR, were significantly greater ($p < 0.01$) and tar deposition significantly less ($p < 0.03$) for 3.95% than 1.77% MJ. Although individual adaptations in smoking topography for 3.95% compared to 1.77% MJ were highly variable, three subjects with the lowest 3.95% MJ:1.77% MJ ratios for CPV also displayed the lowest 3.95% MJ:1.77% MJ ratios for tar deposition. In vitro studies using a standardized smoking technique revealed a mean 25% lower tar yield from 3.95% than 1.77% MJ ($p < 0.05$), but no difference between 1.77% and 0% marijuana. Under the conditions of this study, we conclude that tar delivery is reduced relative to THC content in a minority of subjects, and this reduction appears to be due to a reduced intake of smoke (decreased CPV) and/or a reduced tar yield from the stronger MJ preparation. © 1997 Elsevier Science Inc.

Marijuana Δ^9-tetrahydrocannabinol (THC) Smoking topography Tar yield Tar deposition Lung Carboxyhemoglobin boost "High"

WE have previously shown that compared to tobacco smoking, marijuana smoking results in an approximately fourfold greater deposition of tar in the lung and a four- to fivefold larger boost of carboxyhemoglobin (COHb) in the blood when equivalent quantities of the two substances are smoked (12,16). These differential effects appeared to be mainly due to less filtration of marijuana than tobacco cigarettes, resulting in a relatively greater tar yield from marijuana (13), and the longer breathholding time following inhalation of the smoke of marijuana than that of tobacco, resulting in a greater fractional retention in the lung of the inhaled tar and a greater absorption of carbon monoxide (13,16). These findings suggest that, at least for equivalent weights of plant material smoked, marijuana joints might have a greater potential than tobacco cigarettes for adverse health effects related to the carcinogenicity and respiratory irritant effects of components in tar (6) and the reduced myocardial oxygen delivery (1) and reduced maternal and fetal tissue oxygenation caused (8) by an elevated COHb.

It has been hypothesized that the health hazards from toxic components in marijuana smoke could be reduced if habitual marijuana users smoked higher potency marijuana (4). This hypothesis assumes the following: 1) that smokers are able to "titrate" the amount of THC absorbed during marijuana smok-

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ing in a manner that will result in decreasing their cumulative puff volume of inhaled smoke when smoking a more potent compared to a less potent preparation, to achieve a given desired level of intoxication; and 2) that the yield of tar relative to Δ^9-tetrahydrocannabinol (THC) from marijuana preparations of different potency always decreases as the THC concentration of the preparation increases. To test this hypothesis and these assumptions, we evaluated the effects of varying THC concentrations in marijuana cigarettes (0, 1.77, and 3.95%) on the deposition of tar in the lung, carboxyhemoglobin boost, and subjective and physiological measures reflecting the bioavailability of THC in ten habitual smokers of marijuana.

METHODS

Subjects

We studied 10 male habitual marijuana smokers [mean age (± SD), 23.2 ± 2.3 years], who smoked an average of 12.7 ± 11.5 joints/week and reported a cumulative lifetime smoking history of 27.2 ± 46.5 joint-years (number of marijuana joints per day times the number of years of marijuana smoking). All were in good general health and had normal values for routine pulmonary function tests. None reported intravenous drug abuse or smoking illicit substances other than marijuana. Three were current tobacco cigarette smokers (14.0 ± 13.9 cigarettes/day) and four were ever-smokers of tobacco with a cumulative lifetime smoking history of 3.6 ± 1.1 pack-years (number of packs of cigarettes per day times the number of years of tobacco smoking). The study was approved by the UCLA Human Subject Protection Committee and the California Research Advisory Panel. All subjects signed an approved informed consent form prior to their participation in the study.

Study Protocol and Procedures

Each subject was studied on 3 separate days approximately 1 week apart after refraining from smoking tobacco for ≥1 h and marijuana for ≥6 h. During each study session, subjects smoked a marijuana cigarette (85 mm length × 25 mm circumference) containing either 0.000 ± 0.002% THC (mean weight 833 mg; range 808–864 mg), 1.77 ± 0.01% THC (mean weight 832 mg; range 789–924 mg) or 3.95% THC (mean weight 734 mg; range 687–774 mg), according to a crossover design. The order of assignment of the three different strengths of marijuana to each subject was randomized and subjects were masked to the assignment. All marijuana cigarettes were prepared from Mississippi-grown Mexican marijuana and were supplied by the National Institute on Drug Abuse; the 0% THC preparation was prepared by ethanol extraction. Marijuana cigarettes were stored at 4°C to minimize chemical degradation and were maintained in a humidifier at 60% humidity and 21°C for 24 h before the study to reduce harshness.

Subjects were asked to smoke each marijuana cigarette ad lib but were specifically instructed to stop smoking once they had achieved their desired level of intoxication ("high"). Peripheral venous blood was withdrawn anaerobically immediately before and 2 min after each cigarette was smoked for measurement of the percentage of COHb saturation using a CO-oximeter (Model 282, Instrument Laboratory, Lexington, MA). Immediately prior to smoking at 2, 5, 15, 30, and 45 min after smoking, heart rate was measured electrocardiographically and subjects were asked to rate their level of intoxication on a scale of 0 to 10, with 10 representing the greatest "high" they had ever achieved.

Smoking topographic measures were determined, as previously described (16). Briefly, the volume and number of puffs and the interpuff interval were measured using a (0 Fleisch pneumotachygraph (resistance 0.0068 cm H_2O; linear from 5 to 100 ml/s) connected through a differential pressure transducer (Model 282 MP54-3, Validyne, Northridge, CA) (range ± 2 cm H_2O) to a 12-channel oscilloscopic recorder with a differential integrator-computer and a rapid infrared writer attachment (Honeywell Simultrace Recorder, Model VR-12, White Plains, NY). The pneumotachygraph was connected through 1-cm diameter Tygon tubing (length 70 cm) to the distal end of a glass cylinder (diameter 5 cm; length 12 cm) that contained two 1-cm diameter ventilation ports and was sealed at its proximal end by a rubber stopper. The marijuana cigarette was held in a small plastic holder inserted through the rubber stopper. During a puff, the ventilation ports were occluded by rubber stoppers so that the entire volume of air drawn through the cigarette could be measured by the pneumotachygraph. Between puffs, the ventilation ports were uncovered to prevent extinction of the cigarette or accumulation of carbon monoxide. The volume of smoke and air inhaled into the lungs ("inhaled volume") in association with each puff was measured using inductive plethysmography (Respitrace-Plus, NonInvasive Monitoring Systems, Miami Beach, FL). During calibration maneuvers, inhaled volumes calculated from inductive plethysmography agreed with measurements obtained by spirometry within ±10%. The amount of time the inhaled smoke was retained in the lungs ("breathholding time") was calculated as the interval between the times corresponding to one-third of the maximum inhaled volume and two-thirds of the maximum volume exhaled following breathholding.

The amount of inhaled insoluble smoke particulates (tar) was measured by a previously described proportional smoke-trapping device (10) that was connected to the plastic cigarette holder at the proximal end of the puff-volume measuring apparatus (1). From the plastic cigarette holder, mainstream smoke was diverted into two parallel pathways, one containing one capillary tube and a Cambridge filter pad ("high-resistance" pathway) and the other containing [illegible]n parallel capillary tubes ("low-resistance" pathway). The filter pad trapped the smoke that passed through the high-resistance pathway. The tar (including THC) trapped by the filter was extracted with methanol. The tar content (total insoluble particulate matter) was analyzed by means of a spectrophotometer (wavelength 400 nm). THC concentrations were determined by injecting dilutions of the methanol wash into a Waters high performance liquid-chromatograph outfitted with a diode array detector according to modifications of ElSohly et al. (2). Ion pair technology was employed using a Beckman ultrasphere C18 column, a water:acetonitrile mobile phase of 15:85, and isocratic flow of 2 ml/min. Ultraviolet detection was performed at 220 nm with standards obtained from Alltech, Inc. (San Jose, CA). Because a constant fraction of the tar (approximately 12.5%) was retained in the filter over a wide range of puff volumes and flow rates, the actual quantity of inhaled tar, as well as inhaled THC, could be calculated by multiplying the amount of particulates and THC trapped in the Cambridge filter pad in the high-resistance pathway by the term ([1 ÷ 0.125] − 1), or 7 (10). At the end of the period of breathholding after each puff, subjects exhaled the smoke into a megaphone device, the distal end of which (4.5-cm diameter) was fitted with another Cambridge filter pad attached to a vacuum system (5,16) to trap the exhaled particulates. Following methanol extraction, the latter were also quantitated by spectrophotometry and the ex-

haled THC by HPLC (3) as detailed earlier. The amount of tar or THC retained (deposited) in the lung was calculated by subtracting the amount of exhaled from the amount of inhaled tar or THC.

The amount of tar delivered to the lung from different strengths of marijuana cigarettes is dependent not only on smoking technique but also on the actual tar yield of the cigarettes, which could vary with the potency of the preparation. We, therefore, measured the amount of tar in mainstream smoke generated from five 0%, five 1.77%, and five 3.95% marijuana cigarettes under standardized smoking conditions using a syringe with a 50-ml puff volume, 2-second duration and 30-s interpuff interval to uniform butt lengths of 25 mm. All the tar in the mainstream smoke was captured in a Cambridge filter interposed between the syringe and the cigarette and measured spectrophotometrically after methanol elution, as described above.

DATA ANALYSIS

For each subject, topographic measurements (puff volume, interpuff interval, inhaled volume, breathholding time) were averaged for each cigarette smoked. These mean values, as well as the number of puffs, cumulative puff volume (the product of the mean puff volume and the number of puffs for each cigarette), butt length, and the amounts of inhaled and retained tar and THC were averaged for all 10 subjects for each potency of marijuana smoked. COHb "boost," peak changes in heart rate from baseline and peak subjective ratings of degree of intoxication after smoking each strength of marijuana were also averaged for all subjects. In addition, for each subject, each measurement variable was expressed as a ratio of that variable determined in relation to smoking 3.95% marijuana to that determined for 1.77% marijuana; these ratios served as indicators of the relative pattern for each subject of smoking active marijuana of two different strengths. The Hotelling's T^2 test, a multivariate test for within-subject differences in repeated measures models, was used to determine the significance of differences in smoking patterns, delivery, and deposition of particulates and THC, and the "boost" in COHb and change in heart rate among the different strengths of marijuana cigarettes (9). Multiple comparisons were then performed using paired t-tests, where appropriate. Because the subject's levels of "high" were based on an ordinal scale, these data were analyzed for differences between the THC concentrations using Friedman's nonparametric two-way analysis of variance (7). Differences for all tests were considered significant for p values <0.05. Statistical analyses were performed using SAS (11) and BMDP (2) software.

RESULTS

Smoking topography, pulmonary deposition of tar and THC, COHb boost, and psychophysiologic responses to smoking all showed similarly wide variability across subjects for each strength of marijuana. The extent of this variability is illustrated for cumulative puff volume, breathholding time, tar deposition, and THC retention in Fig. 1, which shows the individual values for these variables for each type of marijuana preparation smoked.

Mean values (±SE) for cumulative puff volume (CPV), inhaled volume (Vol_I), breathholding time, butt length, amount of tar and THC retained in the lung, COHb boost, peak change in heart rate, and peak level of intoxication for each potency of marijuana smoked are shown in Table 1. As expected, both "active" marijuana preparations (1.77% and 3.95% THC) delivered significantly more THC, $F(2, 8) = 51.7$, $p < 0.001$; Hotelling's T^2, to the lung and resulted in a significantly greater change (increase) in heart rate, $F(2, 8) = 24.0$, $p < 0.001$; Hotelling's T^2, than the "inactive" (0% THC) preparation, although neither active preparation elicited a significantly greater "high" than "inactive" marijuana ($p = 0.12$; Freedman nonparametric two-way ANOVA). No differences in any of the measured smoking topographic variables [cumulative puff volume; average puff volume, number of puffs, or interpuff interval (data not shown); inhaled volume; breathholding time; butt length], nor in COHb boost, were noted across the different potencies of marijuana. On the other hand, despite the lack of any mean difference in smoking pattern for the different strengths of marijuana, the average amount of tar delivered to and retained in the lung from the most potent preparation (3.95% THC) was significantly lower than that from both the 0% THC and 1.77% THC preparations ($p < 0.03$). Moreover, the THC delivered to and retained in the lung from 3.95% marijuana was significantly greater than that deposited in the lung from 1.77% marijuana ($p < 0.001$); this difference is reflected in the significantly greater heart rate increase ($p < 0.01$) following the more potent "active" preparation.

The mean percent of inhaled (delivered) tar that was not exhaled and was thus deposited in the respiratory tract was comparable across the different strengths of marijuana (80.7 ± 2.1%, 86.9 ± 3.2%, and 83.6 ± 2.4% for the 0, 1.77, and 3.95% preparations, respectively). Likewise, the average percent of inhaled (delivered) THC that was retained in the lung was similar for the 0, 1.77, and 3.95% potencies (74.1 ± 5.0%, 83.6 ± 3.8%, and 76.5 ± 4.5%, respectively). Consequently, the differences between the amounts of tar (or THC) delivered to the lung between any two strengths of marijuana were similar to the differences between the amounts of tar (or THC) de-

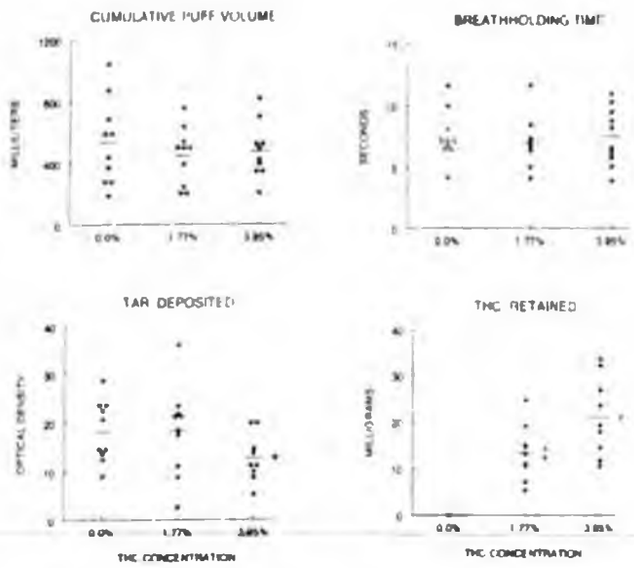

FIG. 1. Individual values for cumulative puff volume (ml) and breathholding time (s) and for amount of tar [optical density (O.D.) units] and amount of THC (mg) deposited in the respiratory tract for 0.0, 1.77, and 3.95% marijuana. Horizontal lines represent mean values. *$p < 0.03$ (compared with 1.77% and 0% THC); †$p < 0.01$ (compared with 1.77% and 0% THC); ‡$p < 0.001$ (compared with 0% THC).

TABLE 1

MEAN VALUES (±SE) FOR SMOKING TOPOGRAPHY, TAR, AND THC DEPOSITION IN THE LUNG, BLOOD CARBOXYHEMOGLOBIN BOOST, AND PSYCHOPHYSIOLOGIC RESPONSES TO THC DETERMINED DURING AND AFTER SMOKING MARIJUANA CIGARETTES OF DIFFERENT THC CONCENTRATION

	TAR O.D.	THC mg	BHT sec	CPV ml	Vol_t liters	Butt length mm	COHb %	High (0–10)	ΔHR min^{-1}
0% THC	18.9	0.1	7.5	534	2.52	16.7	2.6	3.0	6.2
	(2.1)	(0.0)	(0.6)	(87)	(0.28)	(4.3)	(0.5)	(0.7)	(1.6)
1.77% THC	19.9	13.4*	7.0	447	2.17	19.3	2.0	4.3	30.2*
	(2.6)	(2.0)	(0.6)	(5.9)	(0.33)	(4.7)	(0.4)	(0.7)	(3.8)
3.95% THC	13.6[†§]	21.0*[‡]	7.5	479	2.11	19.0	2.0	6.0	39.0*[‡]
	(1.5)	(2.8)	(0.7)	(57)	(0.20)	(7.2)	(0.3)	(0.6)	(4.3)

Definition of abbreviations: Tar = respiratory tar deposition, O.D. = optical density units; THC = respiratory retention of Δ^9-tetrahydrocannabinol; BHT = breathholding time; CPV = cumulative puff volume; Vol_t = inhaled volume of smoke and air; COHb = carboxyhemoglobin saturation; ΔHR = change in heart rate from pre-smoking baseline

*Significantly different from 0% THC; $p < 0.001$

†Significantly different from 0% THC; $p < 0.02$

‡Significantly different from 1.77% THC; $p < 0.01$.

§Significantly different from 1.77% THC; $p < 0.03$.

posited (retained) in the lung between the same two potencies of marijuana.

The ratio of values for the variables shown in Table 1 for 3.95% marijuana to those for 1.77% marijuana were calculated for each subject and averaged across all subjects. The distributions of the individual values for most of these ratios across the 10 subjects are illustrated in Fig. 2. Deviations of these ratios from 1.0 would imply a difference between the more and less potent "active" marijuana preparation with respect to smoking technique, delivery of smoke contents to the lung or the physiological effects of such delivery. The broad range of these ratios, which straddled 1.0 for all variables except the amount of THC delivered to and retained in the lung, reflects the large degree of variability across subjects in differential smoking technique and in subjective and physiological responses to THC between the two strengths of marijuana (Fig. 2). On average, ratios of values for smoking pattern, including cumulative puff volume, breathholding time, and inhaled volume, were close to 1.0. On the other hand, ratios for THC deposition, change in heart rate and "high" were always or mostly above 1.0, while ratios for tar deposition were mostly less than 1.0.

The individual tar yields determined using a standardized, syringe-simulated smoking technique for each of the five cigarettes of each strength that were tested are shown in Fig. 3.

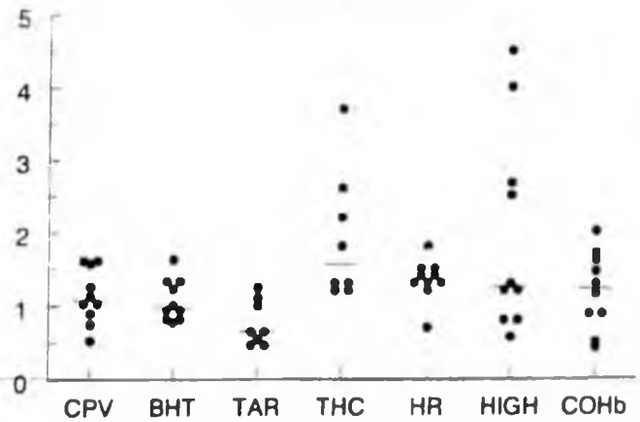

FIG. 2. Individual ratios of values for cumulative puff volume (CPV), breathholding time (BHT), respiratory tar deposition (TAR), respiratory retention of THC (THC), heart rate increase over presmoking baseline (HR), level of intoxication (HIGH) and carboxyhemoglobin boost (COHb) determined for 3.95% marijuana to those determined for 1.77% marijuana (3.95% MJ:1.77% MJ).

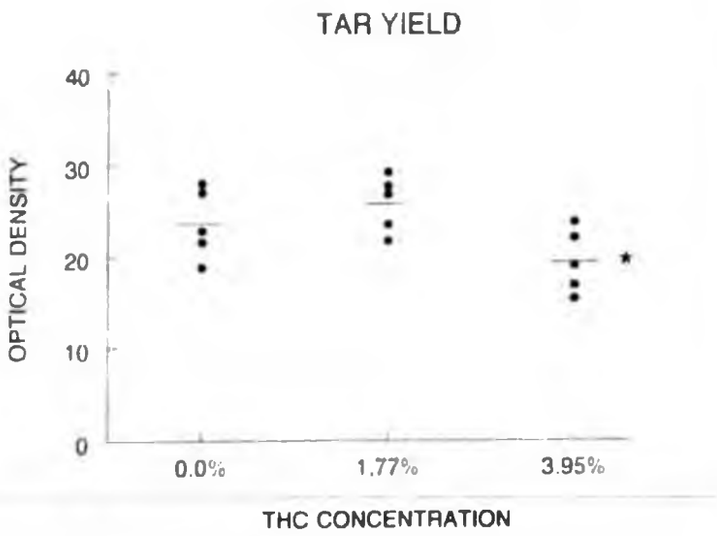

FIG. 3. Individual values for amount of tar (O.D.) in mainstream smoke generated from five 0.0%, five 1.77% and five 3.95% marijuana cigarettes using a syringe with a 50-ml puff volume, 2-s duration and 30-s interpuff interval to butt lengths of 25 mm. Horizontal lines represent mean values *$p < 0.05$ (compared with 1.77% and 0% THC).

The average tar yield from the 3.95% marijuana cigarette was 19.3 ± 1.6 (SEM) optical density (O.D.) units, which was significantly lower ($p < 0.05$) than the tar yields from both the 1.77% preparation (25.2 ± 1.4 O.D.) and the 0% preparation (23.5 ± 1.6 O.D.).

DISCUSSION

The major findings from this study are that, in a small number of healthy, habitual marijuana smokers asked to smoke different strengths of marijuana to a desired level of intoxication, the amount of tar delivered to and deposited in the lung from the most potent marijuana preparation tested was significantly reduced compared to that of less potent preparations, despite the lack of demonstrable overall differences in smoking topography, including cumulative puff volume, across the different strengths of marijuana (Table 1). In contrast, no difference in COHb boost was observed between more and less potent marijuana cigarettes, while THC delivery and lung retention were significantly greater for 3.95% than 1.77% marijuana, as reflected in a significantly greater heart rate increase ($p < 0.01$) following the 3.95% than the 1.77% preparation (Table 1).

Differences in THC delivery and the related physiological responses to smoking marijuana of different strengths were found despite instructions to the subjects to smoke only to their desired level of intoxication. Possible reasons for the observed differences in THC delivery are 1) that subjects were generally unable to "titrate" THC delivery to achieve a uniform "high" from the 1.77 and 3.95% marijuana cigarettes; or 2) that their desired level of intoxication was greater than that which could be achieved with the weaker of the two active marijuana preparations under the conditions of the experiment, in which they were constrained to smoking only a single marijuana cigarette. In favor of the former possibility is that maximum levels of intoxication were not attained in the majority of subjects (7 of 10) until at least 5 min, and in some subjects (4 of 10) as long as 15 min, after completion of smoking, thus compromising their ability to self-titrate intake of smoke (and thus THC) based on levels of "high" perceived during active smoking. On the other hand, it is still possible that adjustments could be made during smoking with the expectation of delayed peak "highs" based on previous experience. The alternative possibility, namely that the single 1.77% preparation was insufficient, even if consumed to the maximum extent tolerable, to produce the desired level of intoxication, appears inconsistent with the finding that mean butt lengths of the smoked 1.77% and 3.95% marijuana cigarettes were nearly identical (19.3 mm and 19.0 mm, respectively). On the other hand, in 3 of the 10 subjects, butt lengths of the 1.77% marijuana cigarette were substantially shorter than those of the 3.95% preparation and, in 2 additional subjects, both preparations were nearly completely consumed (butt lengths 2–4 mm). Therefore, the possibility remains that in this subset of subjects the weaker of the two active preparations was insufficient to yield the desired level of intoxication, even when smoked to a relatively short butt length, in the absence of access to more than one marijuana cigarette.

The observation that the amount of tar deposited in the lung tended to be reduced for 3.95% marijuana compared to 1.77% marijuana (Table 1 and Fig. 1) is difficult to explain solely on the basis of differences in smoking topography, because smoking topography, including the variables that have been found to correlate best with the amount of tar delivered to and retained in the lung (cumulative puff volume and breathholding time) (13) were, on average, nearly identical for both the higher and lower strengths of active marijuana. Smoking marijuana down to a longer butt length would be expected to decrease tar delivery partly due to the increased filtration through the longer shaft of the cigarette (14); because average butt lengths were similar for the two active strengths of marijuana that were studied, however, this factor could not have accounted for the generally lower tar delivery from the more potent cigarette. On the other hand, considerable interindividual variability was observed in the 3.75:1.77% marijuana ratios both for tar delivery and deposition and for cumulative puff volume and breathholding time (Fig. 2). For the most part, those subjects who exhibited lower cumulative puff volumes when they smoked 3.95% marijuana than 1.77% marijuana also deposited lower amounts of tar in their lungs when they smoked the more potent preparation. A similar relationship between breathholding time and respiratory tar delivery for the two active strengths of marijuana was not observed. These observations suggest that, at least in some subjects, the reduced tar delivery to the lung from the higher potency marijuana preparation might be accounted for, at least in part, by adjustments in smoking technique that result in a lower cumulative puff volume.

Reduced tar delivery from more potent marijuana cigarettes could also occur if the actual tar yield from stronger preparations were reduced relative to that from the same quantity of weaker preparations, when smoking technique was standardized. To evaluate this possibility, we measured the amount of tar in mainstream smoke generated from the different strengths of marijuana cigarettes using a standardized in vitro smoking technique. As shown in Fig. 3, the average tar yield from the 3.95% marijuana cigarette was significantly lower ($p < 0.05$) than the tar yields from both the 1.77% and the 0% preparations. Consequently, a reduced tar yield from stronger preparations of marijuana might contribute, at least partly, to less delivery of tar to the lung. On the other hand, no difference was noted between the tar yields of the 0 and 1.77% preparations, so that a linear relationship between the potency of a marijuana cigarette and its tar yield was not apparent over the entire range of potencies (0.00–3.95% THC) of the preparations that we tested. Data from a recent preliminary Australian study on the relative yields of condensed particulate matter (tar) and THC from different samples of seized marijuana ranging in potency from 0.57 to 13.0 % (mean 3.42%; median 1.8%) (Hall, W., National Drug and Alcohol Research Centre, Kensington, Australia; Personal Communication) show a weak relationship between THC content and tar yield for preparations with THC concentrations ≤2.5% and inconsistently lower tar yields for the few preparations tested with THC concentrations >5%. Consequently, had we been able to evaluate the influence of smoking marijuana cigarettes with THC concentrations >5%, we might have found greater reductions in respiratory tar delivery than we demonstrated in the present study for 3.95% compared to 1.77% marijuana.

Mainstream smoke from marijuana or tobacco is a highly concentrated aerosol of liquid particles that is formed by complex chemical reactions, including hydrogenation, pyrolysis, oxidation, decarboxylation, dehydration, chemical condensation, distillation, and sublimation (15). The smoke aerosol is composed of a large variety of organic and inorganic chemicals dispersed in a gaseous medium of nitrogen, oxygen, hydrogen, carbon dioxide, carbon monoxide, and a number of volatile and semivolatile organic chemicals. The tar phase consists of total particulate matter minus water and contains a

number of constituents, including tumor initiators, carcinogens, and cocarcinogens that contribute to the health hazards of smoking. Several factors influence the tar yields of tobacco cigarettes (15) that might also be relevant to marijuana. These include plant genetics and growth conditions that affect chemical composition and physical properties of the leaf, moisture content, the curing and fermentation process, burning temperature, the quality of the cigarette paper (e.g., porosity), and the presence or absence of a filter. Which of these factors may be responsible for the apparently lower tar yield from more potent preparations of marijuana is unclear.

The mean percentage of inhaled tar deposited in the lung in the present study from marijuana cigarettes of different potency (80.7–86.9%) is similar to that previously reported from our laboratory from 0.00 and 1.24% marijuana cigarettes (84.4–86.1%) and higher than that deposited from tobacco cigarettes (64.0%) (16). The greater percentage deposition of inhaled tar from marijuana than tobacco cigarettes is attributable to the longer breathholding time characteristic of marijuana smoking compared to tobacco smoking (13,16). The similarity in mean breathholding times observed in the present study during the smoking of marijuana cigarettes of different strengths (Table 1) is consistent with the comparability in mean percentage of delivered tar that was deposited in the lung across the different potencies of marijuana.

In summary, in a small number of habitual marijuana users studied during the smoking of single marijuana cigarettes of varying potency up to a maximum THC concentration of 3.95%, adjustments of smoking topography to the different strengths of marijuana were highly variable between subjects. Under the conditions of the experiment (limited maximum potency of marijuana and a limit of a single cigarette), smokers generally appeared unable to titrate THC delivery to achieve a uniform "high," so that the level of intoxication and heart rate were often more increased after smoking cigarettes of higher than lower potency. Tar delivery from 3.95% marijuana was reduced relative to that from 1.77% marijuana in 3 of 10 subjects, and the reduction in tar delivery appeared to be related to reduced intake of smoke (lower cumulative puff volume) in these few subjects, as well as to the reduced tar yield during combustion of the stronger marijuana preparation. COHb boost was not affected by the potency of the marijuana smoked. We conclude that, compared to lower potency marijuana cigarettes, stronger preparations appear to lead to a modest reduction in exposure of the lung to tar in some smokers but not to carbon monoxide. We did not assess the influence of varying THC content on the respiratory delivery of volatile constituents other than carbon monoxide in the gas phase of marijuana smoke, some of which are known to be biologically hazardous. Although it is possible that relatively reduced exposure to carcinogenic components in the tar phase of marijuana from smoking cigarettes with a higher THC content might reduce the carcinogenic risk of marijuana smoking, the true health implications of these findings are as yet unclear.

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ELSEVIER

Long-term effects of exposure to cannabis

Leslie Iversen

The long-term use of cannabis, particularly at high intake levels, is associated with several adverse psychosocial features, including lower educational achievement and, in some instances, psychiatric illness. There is little evidence, however, that long-term cannabis use causes permanent cognitive impairment, nor is there is any clear cause and effect relationship to explain the psychosocial associations. There are some physical health risks, particularly the possibility of damage to the airways in cannabis smokers. Overall, by comparison with other drugs used mainly for 'recreational' purposes, cannabis could be rated to be a relatively safe drug.

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Abbreviations
THC Δ^9-tetrahydrocannabinol

Introduction

Cannabis is the most commonly used illicit drug. In many countries, more than 50% of young people have used it at least once and it is widely perceived as relatively safe. Many people believe that there are genuine medical uses for cannabis-based medicines and it seems likely that such products will gain official approval in several Western countries. Concurrently, there is a move towards relaxation of the criminal penalties associated with the recreational use of cannabis — ranging from the down-grading of criminal penalties in the UK to the possibility of full legalization in Canada and Switzerland. In light of these changes in attitude, it is timely to consider again the adverse effects associated with long-term cannabis use over a period of years, as no drug can ever be considered completely safe.

Effects on cognition

Several studies have addressed the question of whether severe deficits in cognitive function develop in chronic heavy users of cannabis, or in animals treated for prolonged periods with the drug. Most reports have shown that there are deficits in the performance of complex cognitive tasks in long-term cannabis users, although there is little evidence that these are qualitatively or quantitatively more severe than those seen after acute drug use [1].

More controversial is the question of whether long-term cannabis use can cause irreversible deficits in higher brain function that persist after drug use stops. Human studies are fraught with difficulties, as described in detail by Earleywine [1]. Indeed, many studies have suffered from poor design. One confounding factor in human studies is that comparisons have to be made between groups of drug users versus non-users; however, it is usually impossible to compare the baseline performance of these groups before cannabis use to see if they are properly matched. Pope *et al.* [2], for example, tested 69 early-onset heavy cannabis users (who began smoking before the age of 17) in a battery of neuropsychological tests after a two-week period of abstinence. The group performed significantly worse than late-onset users or controls, but also displayed a lower verbal IQ. When the data were adjusted for this, all differences between early-onset users and others ceased to be significant.

It is not sufficient to identify a group of cannabis users and simply to test them after stopping cannabis use. One study, for example, recruited 63 current heavy users who had smoked cannabis at least 5000 times in their lives and 72 control subjects [3]. The subjects underwent a 28-day washout from cannabis use, monitored by urine assays. At days 0, 1 and 7, the heavy users scored significantly below control subjects on a battery of neuropsychological tests, particularly in recall of word lists. However, by day 28, there were no differences between the groups in any of the test results, and no significant association between cumulative lifetime cannabis use and test scores. The fact that drug-induced effects on cognitive performance can persist for up to a week after stopping the drug (perhaps because of the persistence of Δ^9-tetrahydrocannabinol [THC] in the body, or because of a subtle withdrawal syndrome) means that many earlier studies that did not allow a sufficiently long washout period might be invalid.

One way of assessing cognitive function is to measure IQ. Fried *et al.* [4] tested the effects of cannabis use in a group of 70 young people by subtracting each person's IQ score at nine years of age (before drug use) from their score at age 17–20 years. Current cannabis use was found to be significantly correlated in a dose-dependent manner with a decline in IQ scores. However, no such decline was seen

in subjects who had formerly been heavy cannabis users and had stopped taking the drug. The authors concluded that cannabis does not have a long-term effect on global intelligence.

This general conclusion was also supported by a review of the 40 published studies that met adequate criteria, which failed to detect any consistent evidence of persisting neuropsychological deficits in cannabis users — although some studies reported subtle impairments in the ability to learn and remember new information [5].

Cannabis and psychiatric illness

There has been a long-standing concern that cannabis use might precipitate mental illness in some users. It is clear that an acute schizophrenia-like psychosis can occur in response to a high dose of cannabis [6•], but whether cannabis use can cause persistent psychiatric illness in people who had not previously shown psychotic symptoms remains contentious. A recent re-analysis of the results of a large scale study of >50 000 Swedish men (age 18–20 years) conscripted into the Swedish army between 1969 and 1970 suggested that those who had used cannabis >50 times before the age of 18 years had a 6.7-fold increased risk of developing schizophrenia in later life [7]. A review of this and four other longitudinal cohort studies also concluded that early cannabis use might be a causal factor for schizophrenia-like illness in later life [8••]. However, the interpretation of such studies is fraught with many difficulties, as reviewed by Macleod *et al.* [9••]. These authors highlighted that proof of a causal relationship is subject to many confounding factors. When known confounding factors were applied to the Swedish army data, for example, the odds ratio was reduced from 6.7 to 3.1 [7]. This, in turn, suggests that other residual unidentified confounding factors are also likely to exist. The published studies show that the existence of 'prodromal' symptoms of psychosis clearly increased the risk of subsequent psychiatric illness in cannabis users [8••]. This factor was adequately controlled for in only one of the five published longitudinal studies [10]. In this New Zealand cohort, even when those exhibiting prodromal symptoms of psychosis were eliminated, those who started cannabis use by age 15 years (but not those who started later) showed a fourfold increase in the risk of developing schizophrenia-like illness by age 26 years. However, the number of subjects involved was small (there were 26 15-year old cannabis users, of whom three developed mental illness) so the statistical power of this study was limited. Degenhardt *et al.* [11] sought to test the hypothesis of a causal relationship between cannabis use and schizophrenia by a careful examination of the incidence of schizophrenia in Australia during the past 30 years. Although the prevalence of cannabis use had increased markedly during this period, there was no evidence of a significant increase in the incidence of schizophrenia. The question of whether cannabis use can precipitate psychiatric illness in a vulnerable minority of previously well people remains unanswered. One could equally argue that a tendency to psychotic illness might increase the likelihood of early cannabis use [9••]. It is possible that cannabis may precipitate schizophrenic illness earlier in vulnerable people who exhibit 'schizophreniform' tendencies. Such a conclusion is supported by the results of a study of 122 newly admitted schizophrenia patients in the Netherlands, which showed a strong association between cannabis use and the age of onset of the first psychotic episode in men, with users experiencing their first psychotic episode 6.9 years earlier than non-users [12].

Other studies have explored the association between cannabis use and depression. One longitudinal study in Australia reported that daily use of cannabis by teenage girls (but not boys) led to an approximately twofold increased risk for depression/anxiety in later life [13]. A review of other studies of this type suggested that heavy cannabis use may increase depressive symptoms in some users, but whether this represents a causal relationship is again unclear [14].

Psychosocial sequelae of cannabis use

Apart from the potential risk of mental illness, there has been a long standing concern that adolescent use of cannabis could lead to reduced educational achievement and reduced motivation — sometimes referred to as an 'amotivational syndrome' [1].

Cherek, *et al.* [15] attempted to assess this experimentally in a study in which human participants earned money by responding on a complex lever-pressing schedule. There was a significant reduction in the number of responses, time spent and money earned when the subjects were retested while smoking cannabis, indicating a drug-induced reduction in motivation.

Various longitudinal studies have sought to establish the relationship between cannabis use and subsequent educational achievement. A study of 1265 New Zealand children [16] showed that cannabis use was dose-dependently related to an increased risk of leaving school without qualifications, failure to enter university and failure to obtain a university degree. A similar conclusion was reached in reviews of other published studies of this type [9••,17]. The review by Macleod *et al.* [9••] was particularly comprehensive; the authors studied 48 published longitudinal studies on the use of cannabis, of which 16 were considered to provide the most robust evidence. Their conclusions for cannabis use were, firstly, a consistent association with reduced educational achievement; secondly, a consistent association with use of other drugs; thirdly, an inconsistent association with psychological problems of various types; and finally, an inconsistent association with antisocial or other

problematic behaviours. They concluded that "Available evidence does not support an important causal relation between cannabis use and psychosocial harm, but cannot exclude the possibility that such a relation exists".

Whatever the nature of the association, it seems clear that long-term heavy cannabis use carries a variety of negative attributes. A case control study compared 108 heavy-use long-term cannabis users, who had on average smoked 18 000 times, with 72 age-matched controls who had smoked cannabis <50 times [18••]. The heavy-use cannabis smokers reported significantly lower educational attainment and lower income than did controls. When asked to rate the subjective effects of cannabis on cognition, memory, career, social life, physical and mental health and various quality-of-life measures, a large majority of heavy-use cannabis smokers reported negative effects of their drug use.

Cannabis and substance dependence

Although it was previously thought that cannabis was not a drug of addiction, it is now recognized that cannabis use can lead to substance dependence in perhaps as many as 10% of regular users, according to the internationally accepted DSMIV definition of 'substance dependence' [6•]. In both animals and humans, a clear withdrawal syndrome can be identified [6•]. In rodents, chronic administration of THC or synthetic cannabinoids leads to downregulation and desensitization of cannabinoid CB_1 receptors in the brain [19]. This might partly explain the tolerance that develops in both animals and humans on repeated use of the drug. In regular cannabis users, abstinence leads to a withdrawal syndrome characterized by negative mood (irritability, anxiety, misery), muscle pain, chills, sleep disturbance and decreased appetite. A placebo-controlled study showed that these symptoms were significantly reduced by oral administration of THC, suggesting that the withdrawal syndrome and underlying substance dependence were related to effects of THC on the cannabinoid CB_1 receptor, rather than to any other component of herbal cannabis [20].

Other potentially toxic effects of long-term cannabis use

Some of the most serious adverse effects of smoked cannabis are on the respiratory system. Although little progress has been made recently in quantifying such risks, warnings continue to be issued about the potential for long-term damage or even malignancy in the airways [21]. It is known that lung macrophages isolated from cannabis smokers exhibit impaired anti-bacterial activity, and one experimental study showed that this might be caused, in part, by reduced expression of inducible nitric oxide synthase and decreased production of nitric oxide [22]. A review of the evidence for immunosuppressant effects of cannabis concluded that, with the exception of the effects of cannabis smoking on broncho-alveolar immunity, there is no evidence that cannabis causes any other serious immunosupression in users [23]. The authors suggested that the effects on lung macrophages might be related to the ability of cannabis in animal studies to cause a shift from Th1 to Th2 cytokine production.

With increasing use of cannabis, there remains a concern that cannabis use during pregnancy might impair foetal development. Reviews of data from humans, however, suggest that such effects are minimal for cannabis users when compared with the well-documented adverse effects of tobacco or alcohol use [24,25•]. Nevertheless, treatment of pregnant rats with high doses of THC did lead to significant reductions in expression of neural adhesion molecule L1 in the foetal brain — a key protein for brain development [26].

Conclusions

A review of the literature suggests that the majority of cannabis users, who use the drug occasionally rather than on a daily basis, will not suffer any lasting physical or mental harm. Conversely, as with other 'recreational' drugs, there will be some who suffer adverse consequences from their use of cannabis. Some individuals who have psychotic thought tendencies might risk precipitating psychotic illness. Those who consume large doses of the drug on a regular basis are likely to have lower educational achievement and lower income, and may suffer physical damage to the airways. They also run a significant risk of becoming dependent upon continuing use of the drug. There is little evidence, however, that these adverse effects persist after drug use stops or that any direct cause and effect relationships are involved.

In contrast, cannabis might have beneficial effects in some medical indications. There is considerable literature obtained from animal studies to suggest that cannabis has analgesic effects [27]. Until recently, however, there has been a dearth of controlled clinical studies to validate such effects in patients. This has now changed, with the publication in the past two years of a number of double-blind placebo-controlled trials showing the effectiveness of cannabinoids in relieving chronic neuropathic pain [28,29] or pain associated with multiple sclerosis [30••, 31]. The largest of these trials involved 630 multiple sclerosis patients and showed significant pain relief after 15 weeks of treatment with either pure THC or cannabis extract [30]. It seems likely that medicinal cannabis will re-enter the Pharmacopoeia.

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The Report of the National Commission on Marihuana and Drug Abuse

Marihuana: A Signal of Misunderstanding

Commissioned by President Richard M. Nixon, March, 1972

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Letter of Transmittal

National Commission on Marihuana and Drug Abuse

801 19th Street N.W.

Washington, D.C. 20006

March 22, 1972

To The President and Congress of the United States:

As Chairman of the National Commission on Marihuana and Drug Abuse, I am pleased to submit to you our first year Report in conformance with the mandate contained in Section 601 of Public Law 91-513, The Comprehensive Drug Abuse Prevention and Control Act of 1970.

This Report "Marihuana, A Signal of Misunderstanding" is an all-inclusive effort to present the facts as they are known today, to demythologize the controversy surrounding marihuana, and to place in proper perspective one of the most emotional and explosive issues of our time. We on the Commission sincerely hope it will play a significant role in bringing uniformity and rationality to our marihuana laws, both Federal and State, and that it will create a healthy climate for further discussion, for further research and for a continuing advance in the development of a public social policy beneficial to all our citizens.

Whatever the facts are we have reported them. Wherever the facts have logically led us, we have followed and used them in reaching our recommendations. We hope this Report will be a foundation upon which credibility in this area can be restored and upon which a rational policy can be predicated.

By Direction of the Commission

Raymond P. Shafer

The President

The President of the Senate

The Speaker of the House

Marihuana: A Signal of Misunderstanding

Introduction

This is the first of two Reports by the National Commission on and Drug Abuse. Public Law 91-513 requires that we report to the President, Congress and the public initially on marihuana and then on the broader issue of drug abuse in the United The second Report will include a review of the marihuana issue with particular attention to studies which have been conducted in the interim.

In large measure, the marihuana issue is a child of the sixties, the visual and somewhat pungent symbol of dramatic changes which have permanently affected our nation in the last decade. Some have that our mandate has placed the cart before the horse, and that we should have focused first on the wider social issue and assessed marihuana's impact on society within that context. much thought and investigation, we now believe that Congress was wise in focusing this Commission's attention first on marihuana. separating it from the rest of the drug controversy, we have been better able to analyze the unique position marihuana occupies in our society.

Our mandate was a broad one, covering, for example, the nature and scope of use, the effects of the drug, the relationship of marihuana use to other behavior and the efficacy of existing law. Realizing that marihuana had never before in the American experience been the subject of a concentrated, authoritative governmental study, we launched a comprehensive research and fact-finding effort. We sought.. to evaluate and supplement existing material, to fill knowledge voids. and to assess the so-called truths commonly posed in the marihuana debate.

Soon after funds became available on March 22, 1971, we commissioned more than 50 projects, ranging from a study of the effects of marihuana on man to a field survey of enforcement of the marihuana laws in six metropolitan jurisdictions. Of particular importance in our fact-finding effort were the opinions and attitudes of all groups in our society.

Through formal and informal hearings, recorded in thousands of pages of transcripts, we solicited all poi: .s of view, including those of public officials, community leaders, professional experts and students. We commissioned a nationwide survey of public beliefs, information and experience referred to in this Report as the National Survey. In addition, we conducted separate surveys of opinion among', district attorneys, judges, probation officers, clinicians, university health officials and free clinic personnel.

This inquiry focused on the American experience. However, we have been well aware from the outset that the scope of marihuana use in the United States differs considerably from that in other countries where the drug has been used for centuries. Accordingly, the Commission sought to put the American experience in perspective by seeing the situation first hand in India, Greece, North Africa, Jamaica, Afghanistan. and other countries.

Because of our initial concentration on marihuana. certain issues common to marihuana and other drugs have been deferred for more complete coverage in the second Report. For

example, a detailed analysis of educational programs about marihuana and its use will be considered when we evaluate drug education programs in general.

Further, we do not discuss the rehabilitation of the problem marihuana user since no such specialized programs exist; we found the subject is best approached from a broader perspective of rehabilitation programs for problem users of all non-narcotic drugs. An examination of federal and state organizational response to the drug issue, as well as an in-depth study of general law enforcement strategies, have both been undertaken and will continue, but will not be reported fully until the second year.

Officers of the Federal Government have set a high priority on fuller understanding of the marihuana issue and appropriate governmental action. President Nixon has frequently expressed his personal and official commitment to providing a rational and equitable public response to the use and misuse of drugs. Similarly, Congress has shown its concern in passing the Comprehensive Drug Abuse Prevention and Control Act of 1970. In appointing this Commission, both the President and Congress have recognized the need for an independent, nonpartisan appraisal of the nature of marihuana and the consequences of its use, for a similar appraisal of the abuse of all drugs, and for appropriate recommendations for public policy as a result of both studies.

The Commission decided early in its deliberations to write a Report that was complete but not overly technical so that the reader could understand the points discussed without analyzing detailed studies. Some. studies and supporting data are included in an Appendix to the Report, which is published separately. For the researcher and others interested in greater detail, the Appendix provides the necessary technical data.

This Report focuses on marihuana, the popular name for a mixture of stems, leaves and flowering tops of the Indian hemp plant, Cannabis Sativa L. This Report presents the most significant information gathered to date about the drug and its users, concluding with the Commission's recommendations concerning the most appropriate public response to marihuana usage in our society.

I -- marihuana and the problem of marihuana

"There are no whole truths; all truths are half-truths. It is trying to treat them as whole truths that plays the devil."

Alfred North Whitehead (1953)

We are a nation of problem-solvers. We are restless and impatient with perceived gaps between the way things are and the way we think ought to be. Understandably, such an impulse toward self-correction never leaves us wanting for social problems to solve. Although it is a prerequisite to social progress, this problem-solving orientation misdirects our attention. In order to maximize public awareness we are apt to characterize situations as being far worse than they really are. Because any activity is commonly regarded as a move toward a solution, rhetoric and stopgap legislation sometimes substitute for rational reflection. We become so impressed with social engineering that we overlook inherent human limitations.

Since the mid-sixties, American society has been increasingly agitated by what has been defined as a marihuana problem. The typical sequences of "a national problem" have resulted: exaggeration, polarization and the inevitable demand for a solution. The appointment of this Commission and the publication of this Report reflect the escalation of marihuana use into the realm of social problem. Since the beginning of our official life, we have grappled with the threshold question: Why has the use of marihuana reached problem status in the public mind?

Origins of the Marihuana Problem

Marihuana has been used as an intoxicant in various parts of the world for centuries and in this country for 75 years. Yet use of the drug has been regarded as a problem of major proportions for less than a decade. We will not find the reasons for contemporary social concern in pharmacology texts or previous governmental reports, for we are dealing with two separate realities: a drug with certain pharmacologic properties and determinable, although variable, effects on man; and a pattern of human behavior, individual and group, which has, as a behavior, created fear, anger, confusion, and uncertainty among a large segment of the contemporary American public. The marihuana behavior pattern is the source of the marihuana controversy.

The most apparent feature of the behavior is that it is against the law. But inconsistency between behavior and the legal norm is not sufficient, in itself, to create a social problem. Marihuana, has been an illegal substance for several decades; and the widespread violation of laws against gambling and adultery have not excited the public to the same extent as has marihuana-smoking in recent years.

At the same time, we suspect that illegality may play an important role in problem definition where drugs are concerned. Alcohol is of proven danger to individual and societal health and the public is well aware of its dangers, yet use of this drug has not been accorded the same problem status. Marihuana's illegality may have been a necessary condition for the marihuana problem, but the increased violation of the legal proscription does not by itself explain the phenomenon.

The Commission believes that three interrelated factors have fostered the definition of marihuana as a major national problem. First, the illegal behavior is highly visible to all segments of our society. Second, use of the drug is perceived to threaten the health and morality not only of the individual but of the society itself. Third, and most important, the drug has evolved in the late sixties and early seventies, as a symbol of wider social conflicts and public issues.

VISIBILITY

More than anything else, the visibility of marihuana use by a segment of our population previously unfamiliar with the drug is what stirred public anxiety and thrust marihuana into the problem area. Marihuana usage in the United States has been with us for a very long period of time, dating back to the beginning of the century. For decades its use was mainly confined to the underprivileged socioeconomic groups in our cities and to certain insulated social groups, such as jazz musicians and artists. As long as use remained confined to these groups and had a negligible impact on the dominant social order, the vast majority of Americans remained unconcerned. From the other side, the insulated marihuana user was in no position to demand careful public or legislative scrutiny.

However, all this changed markedly in the mid-1960's. For various reasons, marihuana use became a common form of recreation for many middle and upper class college youth. The trend spread across the country, into the colleges and high schools and into the affluent suburbs as well. Use by American servicemen in Vietnam was frequent. In recent years, use of the drug has spanned every social class and geographic region.

The Commission-sponsored National Survey, "A Nationwide Study of Beliefs, Information and Experiences," indicated that some 24 million Americans have tried marihuana at least once and that at least 8.3 million are current users.

Other surveys uniformly indicate that more than 40% of the U.S. college population have tried marihuana, and in some universities the figure is much higher. Also, use of the drug has become almost as common among young adults out of college, and among older teenagers in high school. The National Survey indicates that 39%, of young adults between 18 and 25 years of age have tried marihuana. The stereotype of the marihuana user as a marginal citizen has given way to a composite picture of large segments of American youth, children of the dominant majority and very much a part of the mainstream of American life.

Public confusion, anger, and fear over this development became increasingly apparent during the mid and late 1960's. Such mass deviance was a problem and the scope of the problem was

augmented by frequent publicity. The topic of the usage of marihuana by the young received considerable attention from newspapermen and television reporters. The drug's youthful users abetted the media in this regard by flaunting their disregard of the law, Few of us have not seen or heard of marihuana being used en masse at rock concerts, political demonstrations and gatherings of campus activists.

In addition, new scientific and medical interest in marihuana and its use was stimulated by the sudden public interest. For the first time in the American experience, the drug became the subject of intensive scrutiny in the laboratories and clinics. Unfortunately, this research was conducted in the spotlight of public controversy. Isolated findings and incomplete information have automatically been presented to the public, with little attempt made to place such findings in a larger perspective or to analyze their meanings.

Any new marihuana research has had ready access to the news spotlight and often has been quickly assimilated into the rhetoric of the marihuana, debate. Science has become a weapon in a propaganda battle. Because neither the reporters nor the public have the expertise to evaluate this information, the result has been an array of conflicting anecdotal reports, clinical studies on limited populations, and surveys of restricted utility.

Visibility, intense public interest, and fishbowl research are all important components of the marihuana problem.

PERCEIVED THREATS

Although marihuana is taken by most users for curiosity or pleasure, the non-using public still feels seriously affected by use of the drug. Several decades ago it was popularly asserted that the drug brought about a large variety of social and individual ills, including crime and insanity. As a result it was prohibited by federal law in 1937. The marihuana explosion of the mid-sixties occurred within the context of 30 years of instilled fear. Although based much more on fantasy than on proven fact, the marihuana "evils" took root in the public mind, and now continue to color the public reaction to the marihuana phenomenon. Even beyond the violation of law, the widespread use

of marihuana, is seen as a threat to society in other ways. And the threats grow proportionately as the controversy swells.

It has been astutely observed that any statement frequently repeated in public assumes the status of fact. With so many people continually arguing about marihuana, the public has understandably become alarmed and confused.

On the basis of the National Survey, we have tried to identify the ways in which the public feels threatened by marihuana use. Essentially these threats fall into three general categories: threats to the public safety, threats to the public health, and threats to the dominant social order.

In terms of public safety, the concern is with the relationship between marihuana and aggressive behavior, crime and juvenile delinquency. Threats to the public health usually refer initially to the impact of marihuana on the user. Lethality, psychosis, addiction potential and effects of chronic long-term use, are major concerns. Additionally, the fear exists that marihuana leads to the use of more dangerous drugs, especially LSD and heroin.

The threat which marihuana use is thought to present to the dominant social order is a major undercurrent of the marihuana problem. Use of the drug is linked with idleness, lack of motivation, hedonism and sexual promiscuity. Many see the drug as fostering a counterculture which conflicts with basic moral precepts as well as with the operating functions of our society. The "dropping out" or rejection of the established value system is viewed with alarm. Marihuana becomes more than a drug; it becomes a symbol of the rejection of cherished values.

SYMBOLISM

The symbolic aspects of marihuana are the, most intangible of the items to which the Commission must address itself, and yet they may be at the heart of the marihuana problem. Use of marihuana was, and still is, age-specific. It was youth-related at a time in American history when the adult society was alarmed by the implications of the youth " movement": defiance of the established order, the adoption

of new life styles, the emergence of "street people," campus unrest, drug use, communal living, protest politics, and even political radicalism. In an age characterized by the so-called generation gap, marihuana symbolizes the cultural divide.

For youth, marihuana became a convenient symbol of disaffection with traditional society, an allure which supplemented its recreational attraction. Smoking marihuana may have appealed to large numbers of youth who opposed certain policies or trends, but who maintained faith in the American system as a whole. In ;a time when symbolic speech is often preferred to the literal form, marihuana was a convenient instrument of mini-protest. It was also an agent of group solidarity, as the widely-publicized rock concerts so well illustrate.

For the adult society, the decade of the sixties was a distressing time. The net effect of racial unrest, campus disruption, political assassination, economic woes and an unpopular war was widespread uneasiness. Attending a general fear that the nation was witnessing its own disintegration was a desire to shore up our institutions and hold the line. That line was easy to define where drugs, particularly marihuana, were concerned.

Use of drugs, including marihuana, is against the law. For many, marihuana symbolized disorder in a society frustrated by increasing lawlessness. Insistence on application of the law tended also to harden views, thereby escalating still further the use of marihuana as a symbolic issue.

The social conflicts underlying the drug's symbolic status have dissipated somewhat in the past few years; and in some ways, the Commission has similarly noted a partial deflation of the marihuana problem and of the emotionalism surrounding it. We are hopeful that our attempt to clarify the scientific and normative dimensions of marihuana use will further deemphasize, the problem orientation and facilitate rational decision-making.

The Need for Perspective

This Commission has the task of exploring the marihuana

controversy from as many vantage points as possible in its attempt to make sound, realistic and workable policy recommendations. Because we are dealing essentially with a complex social concern rather than a simple pharmacologic phenomenon, any social policy decision must discuss the realities of marihuana as a drug, marihuana use as a form of behavior, and marihuana as a symbol.

Particularly important is the determination of the longevity of the behavior. Are we dealing with a behavior that is becoming rooted in our culture or are we experiencing an aberration, a fad that will in time, of its own accord, pass away?

The vortex of the marihuana controversy is the present, but the prudent policy planner must not be blinded by the deluge of recent statistics. It is important that we scan the past for clues about the meaning of certain behavior and the promise offered by various social policy responses. We are convinced that a wider historical understanding will also go a long way toward deflating marihuana as a problem.

HISTORICAL PERSPECTIVE

When viewed in the context of American society's ambivalent response to the non-medical use of drugs, the marihuana problem is not unique. Both the existing social policy toward the drug and its contemporary challenge have historical antecedents and explanations. Somewhat surprisingly, until the last half of the 19th century, the only drugs used to any significant extent for non-medical purposes in this country were alcohol and tobacco.

American opinion has always included some opposition to the nonmedical use of any drug, including alcohol and tobacco. From colonial times through the Civil War, abstentionist outcries against alcohol and tobacco sporadically provoked prohibitory legislation. One 18th century pamphleteer advised against the use of any drink "which is liable to steal away a man's senses and render him foolish, irascible, uncontrollable and dangerous." Similarly, one 19th century observer attributed delirium tremens, perverted sexuality, impotency, insanity and cancer to the smoking and chewing of tobacco.

Despite such warnings, alcohol and tobacco use took deep root in American society. De Tocqueville noted what hard drinkers the Americans were, and Dickens was compelled to report that "in all the public places of America, this filthy custom [tobacco chewing] is recognized." Nonetheless, the strain in our culture opposed to all non-medical drug use persisted and in the late 19th century gained ardent adherents among larger segments of the population.

Beginning in earnest around 1870, abstentionists focused the public opinion process on alcohol. As science and politics were called to the task, public attention was drawn to the liquor problem. "Liquor is responsible for 19% of the divorces, 25% of the poverty, 25% of the insanity, 37% of the pauperism, 45% of child desertion and 50% of the crime in this country," declared the Anti-Saloon League. "And this," it was noted, "is a very conservative estimate."

The Temperance advocates achieved political victory during the second decade of the 20th century. By 1913, nine states were under statewide prohibition, and in 31 other states local option laws operated, with the ultimate effect that more than 50% of the nation's population lived under prohibition. Four years later, Congress approved the 18th Amendment and on January 16, 1919, Nebraska became the 36th state to ratify the Amendment, thus inscribing national Prohibition in the Constitution.

Although on a somewhat smaller scale and with lesser results, public attention was simultaneously attracted to a growing tobacco problem. Stemming partly from the immediate popularity of cigarette-smoking, a practice introduced after the Civil War, and partly from riding the coattails of abstentionist sentiment, anti-tobacconists achieved a measure of success which had previously eluded them. The New York Time editorialized in 1885 that:

The decadence of Spain began when the Spaniards adopted cigarettes and if this pernicious habit obtains among adult Americans, the ruin of the Republic is close at hand. . . .

Between 1895 and 1921, 14 states banned the sale of cigarettes.

Although though there has been some posthumous debate about the

efficacy of alcohol Prohibition as a means of reducing excessive or injurious use, the experiment failed to achieve its declared purpose: elimination of the practice of alcohol consumption. The habit was too ingrained in the society to be excised simply by cutting off legitimate supply.

In addition, the 18th Amendment never commanded a. popular consensus; in fact, the Wickersham Commission, appointed by President Hoover in 1929 to study Prohibition, attributed the Amendment's enactment primarily to public antipathy toward the saloon, the large liquor dealers and intemperance rather than to public opposition to use of the drug.

Subsequent observers have agreed that Prohibition was motivated primarily by a desire to root out the institutional evils associated with the drug's distribution and excessive use; only a minority of its supporters opposed all use. And in this respect, Prohibition succeeded. Upon repeal, 13 years after ratification, liquor was back, but the pre-Prohibition saloon and unrestrained distribution had been eliminated from the American scene.

Both the scope of the alcohol habit and the ambivalence of supporting opinion are manifested in the internal logic of Prohibition legislation. The legal scheme was designed to cut off supply, not to punish the consumer. Demand could be eliminated effectively, if at all, only through educational efforts. Only five states prohibited possession of alcohol for personal use in the home. Otherwise, under both federal and state law, the individual remained legally free to consume alcohol.

The anti-tobacco movement was not propelled by the institutions outrage or the cultural symbolism surrounding the alcohol problem It never succeeded on a national scale. Local successes were attributable to the temporary strength of the abstentionist impulse, together with the notion that tobacco-smoking was a stepping-stone to alcohol use Lacking the consensus necessary to reverse a spreading habit, tobacco "prohibition" never extended to possession. Insofar as the anti-tobacco movement was really a coattail consequence of alcohol Prohibition, is not surprising that all 14 states which had prohibited sale repealed their proscriptions by 1927.

By the early 1930's, the abstentionist thrust against alcohol and tobacco had diminished. State and federal governments contented themselves with regulating distribution and extracting revenue. When the decade ended, the general pu lic no longer perceived alcohol and tobacco use as social problems. The two drugs had achieved social legitimacy.

A comparison between the national flirtation with alcohol and tobacco prohibition and the prohibition of the non-medical use of other drugs is helpful in analyzing the marihuana issue. In 1900, only a handful of states regulated traffic in "narcotic" drugs--opium, morphine, heroin and cocaine even though, proportionately, more persons probably were addicted to those drugs at that time than at any time since. Estimates from contemporary surveys are questionable, but a conservative estimate is a quarter of a million people, comprising at least 1% of the population. This large user population in 1900 included more females than males, more whites than blacks, was not confined to a particular geographic region or to the cities, and was predominantly middle class.

This 19th century addiction was generally accidental and well hidden. It stemmed in part from over-medication, careless prescription practices, repeated refills and hidden distribution of narcotic drugs in patent medicines. Society responded to this largely invisible medical addiction in indirect, informal ways. Self -regulation by the medical profession and pharmaceutical industry, stricter prescription practices by the state governments and regulation of labeling by the Federal Government in 1906 all combined in the early years of the new century to reduce the possibility of this accidental drug addiction.

About this same time, during the late 19th and early 20th centuries, attention within the law enforcement and medical communities was drawn to another use of narcotics----the "pleasure" or "street" use of these drugs by ethnic minorities in the nation's cities. Society reacted to this narcotics problem by enacting criminal legislation, prohibiting the non-medical production, distribution or consumption of these drugs. Within a very few years, every state had passed anti-narcotics legislation, and in 1914 the Federal Government passed the Harrison

Narcotics Act.

The major differences between the temperance and anti-narcotics movements must be, emphasized. The temperance, movement was a matter of vigorous public debate; the anti-narcotics movement was not. Temperance legislation was the product of a highly organized nation-wide lobby; narcotics legislation was largely ad hoc. Temperance legislation was designed to eradicate known problems resulting from alcohol abuse; narcotic--, legislation was largely anticipatory. Temperance legislation rarely restricted private activity; narcotics legislation prohibited all drug-related behavior, including possession and use.

These divergent policy patterns reflect the clear-cut separation in the public and professional minds between alcohol and tobacco on the one hand, and "narcotics" on the other. Use of alcohol and tobacco were indigenous American practices. The intoxicant use of narcotics was not native, however, and the users of these drugs were either alien, like the Chinese opium smokers, or perceived to be marginal members of society.

As to the undesirability and immorality of nonmedical use of narcotics, there was absolutely no debate. By causing its users to be physically dependent, the narcotic drug was considered a severe impediment to individual participation in the economic and political systems. Use, it was thought, automatically escalated to dependence and excess, which led to pauperism, crime and insanity. From a sociological perspective, narcotics use was thought to be prevalent among the slothful and immoral populations, gamblers, prostitutes, and others who were already "undesirables." Most important was the threat that narcotics posed to the vitality of the nation's youth.

In short, the narcotics question was answered in unison: the nonmedical use of narcotics was a cancer which had to be removed entirely from the social organism.

Marihuana smoking first became prominent on the American scene in the decade following the Harrison Act. Mexican immigrants and West Indian sailors introduced the practice in the border and Gulf states. As the Mexicans spread throughout the West and immigrated

to the major cities, some of them carried the marihuana habit with them. The practice also became common among the same urban populations with whom opiate use was identified.

Under such circumstances, an immediate policy response toward marihuana quite naturally followed the narcotics pattern rather than the alcohol or tobacco pattern. In fact, marihuana was incorrectly classified as a "narcotic" drug in scientific literature and statutory provisions. By 1931, all but two states west of the Mississippi and several more in the East had enacted prohibitory legislation making it a criminal offense to possess or use the drug.

In 1932, the National Conference of Commissioners on Uniform State Laws included an optional marihuana, provision in the Uniform Narcotic Drug Act, and by 1937 every state, either by adoption of the Uniform Act or by separate legislation, had prohibited marihuana use. In late 1937, the Congress adopted the Marihuana Tax Act, superimposing a, federal prohibitory scheme on the state scheme.

Not once during this entire period was any comprehensive scientific study undertaken in this country of marihuana, or its effects. The drug was assumed to be a 'narcotic' to render the user psychologically dependent, to provoke violent crime, and to cause insanity. Although media attention was attracted to marihuana use around 1935, public awareness was low and public debate non-existent. As long as use remained confined to insulated minorities throughout the next quarter century, the situation remained stable. When penalties for narcotics violations escalated in the 1950's, marihuana penalties went right along with them, until a first-offense possessor was a felon subject to lengthy incarceration.

With this historical overview in mind, it is not surprising that the contemporary marihuana experience has been characterized by fear and confusion on one side and outrage and protest on the other. As scientific and medical opinion has become better known, marihuana has lost its direct link with the narcotics in the public mind and in the statute books.

But extensive ambivalence remains about the policies for various drugs. Marihuana's advocates contend that it is no more or less

harmful than alcohol and tobacco and should therefore be treated in similar fashion. The drug's adversaries contend that it is a stepping-stone to the narcotics and should remain prohibited. At the present time public opinion tends to consider marihuana less harmful than the opiates and cocaine and more harmful than alcohol and tobacco.

Interestingly, while marihuana. is perceived as less harmful than before, alcohol and tobacco are regarded as more harmful than before. In some ways, the duality which previously characterized American drug policy has now been supplanted by an enlightened skepticism as to the variety of approaches to the non-medical use of various drugs.

Despite this shift in attitudes, however, the use of alcohol and tobacco is not considered a major social problem by many Americans, while marihuana use is still so perceived.

This remains true despite the fact that alcoholism afflicts nine million Americans. According to the National Institute on Alcohol Addiction and Alcoholism of the National Institute of Mental Health: alcohol is a factor in half (30,000) of the highway fatalities occurring each year; an economic cost to the nation of $15 billion occurs as a result of acoholism and alcohol abuse; one-half of the five million yearly arrests in the United States are related to the misuse of alcohol (1.5 million offenses for public drunkenness alone) ; and one-half of all homicides and one-fourth of all suicides are alcohol related, accounting for a total of 11,700 deaths annually.

Similarly, tobacco smoking is not considered a major public concern despite its link to lung cancer and heart disease. According to the Surgeon General in The Health Consequences of Smoking, 1972:

cigarette smoking is the, major "cause" of lung cancer in men and a significant "cause" of lung cancer in women; the risk of developing lung cancer in both men and women is directly related to an individual's exposure as measured by the number of cigarettes smoked, duration of smoking, earlier initiation, depth of inhalation, and the amount of "tar" produced by the cigarette; and data from numerous prospective and retrospective studies indicate that

cigarette smoking is a significant risk factor contributing to the development of coronary heart disease (CHD) including fatal CHD and its most severe expression, sudden and unexpected death.

CULTURAL PERSPECTIVE

Realizing the importance of social change in understanding the issues surrounding the use of marihuana and other drugs, the Commission decided early that an objective appraisal of cultural trends was vital for the development of policy recommendations. Since neither the increase in marihuana use nor its attendant controversy is an isolated phenomenon, we sought a wider cultural perspective. To this end, the Commission sponsored a wide-ranging seminar on "Central Influences on American Life." With the cooperation of the Council for Biology in Human Affairs of the Salk Institute, we elicited a three-day conversation among 13 exceptionally thoughtful and perceptive observers of American life.*

*The participants included Jacques Barzun, as moderator, Mary Bingham, Claude T. Bissell, Kenneth Boulding, Robert R. Bowie, Theodore Caplow, Jay W. Forrester, T. George Harris. Rollo May, Jay Saunders Redding, Jonas Salk, Ernest van den Haag, and Leroy S. Wehrle.

It is well beyond both our mandate and our competence to attempt a definitive presentation of the status of the American ethical system However, we shall try to suggest some of the more salient influence in our changing society, recognizing that only against the backdrop of society's fears, aspirations and values can a rational response to marihuana be formulated. Although we are not prepared to identify specific causal connections between these social trends and marihuana use, we do believe that some of the major points raised in the discussion of cultural change provide essential background in understanding the marihuana problem.

The Search for Meaning

One overriding influence in contemporary America is the declining capacity of our institutions to help the individual find his place in

society. As one of the participants at the Seminar observed:

A society is stable, peaceful, happy, not when it has rid itself of the tensions-because you never get rid of the tensions, because people's drives will be satisfied in ways that clash and so on-but when a very high proportion of the people feel fulfillment of some sort within the context which the society normally provides. The long-term problem now, for many many people, not just young people, is that this condition is not met.

Another noted:

What is wrong with our social system, it seems to me, is that it no longer inspires in people a feeling of purpose, meaningfulness and so on.

A number of institutional trends have joined to deprive the individual of a sense of communal inspiration. Perhaps most important is the economic element. Whereas the individual's economic achievement formerly gave his life broad social meaning and inspired his existence, automation and technological advance have tended to depersonalize the individual's role in the economy. Instead of the economic system being dependent on individual productivity, the individual is increasingly dependent on the system. As his work dwindles in significance to the total society, it diminishes in meaning for him. Moreover, as more and more of our people share the nation's affluence, Horatio Alger's example is no longer needed to climb the economic ladder.

A particularly emphatic manifestation of the declining economic demand on the individual is the institutionalization of leisure time. Whereas the economy used to require long hours of work, now it barely requires more than a five-day week. Expanding vacation time and reduced work-weeks tend to diminish the strength of the work ethic. The implications of enforced leisure time are only now becoming apparent, and the concept of "idle hands are the devil's plaything" has to be reexamined in terms of acceptable forms of non-work behavior. This new time component, allowing for the assertion of individuality, has produced both privileges and problems.

In the last decade we have seen the beginnings of the institutionalization of this leisure ethic. A leisure-time industry has sprung up to organize this time period for the individual. Many Americans, due to the nature of their jobs in an automated economic system, find little personal satisfaction in their work, and many are now searching for individual fulfillment through the use of free time. Where meaning is not found in either work or recreational pursuits, the outcome is likely to be boredom and restlessness. Whether generated by a search for individual fulfillment, group recreation or sheer boredom, the increased use of drugs, including marihuana, should come as no surprise.

Another social development which has chipped away at individual identity is the loss of a vision of the future. In an age where change is so rapid, the individual has no concept of the future. If man could progress from land transportation to the moon in 60 years, what, lies ahead? Paralleling the loss of the technological horizon is the loss of a vision of what the future, in terms of individual and social goals, ought to look like. Are times moving too fast for man to be able to plan or -to adjust to new ways and new styles? This sense of the collapsing time frame was best summed up by one of the Seminar participants:

.... there are great forces that have developed over the last several decades that cause one to lose sight of the distant future. Let me contrast a rural farm family of several decades ago which settled a farm. They expected their children to live there, they can imagine their grandchildren living there-there is an image of the future. There is really no one who [now] has any image of where his great grandchildren will he or what they will do. This comes about because of the nature of industrial society; it comes about because we have retirement plans instead of looking after one's own old age. There area whole set of these [factors].

Now the morality, the ethics get tied into it because ethics are really a long-time horizon concept. It's something you engage in because it's contrary to immediate reward and immediate gratification and so you look to some distant future. But as one loses sight of any future then I think the ethics and morality creep up to the very near term also . . . We have no one who has got an image of this country two

hundred years from now, who is trying to create a structure that be believes will exist that long. So a number of these things . . . tie together in terms of the long-term goals and how they have shifted. In any of our systems there tend to be a conflict between the short-term and the long-term goals. If the long-term goals are lost sight of then the short-term expediencies seem to be the things that well up.

To the extent that planning for the future no longer gives the individual his inspiration, he must look to the present. Such a climate is conducive to pleasure-seeking, instant gratification and an entire life-perspective which our society has always previously disclaimed A third force depriving the individual of a presumed place in society is the loss of a sense of community, a sense of belonging. Mobility, mass living and rapid travel all conspire to destroy the smaller community. The family moves from place to place and then separates with each child going his own way. This global thinking leaves little time for home-town concern.

The dissipation of geographic roots parallels a social uprooting. As one of our Seminar participants noted:

When you grow up with a small number of people with whom you have to live for a while, it does something which isn't done now. It forces you to face yourself. It forces you to ask what kind of pet-son you are, because you can't get away with it with a group you're going to have to live with. They know what you really are. The mobility has the effect of making it possible for people to live playing parts for years. It seems to me we see it among the youngsters: role playing as distinguished from being somebody. . . .

All of these social trends have their most potent impact on young people who are just beginning to develop their values, beliefs and commitments. The adult society has found it easier to adjust to the emergence of the leisure value. Having experienced it as a gradual process, they see it as a reward for previous toil. For many of our young, however, a substantial segment of leisure time may be considered an essential part of living; they have known no other experience. Similarly, an adult society, increasingly influenced toward the present, at least has developed an historical perspective. Also, adult values were internalized at a time when a future vision

was possible. For many of the young, however, the present weighs more, heavily. This notion is best reflected in the vociferous youth response to the Vietnam conflict, the embodiment of a war fought for the future,

Finally, all of these cultural changes have occurred, especially for the young, in an environment of affluence. The successful economic system has maximized individual freedom. But the individual has been given unlimited choices at exactly the time when a, value system within which to make such choices is in doubt. Because he has no sense of direction, the result is restlessness, boredom and an increase in the likelihood of present-oriented choices. Self-destructive drug-taking is one form such behavior may take. One of our Seminar participants observed in this connection:

It seems to me that you've got this affluence. So that while most of us grew up with the feeling that the channels within which we were going to have to move and make choices were very narrow, channels for these youngsters look absolutely open. It's an absolutely a, la carte menu-it's the biggest a la, carte menu you can imagine. [This occurs] in a situation in which this sense of radical change is going on so fast that you can't master it, together with a feeling that the society is being operated by very large organizations which you can't get a grip on, giving one a sense of helplessness, of not knowing where to take hold. All these things inherently are disorienting to youngsters and don't give them a, feeling of challenge, [but rather] a doubt as to the meaning of their own lives, of the significance of their being here, [a sense of] being atoms. So then they do act like children in the sense of behaving violently to call attention to themselves. They do a whole lot of other things which, it seems to me, are the sort of things you often see when people feel their lives have no meaning.

Skepticism

Another major influence in contemporary American life with substantial relevance to the marihuana problem is the uneasy relationship between the individual and society's institutions, particularly the state. For 50 years, there has been a continuing upward flow of power to large institutional units, whether they be

consequences of the social and economic changes which have occurred over the last several decades. The best example, and the one most germane to the youth, is the educational system. Two generations ago, the labor force could assimilate the large majority of the nation's youth. Neither a high school nor a college education was prerequisite to occupational choice or achievement. Increased educational attainment was presumed to be limited to either the privileged or the able and would be rewarded by certain careers.

Today, however, the labor force grows more quickly than the system is able to assimilate it, and the educational system now serves as custodian as well as teacher. Although we sincerely wish to achieve the democratic ideal of a highly educated populace, we also keep our children in school as long as possible because we have nothing else for them to do. The trend is strikingly apparent even in the last 20 years.

Percent enrolled in school

Age	**1950**	**1970**
14-15	94.7	98.1
16-17	71.3	90.0
18-19	29.4	47.7
20-24	9.0	21.5

This custodial function confronts educators with a dilemma. Attrition is not in society's best interest; thus, single-minded devotion to the highest levels of achievement would be dysfunctional. In a sense, because the system no longer wants to turn away its subjects, the notion of failure has lost its meaning. As one of the Seminar participants observed:

I think one of the problems is that there is no longer a penalty for failure. We-the educators-have had to lower standards in order to accommodate these people who need no longer fear failure. Of course this has been a cyclical thing, a wheel within a wheel. [If] there is no longer a penalty for failure, then there is no longer the need to acquire.

The changing function of education has been felt in both the secondary schools and in our institutions of higher learning. Numerous high school graduates cannot read. Colleges and junior colleges have sprung up overnight to accommodate the population, but many provide classrooms with little specific purpose. Only slowly is the educational system beginning to come to grips with its role in a changed society. At the university level, many educators have been appalled at sacrifices which have ensued from the custodial feature; rote learning, they contend, has supplanted citizen and character education.

Uncertainty about the role of the educational system has not escaped the students, particularly at the college level. Many of our youth, pressed into longer attendance, question its need or desirability. The demand for "relevance" is but another reflection of the search for meaning, for an understandable role in society. Drug use has perhaps provided an outlet for some members of this restless generation, uncertain of its place.

The Limits of Rationality

The social response to the individual's search for meaning has fostered an ambivalence, an unwillingness to act, a paralysis. In large measure, according to one Seminar member, this default of authority reveals the intensity of the search:

In the same way we are getting universities that can't teach, families that can't socialize and police forces that can't catch criminals. In every case, the same issue is involved: the subject of authority questions the legitimacy of authority and the exerciser of it is unable to find-very often doesn't even try to find-a defense, because he feels in himself a sympath as do so many parents, with the challenge.

To a significant extent, society is waiting, hoping that the impulse for change will settle around certain fundamental attributes of the American ethic. At the present time, however, no consensus about the nature of these fundamentals exists. We are all looking for values that have deep roots, as we attempt to sort out the durable from the ephemeral.

All of the participants at our Central Influences Seminar agreed that the unique feature of this search was its a rational quality. As one observer put it:

We have been discussing the question of how we change a society. I don't think it's changed by rational intention. As I understand societies, historically and our own, what really is required to change it is something on a deeper level that involves myth, ritual, sacrament-a number of these functions that have always been related to societies. On these you can't just suddenly make up your mind and then prescribe.

Regarding our problem of authority, you cannot really ask the question: why can't these people hang onto their authority? They can't hang onto it because what gave them authority is something not of themselves, but part of the society, part of a ritual, a sacrament: a way of behaving in the group which gave them authority, [whether] professorial, parental or policy authority. In each one of these cases, what we see is not the diminishing of these men so much but rather the developing emptiness, the lack of the particular ethic that gave them authority to start with. This is why we are in a terrible dilemma.

What is essentially lacking is a system of ethics, morality or religion that gives birth -to the myths, the rituals, the sacraments that are its

expression. These touch human beings on the unconscious level. These are the ways we see the world. They are not our conscious thought, but the ways we form ourselves, form each other, love each other or hate each other-in terms not so much of rational intention as a deeper unconscious-conscious and unconscious-which is my definition of a myth; much more of a feeling level, a living level. That is what is not present now.

What we need, below and above all of our deliberations, is the growth and development of an ethical system. We just do not have this now.

As we move into the 1970's, our society is collectively engaged in the task -of determining what America means, and how each individual should find fulfillment in `a changing age. From this wider perspective of flux emerges an uncertainty about what the increased prevalence of marihuana use means for the individual and the total society.

Formulating Marihuana Policy

Present symbolism, past implications, and future apprehensions all combine to give marihuana many meanings. These diverse notions of what marihuana means constitute the marihuana problem. In this atmosphere, the policy-maker's position is precarious insofar as no assumption is beyond dispute. Accordingly, the Commission has taken particular care to define the process by which a social policy decision should be reached.

In studying the arguments of past and present observers to justify a particular kind of marihuana policy, we conclude that a major impediment to rational decision-making in this area is oversimplification. As suggested earlier, many ingredients are included in the marihuana mix-medical, legal, social, philosophical, and moral. Many observers have tended to isolate one element, highlight it and then extrapolate social policy from that one premise. In an area where law, science and morality are so intertwined, we must beware of the tendency toward such selectivity.

SCIENTIFIC OVERSIMPLIFICATION

It is wrong to assume, as many have done, that a particular statement of marihuana's effects compels a given social policy or legal implementation. An accurate statement of the effects of the drug is obviously an important consideration, but it is conclusive only if the effects are extreme one way or the other. For example, if the use of a particular drug immediately causes the user to murder anyone in his presence, we have no doubt that a vigorous effort to eliminate use of that drug would be in order. On the other hand, if the effects of the drug are purely benign, presenting no danger whatsoever to the user or society, no reason would exist to suppress it.

We know of no psychoactive substance, including marihuana, which falls at either of these extremes. Thus, it begs the issue to contend, as some have done, that because we don't know enough about the effects of heavy, chronic use, we should maintain the status quo. We know a lot about the adverse effects of alcoholism and heavy cigarette smoking, and yet no responsible observer suggests that we should adopt total prohibition for these drugs. Similarly, previous estimates of marihuana's role in causing crime and insanity were based quite erroneous information; but to infer from this that marihuana should be considered totally benign and hence made freely available is also not logical. Both approaches are simplistic; both approaches fail to take into account the social context in which the drug is used and the dynamic factors affecting the role that marihuana use may or may not play in the future.

A similar manifestation of scientific oversimplification is the focus on causality. Many opponents of marihuana use feel compelled to establish a causal connection between marihuana use and crime, psychosis, and the use of other drugs, while, their adversaries focus the dispute on negating such relationships. The Commission believes that this tendency misses the mark.

The policy-maker's task is concerned primarily with the effects of marihuana on human behavior. For both philosophical and practical reasons, proof of causal relationships is next to impossible. At the same time, however, the extent to which marihuana use is associated with certain behaviors and whether any significant relationships exist

can offer important clues.

We must be cautious when dealing with such data. Yet we cannot afford to paralyze the decision-making process simply because absolute "proof " is lacking. Spokesmen on both sides of the marihuana debate should focus not on causation but instead on the relevance of the association between various behavioral effects and marihuana use.

PHILOSOPHICAL OVERSIMPLIFICATION

Some partisans stoutly maintain that the state has no right to interfere with essentially private conduct or that the state has no right to protect the individual from his own folly. Some of the greatest minds of the Western world have struggled over such philosophical issue always with the same outcome: a recognition of the need to draw a line between the individual and his social surroundings. That is, everything an individual does, in private or not, potentially may affect others. The issue is really to determine when the undesirable effect upon others is likely enough or direct enough for society to take cognizance of it and to deal with it. Coupled with this is the further question of whether the nature of the behavior and its possible effect is such that society should employ coercive measures.

Advocates of liberalization of the marihuana laws commonly contend either that the decision to use marihuana is a private moral decision or that any harm flowing from use of the drug accrues only to the user. Defenders of the, present restrictions insist that society not only has the right but is obligated to protect the existing social order and to compel an individual to abstain from a behavior which may impair his productivity. Unfortunately, the issue is not so simple and the line often drawn between the private conduct and behavior affecting the public health and welfare, is not conclusive or absolutely definable.

For example, a, decision to possess a firearm, while private is considered by many to be of public magnitude, requiring governmental control. A decision to engage in adulterous conduct, although generally implemented in private, may have public consequences if society believes strongly in the desirability of the

existing family structure. Similarly, excessive alcohol consumption, in addition to its adverse effects on individual health, may impair familial stability and economic productivity, matters with which the total society is concerned.

So, while we agree with the basic philosophical precept that society may interfere with individual conduct only in the public interest, using coercive measures only when less restrictive measures would not suffice this principle merely initiates inquiry into a rational social policy but does not identify it. We must take a careful look at this complicated question of the social impact of private behavior. And we must recognize at the outset the inherent difficulty in predicting effects on public health and welfare, and the strong conflicting notions of what constitutes the public interest.

Again and again during the course of our hearings, we have been startled by the divergence of opinion within different segments of our population. Sometimes the disagreement is quite vehement, and relates to the underlying social concerns of particular groups. For example, we were told repeatedly by leaders of the urban black communities that they wanted to purge all drug use from their midst, marihuana included, and that the "legalization" of marihuana would be viewed as part of a design to keep the black man enslaved.

On the other hand, we were informed repeatedly by the activist student element that the pre-sent social policy regarding marihuana was merely a tool for suppression of political dissent, and until the law was changed, there could be no hope of integrating the dissident population into the mainstream of American society.

Such statements reemphasize the degree to which marihuana is regarded as a symbol of a larger social concern.

The conflicting notions of the public interest by different segments of the population reinforced in the Commission's deliberations the realization that we have been called upon to recommend public policy for all segments of the population, for all of the American people. The public good cannot be defined by one segment of the population, the old or the young, users or non-users of marihuana, ethnic minorities or white majority. At the same time, the fears of

each of these groups must be taken into consideration in arriving at the basic social objectives of the Commission's public policy recommendation. Where such fears are real, they must be confronted directly; where they are imagined, however, they must be put in perspective and, hopefully, laid to rest.

SOCIOLOGICAL OVERSIMPLIFICATION

Public debate and decision-making in our society suffer from the glorification of statistical data. After a particular social phenomenon, such as marihuana use, has been defined as a problem, armies of social scientific researchers set out to analyze and describe the problem. A sophisticated computer technology instantly translates millions of bits of data into correlations, probabilities and trends. The most striking findings are then fed to a data-hungry public. The result is data overload.

Descriptive information about the nature and scope of marihuana use as a behavior is an essential component of the policy-maker's knowledge-base. However, such information does not in itself have social policy implications. The policy-maker must define goals and evaluate means; only after he asks the right questions will statistical data suggest useful answers. Unfortunately, a tendency exists in the marihuana debate to assign prescriptive meanings to descriptive data without testing the underlying assumptions. Further, the data have often been accumulating in a fragmented way. No overall plan was devised beforehand; the result has been an ad hoc use of available data triggered by individual research interests rather than by long-term policy needs.

What does it mean that 24 million people have tried marihuana? Some have suggested that it means marihuana ought to be legalized. But does it mean the same thing if 15 million tried the drug once and have decided not to use it again? And does it mean the same thing if popular interest in the drug turns out to be a passing fancy, which wanes as suddenly as it waxed?

On the other side of the controversy, what does it mean that a substantial percentage of the public would favor increased penalties for marihuana use? The prescriptive implications of a democratic

impulse may be offset by a preference for individual freedom of choice. Also, this segment of public opinion may have been influenced by incorrect information, such as unwarranted belief in marihuana's lethality or addiction potential. So, although the policy-maker must be aware of political realities, he must not allow his function to be supplanted by public opinion polls. This is an area which requires both awareness of public attitudes and willingness to assert leadership based on the best information available.

LEGAL OVERSIMPLIFICATION

Perhaps the major impediment to rational decision-making is the tendency to think only in terms of the legal system in general and of the criminal justice system in particular. This thinking is certainly understandable, given the history of marihuana's involvement with the criminal law. Nonetheless, the law does not exist in a social vacuum, and legal alternatives can be evaluated only with reference to the values and policies which they are designed to implement and the social context in which they are designed to operate.

Legal fallacies are apparent on both sides of the marihuana controversy. Many of the persons opposed to marihuana use look exclusively to the law for social control. This reliance on the law is stronger today because many of our fellow citizens are uneasy about the diminishing effectiveness of our other institutions, particularly when the non-legal institutions have been relatively lax in controlling drug related behavior. Increasing reliance is placed upon the legal system to act not only as policeman, but as father confessor, disciplinarian, educator, rehabilitator and standard-bearer of our moral code. Little or no thought is given to what impact this over-reliance on the law has on the viability of other social institutions, not to mention it's effect on the legal process.

A society opposed to marihuana use need not implement that policy through the criminal law. Non-legal institutions, such as the church, the school and the family, have great potential for molding individual behavior. Accordingly, the policy-maker must delicately assess the capacity of the legal system to accomplish its task and must consider the mutual impact of legal and non-legal institutions in achieving social objectives.

We recognize the short-sightedness of an absolute assumption that the criminal law is the necessary tool for implementing a social policy opposed to marihuana use. But equally short-sighted is the opposing contention which attempts to analyze the law separately from its underlying social policy objective. This argument assumes that if the law isn't working, or if the costs of enforcing the law outweigh its benefits, the law should, therefore, be repealed.

If society feels strongly enough about the impropriety of a certain behavior, it may choose to utilize the criminal law even though the behavior is largely invisible and will be minimized only through effective operation of other agencies of social control. Laws against incest and child-beating are good examples. In weighing the costs and benefits of a particular law, one must provide a scale and a system of weights. The scale is the normative classification of behavior, and the system of weights is the largely subjective evaluation of the importance of the values breached by the behavior. This weighing process is what is open to dispute.

In sum, no law works alone. Where an unquestioned consensus exists about the undesirability of a particular behavior and all social institutions are allied in the effort to prevent it, as is the case with murder and theft, the law can be said to "work" even though some murders and thefts may still be committed. Where society is ambivalent about its attitude toward the behavior and other institutions are not committed to its discouragement, the law cannot be said to be working, even though many people may not engage in the behavior because it is against the law.

The question is whether the social policy, which the law is designed to, implement, is being achieved to a satisfactory extent. To determine the role of law regarding marihuana, we must first look to society's values and aspirations, and then define the social policy objective. If we seek to discourage certain marihuana-related behavior, we must carefully assess the role of the legal system in achieving that objective.

The Report

In this Chapter, we have tried to put the marihuana problem in perspective. In the remainder of this Report, we explore several aspects of the phenomenon of marihuana use, its effects, its social impact and its social meaning, assessing their relative importance in the formulation of social policy.

In Chapter II, we consider the effects of the drug on the individual user, with particular attention to the size of the user population for whom various effects are relevant. The Commission emphasizes that this material is related only indirectly to its policy-making function. The social policy planner is concerned not about the effects on the individual per se, but about the impact of any adverse effect on his behavior and on the larger society and about the meaning of this behavior in the larger social perspective. The material in Chapter II serves primarily to educate and inform.

In Chapter III, the Commission evaluates the various threats which marihuana use is perceived to present to the public safety, public health, and dominant social order. This Chapter is designed to assess the social impact of marihuana use, the initial step in the policy making process.

In Chapter IV, we consider what role marihuana use plays and will play in the life of American society. This is the dynamic element of marihuana use and is the most intangible of the marihuana realities, but is particularly important from a policy-planning perspective. This consideration is the one most overlooked by contemporary observers and participants in the marihuana debate.

Because social meaning is not a directly measurable entity, we must examine the ways in which society responds to the behavior and whether such responses, both formal and informal, are fluid or static. After analyzing public opinion, law enforcement behavior and the reactions of medical, educational, and other segments of the population, we then discuss what marihuana use has come to mean and is likely to mean in the future. Particularly important in this highly speculative endeavor is the wider cultural perspective which we described earlier in this Chapter.

In Chapter V, we bring this information to bear on a policy-making process. After establishing the philosophical framework, we explore the spectrum of social policy options, choosing the one we judge most suitable to the present time. Then we consider the range of legal alternatives for implementing this chosen policy, and select the one we believe to be most appropriate for achieving it.

In an addendum to the Report, we present some ancillary recommendations. Some of these recommendations flow from our basic premise, others are a result of independent evaluation by the Commission of other areas of concern.

We ask the reader to set his preconceptions aside as we have tried to do, and discriminate with us between marihuana, the drug, and marihuana, the problem. We hope that our conclusions will be acceptable to the entire public, but barring that, we hope at the least that the areas of disagreement and their implications will be brought into sharper focus.

The National Commission on Marihuana and Drug Abuse

Marihuana - A Signal of Misunderstanding.

Chapter II

marihuana use and its effects

"Facts are stubborn things; and whatever may be our wishes, our inclinations, or the dictates of our passions, they cannot alter the state of facts and evidence." John Adams (1770)

The ultimate objective of the Commission is to evaluate the total impact of actual and potential marihuana use on contemporary American society. This endeavor involves three phases: first, an evaluation of the nature and scope of contemporary American marihuana use; second, a careful reevaluation of the pharmacological effects of the drug on the human body with special emphasis on the drug's capacity to alter or modify behavior; and third, an evaluation of the impact of marihuana use on society. This chapter deals with the first and second phases, and Chapter Three deals with the third.

The Marihuana User

Cannabis has been used widely for many centuries in nonindustrialized countries of Asia and Africa. Today, as in earlier years, use of drug is concentrated primarily among lower socioeconomic groups. in these countries, the practice is estimated to be confined to a tenth of the lower socioeconomic, male population. Although such use of the drug is well-established, it offers little direct comparison with the American experience.

Although the commercial, industrial and therapeutic value of the hemp plant was widely recognized and exploited in the United States from the earliest days of its history, knowledge and use of its intoxicating and psychoactive properties remained largely unknown until about 1900.

At that time, the custom of smoking marihuana was generally limited to groups of Mexican itinerant workers in the border states of the Southwest. By 1910, marihuana use began to emerge in other southern states and cities, particularly New Orleans, and in the port cities along the Mississippi River. In time, these cities became distribution centers for enterprising sailors. From there, marihuana use spread cross-country to other urban centers, mining camps, railroad construction sites, farm labor camps, "bohemian" communities of artists and jazz musicians, and various other groups outside the mainstream of American society.

Recently, of course, use of the drug has spread to young, white, middle class groups and especially to high school and college populations.

DEMOGRAPHIC CHARACTERISTICS

On the basis of the Commission-sponsored National Survey, we have concluded that contemporary marihuana use is pervasive, involving all segments of the U.S. population. The Survey estimated that about 24 million Americans over the age of 11 years (15% of the adults 18 and over, and 14% of the 12-17 year olds) have used marihuana at least once, referred to in this Report as ever-users. Until recently twice as many males as females had used it; the most up-to-date studies of high school students, college-age individuals, and young adults carried out by the Commission indicate that this sex differential appears to be diminishing. In many youthful populations use is almost equally distributed between males and females.

Marihuana use does not appear to vary significantly by race. With respect to the religious affiliation of the users, Jews and Catholics appear to be slightly overrepresented as compared to Protestants.

Usage is highest in cities, towns, and suburbs but not uncommon in rural areas. States in the Northeast and West have considerably higher rates of use than have the North Central states, which in turn have significantly higher rates than those in the South.

Use is found in all socioeconomic groups and occupations, though slightly more predominant among persons with above-average

incomes. A New York survey of the state's general population indicated that ever-use as well as regular use is almost equally prevalent among sales workers, clerical workers, skilled, semiskilled and unskilled workers, managers, owners, professionals and technical workers.

At the same time, the incidence of use seems to vary according to educational attainment. Among all adults not now in school, 5% of those with an eighth grade education or less have used the drug, contrasted with 11% of those who completed some high school, 14% of those who graduated from high school, 25% of those who completed some college and 21 % of those who graduated from college.

Age is presently one of the most significant correlates of marihuana use. Among the total population, those who have tried or used marihuana at least once, termed ever-users, are heavily concentrated in the 16-25 age bracket. Of all the ever-users, about half are in this group. At the same time, however, we should emphasize that use is by no means confined to teenagers and young adults.

The proportion of individuals in different age groups who have used marihuana is indicated in Figure 1.

The incidence of use is greatest among young people: 27% of the 16-17 year olds, 40% of the 18-21 year olds, and 38% of the 22-25 year olds have tried marihuana; at the low extremes, 6% of the 12-13 year olds and 6% of the over-50 generation have used the drug.

Among those now in school, incidence also seems to rise with increasing school level: Ever-users represent 44% of those persons now in college or graduate school; 30% of high school juniors and seniors; 17% of freshmen and sophomores; and 8% of students in junior high school.

At the same time, the use of the drug among adults is by no means confined to college students. Even among the 18-25 year olds, 75% of the ever-users are not now in school.

The initial patterns of contemporary marihuana use appear to be shifting; there is a trend toward increased use among college students as well as non-college students. Non-student users now span social class, income level and occupational classification. In addition, the proportion -of users increases during the teens, peaks during the young adult years and then falls off rapidly (Figure 1).

Having described the incidence of any use of marihuana ever, and demographic characteristics of the 24 million Americans who have tried the drug, we recognize the need to place this information into perspective. The policymaker must also be concerned with the patterns of use: frequency, amount consumed at each smoking, and duration of use.

PATTERNS OF USE

The most striking of the use patterns revealed in the National Survey is that 41 % of the adults and 45 % of the youth who have ever used marihuana reported that they no longer use the drug. Twenty-nine percent of the adults and 43% of the youth reported that they are still using marihuana (see Table 1). When asked why they bad terminated use, the overwhelming majority of adults (61%) specified, among other reasons, that they had simply lost interest in the drug.

Table I.-EXPERIENCE WITH MARIHUANA

Percent of ever-users

Frequency	Adults (18 and over)	Youth (12-17)	Designation
Have used marihuana but no longer use.	41	45	Experimenters.

Once a month or less 9 15

2-3 times pet month 8 10 Intermittent users.

Once per week 4 9 @

Several times per week 5 4 Moderate users.

Once daily 1 1 1

More than once daily 2 4 Heavy users.

No answer 30 12

These data indicate that at least 41% of the adults and 45% of the youth have used marihuana but have -discontinued use; 9% of the adults and 15% of the youth use the drug sporadically, once a, month or less. These persons can be characterized as experimental marihuana users.*

To ensure an understanding of this section of the Report, some definitions are required at this juncture. In this report, the Commission employs the following designations:

Frequency of Use

Experimental-At least one trial to once a month or less.

Intermittent-Two to 10 times monthly.

Moderate-11 times monthly to once, daily.

Heavy-Several times daily.

Very Heavy-Almost constant intoxication with potent preparations; brain rarely drug free.

Duration of Use

Short Term-Less than two years.

Long Term-Two to 10 years.

Very Long Term-Over 10 years.

Twelve percent of the adults and 19% of the youth who have ever used marihuana can be designated intermittent users; they continue to use the drug more than once a month, but less than several times a week, probably on weekends. Six percent of the adults and five percent of the youth are moderate users who continue to use marihuana several times a week to once daily.

Finally, 2% of the adults and 4% of the youth who have ever used marihuana are heavy users: they use the drug several times daily. A very small fraction of these heavy users may be very heavy users, who are intoxicated most of their waking hours and probably use very potent preparations of the drug.

In addition to frequency, duration of use is an important variable in discussing use patterns and especially when considering drug effects. Most users in this country have smoked the drug over a short term, that is, less than two years. Others have used the drug over a long term, two to 10 years. Very few Americans can be considered very long term users, that is, over 10 years.

Another important element of use is the amount of marihuana used on each occasion. Most intermittent and moderate users average about one-half to one cigarette per occasion, usually at night. Most heavy users smoke at least one to two cigarettes an occasion, with a few using as many as five consecutively.

As this brief description of use patterns suggests, marihuana use and the marihuana user do not fall into simple, distinct classifications. Although it is possible to sketch profiles of various marihuana-using populations, no valid stereotype of a marihuana user or non-user can be drawn. The spectrum of individuals who use or have used

marihuana varies according to frequency, intensity and duration of use. It is meaningless to talk of "the marihuana user" or "marihuana use" without first clarifying descriptive data.

*All respondents for the National Survey were asked to complete a self administered questionnaire. This instrument covered many sensitive areas, including a series of items on personal experience with marihuana and other drugs. Given the nature of the questions, the contractor took every precaution to insure that the interviewee responded honestly and that his responses were kept strictly confidential. Even the interviewer who orally administered the rest of the Survey was not permitted to view the written instrument.

One of the inevitable costs of such confidentiality is the risk that a certain percentage of respondents would not complete one or more of the questions. Where a significant number of questions remained unanswered, the questionnaire was not tabulated at all. However, in 30%, of the otherwise complete questionnaires, the adult respondents who had ever used the drug did not answer the question, "On the average, about how often do you use marihuana at the present time?"

Concerned about the meaning of this non-response rate, the, Commission directed the contractor to conduct a detailed analysis comparing the non-respondents with all respondents and with those individuals who had never used marihuana at all. On the basis of this analysis, we are confident that the overwhelming majority, if not all, of the non-respondents are experimenters.

In the first place, the demographic characteristics of the non-respondents coincide closely with those of the non-users and less frequent users. Very few of the young adults, where more frequent use is concentrated, failed to respond.

Secondly, the non-respondents are disproportionately located in the geographic regions where use was least prevalent and least frequent. For example, 50% of the ever-users in the North Central region failed to respond, compared to 71% in the West. Yet only 5% of the ever-users in the North Central region continue to use the drug more than once a week, compared to 21% in the West; and less than .5%

of the ever-users in the North Central region use the drug more than once a day, as compared to 4% in the West.

PROFILES OF USERS

Several studies by the Commission and many other recent college and high school surveys have elucidated a variety of personality types or categories of marihuana users. These profiles relate primarily to the patterns depicted above and to the meaning of marihuana use for various individuals. Essentially we will describe a continuum with much overlapping among the categories. The reader should understand that group identification is at best a hazardous occupation; the traits described are not exclusive to marihuana users. A much larger number of individuals who have not used the drug can be similarly described.

Experimental Users

The first and by far the largest group has been designated as "experimenters" because of their extremely infrequent or non-persistent marihuana usage. Experimentation with the drug is motivated primarily by curiosity and a desire to share a social experience. These experimenters are characteristically quite conventional and practically indistinguishable from the non-user in terms of life style, activities, social integration, and vocational or academic performance.

Disciplined, optimistic, and self-confident, experimenters appear to be as conventional, responsible, goal-oriented and orderly as non-users.

Intermittent Users

The intermittent users are motivated to use marihuana for reasons similar to those of the experimenters. They use the drug irregularly

and infrequently but generally continue to do so because of its socializing and recreational aspects. For the intermittent user, marihuana often contributes to the establishment and solidification of close social relations among users similarly inclined. The individual has a sense of belonging to an intimate group.

Investigations of behavioral aspects of marihuana smoking clearly demonstrate that marihuana smoking is a social activity, believed by intermittent users to enhance the enjoyment of shared activities, especially music, art, films and food.

In a Commission-sponsored study to determine the effects of repeat doses of marihuana, under free access conditions, the subjects smoked almost exclusively in groups. A certain number of these individuals tended to share much of their leisure time in common activities, and marihuana, smoking was the focal activity around which other types of social interactions revolved, such as conversation, watching TV, listening to music and playing games. The intermittent users studied exhibited an increased sense of well-being, relaxation, and friendliness during these activities. They were more inclined to seek and emphasize the social rather than personal effects of the drug.

Intermittent marihuana users, like the experimenters, are generally conventional in most respects. They are more liberal politically and socially and they tend to stress education for personal improvement rather than for recognition or high grades. Like many non-users, these individuals are likely to be self-expressive, intellectually and culturally oriented, creative, and flexible. Placing a high value on experimentation and responsible, independent decision-making, they often manifest a desire to search for new experiences, res' 'ting in some behaviors which depart from the norms of the larger society. Often accompanying their search is a sense of uncertainty about the future.

Moderate and Heavy Users

The final groups of marihuana users are the moderate and heavy users. This range is wide and includes indiv duals who use

marihuana more than 10 times a month to several times a day. Practically all of the American research effort to date has focused on the large majority of individuals who use less often, that is, the experimental and intermittent users. Consequently, not enough is known about characteristics and behavior of the moderate and the heavy users, so it is difficult to distinguish accurately between the two groups. We suspect however that the moderate users share traits with both the intermittent and the heavy users. Having already discussed the intermittent group, we will now turn to the characteristics of the heavy group.

Heavy users seem to need the drug experience more often. Their initial and continued marihuana use is motivated not only by curiosity and an urge to share a social experience but also by a desire for "kicks," "expansion of awareness and understanding," and relief of anxiety or boredom.

Generally, the heavy marihuana user's life style, activities, values and attitudes are unconventional and at variance with those of the larger society. These individuals are more pessimistic, insecure, irresponsible, and nonconforming. They find routine especially distasteful. Their behavior and mood are restless and uneven.

Heavy users place particularly strong emphasis on impulsive response in the interest of pleasure-seeking, immediate gratification, and individual expression. They tend to evidence social and emotional immaturity, are especially indifferent to rules and conventions, and are often resistant to authority. However, several surveys have also revealed that they tend to be curious, socially perceptive, skillful and sensitive to the needs of others, and possess broadly based, although unconventional, interests.

The Boston free-access study permitted the Commission to observe a group of individuals whose life styles, activities, values and attitudes are representative of a segment of the unconventional youthful subculture. The month-long period of controlled study during the fall prevented the participation of individuals who were married, steadily employed, or enrolled in school.

Individuals who smoked marihuana once a week or less were

sought by the researchers but were exceedingly unusual among the population available for the study. Consequently, the group studies contrasted with the student and full-time working populations in which weekly marihuana use is more common. For this reason, the intermittent users studied appeared to be similar to, rather than different from, the moderate and heavy users studied. Both groups had used marihuana for an average of five years.

Under the study's confined conditions, participants tended to smoke more marihuana than they did "on the outside." The intermittent users, who by our definition averaged eight times a month under outside conditions, averaged three cigarettes a day during the study. The range was from one-half to six cigarettes daily.

The moderate and heavy users, who "on the outside" averaged 33 times a month, now averaged six-and-a-half cigarettes a day. The range was three-and-a-half to eight cigarettes. In discussing the Boston study, we will call this group "daily" users.

Smoking usually occurred at night, sometimes during the afternoon and only occasionally upon awakening. The intermittent and heavy users usually smoked one cigarette a session. The daily users were more likely to smoke more than one a session. A few individuals in the daily group could have been considered constantly intoxicated on a few occasions during the 21 -day period.

The mean age of the subjects studied was 23. Based on IQ testing, they were superior intellectually, although they had completed, on the average, only two-and-a-half years of college. Their job histories were rather erratic, characteristic of a pattern of itinerant living. The intermittent users -were from a middle or upper class background, while the daily users generally shared a lower socioeconomic status. Broken homes and instances of alcohol or drug abuse were more common in the family backgrounds of the daily users.

Alcohol was rarely used by the subjects. Use of hallucinogens and amphetamines was significantly more widespread and had begun earlier in the daily user group. In contrast to the intermittent group, the daily users almost uniformly reported that marihuana smoking produced relaxation, noting **also** increased alteration **in** perception or

psychedelic-like effects. Similarly, they reported an increased sense of well-being, friendliness, carefreeness and decreased hostility. Additionally, the daily users appeared to demonstrate a moderate psychological dependence **on** the marihuana experience while the intermittent users demonstrated little or no psychological dependence.

Analysis of social-behavioral aspects of daily users' marihuana smoking clearly demonstrated that it is a pivotal social activity around which conversation, other personal interactions, and much of the users' lives revolve. Smoking almost exclusively occurred in groups and was the focal activity around which these groups formed. The daily users exhibited a readiness to take part in but not to initiate a smoking session.

In contrast to the intermittent users, all the daily users in a group smoked when marihuana was made available. Marihuana smoking appeared to be a primary means of reinforcing group solidarity. Yet these users were more inclined to seek the personal effects of the drug rather than the socializing effects sought by the intermittent users.

The social adjustment of the daily users, when judged from a traditional psychiatric standpoint, was impaired. Individuals tended to be more withdrawn and to interact less with each other than the intermittent users, regardless of the type of activity or state of intoxication. However, the daily users did appear to accommodate themselves better than the intermittent users to the effects of the intoxication on social interaction.

Despite a relatively high level of scholastic attainment and superior intelligence, many of the subjects were performing well below their intellectual capability, usually working at menial, mechanical or artisan tasks. They were not oriented toward achieving the traditional goals of the larger society.

Nonetheless, during the period of the Boston study, the subjects could not be characterized as displaying a general lassitude and indifference, carelessness in personal hygiene or lack of productive

activity, all supposed to be characteristic of very heavy use. Even during the periods of heaviest marihuana smoking, they maintained a high level of interest and participation in a variety of personal activities, such as writing, reading, keeping up on current world events, and participating in athletic and aesthetic endeavors.

Additionally, all of the subjects maintained a desire to complete all aspects of the research study. Although they could be labeled 'underachievers" in terms of the traditional standards of the larger society, these individuals were motivated to pursue actively the interests and activities of their **own** subculture.

Generally, most studies which have been undertaken indicate that individuals who are heavy marihuana users cannot find a place for themselves in conventional society. Their heavy marihuana use may reflect and perhaps perpetuate their unconventionality while providing social acceptance in one of the non-conventional subcultures.

Very Heavy Users

The Commission's analysis of frequency, quantity and duration of marihuana use suggest that the United States is at the present time in a fortunate position. All of the studies available to the Commission have indicated that only a minute number of Americans can be designated as very heavy marihuana users. These studies uniformly indicate that chronic, constant intoxication with very potent cannabis preparations is exceedingly rare in this country.

The Commission believes that important distinctions must be made between the daily (moderate and heavy) American marihuana user and the very heavy hashish or charas user in other parts of the world where cannabis is widely cultivated and its use deeply ingrained. Many of the North African and Asian users do not employ the drug only as an intoxicant in the western sense. Instead, it is frequently used in "folk medical practice," in religious rites and as a work adjunct particularly in those occupations which are physically demanding, monotonous, unintellectual, and offer little possibility of advancement.

In these countries, very heavy use is typically associated with young males from a lower socioeconomic background. Nonetheless, use is more widespread among all ages and elderly chronic users are not uncommon.

Generally, these very heavy users consume high amounts of very potent preparations continually throughout the day so that they are rarely drug-free. These individuals evidence strong psychological dependence on the drug, requiring compulsive drug-taking. Clear-cut behavioral changes occur in these extreme cases. The very heavy User tends to lose interest in all activities other than drug use. A common element of the behavioral pattern is lethargy and social deterioration. Not surprisingly, these users have been held in low esteem and very heavy use has been subject to societal disapproval in almost all countries.

BECOMING A MARIHUANA USER

Our attempt to classify marihuana users is primarily for descriptive purposes. It does not imply that all individuals who resemble any of the categories are necessarily marihuana users. Nor is it implied that all marihuana users fit neatly or precisely into these slots. There is no "typical" marihuana user, just as their is no typical American. The most notable statement that can be made about the vast majority of marihuana users-experimenters and intermittent users-is that they are essentially indistinguishable from their non-marihuana using peers by any fundamental criterion other than their marihuana use.

But if most users and non-users of marihuana essentially are indistinguishable, why have some people chosen to use the drug and others not, and why have some people continued to use it and others not? An important part of the explanation is that use of marihuana, like all human behavior, occurs within specific social and cultural settings. The individual's biological characteristics and personality probably play an important role in determining the pattern his use will take. However, the cultural and social setting play a larger role in determining whether be will use it at all.

Numerous studies have demonstrated that the young person who chooses to use marihuana differs in some important sociological respects from his peer who does not choose to do so. These differences relate to his willingness to experiment with a drug, especially a forbidden one. in short, the process of becoming a marihuana user is not a " seduction of the, innocent" as is often portrayed. Based on interrelated familial, social and cultural factors, persons, especially young persons, who may choose to use marihuana can be predicted statistically.

Parental Influence

The decision to use marihuana is related to parental life style.

Parents provide the most important example of acceptable drug-taking behavior for their children. That marihuana users frequently have medicine-taking, cigarette-smoking, or liquor-drinking parents has been demonstrated. In a series of Canadian studies, grade and high school students who said their mothers took tranquilizers daily were three times more likely to try marihuana than the students who did not so report.

Beyond the influence of a drug-taking example, parents have the primary influence on their childrens' acquisition of skills, values and attitudes necessary to be mature and responsible adults. Many parents have oriented their children toward becoming independent, competent, educated, and adaptive adults.

Simultaneously, many young people observe in their parents' lives the trend toward shorter work periods, earlier retirement and increased emphasis on leisure time activities. It appears that the incidence of adolescent marihuana use is strongly correlated with this trend toward increased leisure time.

Situational Factors and Behavioral Correlates

All studies of the ever user, including the Commission-sponsored National Survey, have established that marihuana smoking is

significantly correlated with a number of demographic variables. Males, college students, and residents of metropolitan areas, especially in the Northeast and West, are generally overrepresented in proportion to their percentage of the total population.

Among the behaviors statistically correlated with marihuana, use are radical politics, visits to psychiatrists, sexual freedom, and separate residences from parents. The most significant behavior seems to be use of legal drugs, especially alcohol and tobacco. Young people who choose to experiment with marihuana are fundamentally the same people, socially and psychologically, as those who use alcohol and tobacco. For example, in a study of high school youngsters, only 3% of all the nonsmokers in the sample had ever tried marihuana, compared with 50% of all the current cigarette smokers. Similarly, for alcohol drinking outside the family setting, only 2% of all the nondrinkers had tried marihuana, as compared to 27% of the drinkers. The National Survey tends to confirm the close association between marihuana use and cigarette smoking and alcohol use. Among all the adults sampled in the Survey, 71% had smoked cigarettes and 39% are current smokers. Similarly, of adult non-marihuana users, 70% have smoked cigarettes and 38% are current smokers. These percentages increase somewhat for marihuana users: 87 have smoked cigarettes and 54% are current cigarette smokers.

In regard to alcohol consumption, 40% of all the adults sampled indicated that they had not consumed beer or bard liquor in the 30 d..ys prior to the survey. Marihuana users tended to have consumed alcohol more often than non-marihuana users (Table, 2).

Table 2.-LIQUOR CONSUMPTION DURING 30-DAY PERIOD

	1-4 days	5-10 days	11 or more days	No answer
Percent of nonmarihuana users. .	**45**	**19**	**6**	**7**	**21**

Percent of marihuana users..... 26 30 12 8 24

Social Group Factors

One of the most influential factors in determining behavior in contemporary America among adolescents and young adults is peer group influence. Knowing other people who use marihuana predisposes the individual to use marihuana, and having marihuana-using friends provides the social opportunity for the curious. Ile individual who is already part of a, social group which uses marihuana indicates by this choice that his attitudes and values are already to some degree compatible with illicit drug use.

Social peer groups are especially influential upon individuals who have not yet become "successful" adults, such as adolescents, college students and young adults, who spend a great deal of time and effort competing for status in situations where status opportunities are minimal. The social peer group provides an opportunity for achieving status among equals by demonstrating competence and autonomy. Outstanding performance in athletics, organizations or academics demonstrates competence but not autonomy because these activities are adult-oriented and controlled. Additionally, only a relative few are able to excel.

Opportunity to prove oneself is more readily available in the peer group. Often, adolescents participate in forms of delinquent behavior, termed symbolic infractions, in order to demonstrate autonomy and competence to their peers. These include joy-riding, vandalism, sexual promiscuity, underage drinking, violation of rules of decorum and dress, and purposeless confrontation with authority.

Marihuana use has recently been added to the list of infractions and offers several advantages for adolescents and young adults. Most important, it provides a shared group experience which offers the, shy, lonely, socially awkward neophyte a means of entrance to the group, complete with its own ceremonial initiation. Repetition of the behavior serves to increase closeness and commitment to the group. Usually the experience is pleasurable and the individual is able to

control his level of intoxication. This delinquency is viewed as relatively harmless to oneself and others, although its symbolic impact on parents and authority is often greater than that of other common infractions.

Therefore, a, subtle process of acquiring attitudes favorable to drug use, of having friends and acquaintances who define the marihuana experience in acceptable and pleasurable terms, and of having a social belief system which prepares one to accept the conversion process to begin with, are all powerful complementary factors which direct a young person toward marihuana use. At this point, the use of marihuana provides further opportunities for acquiring new marihuana using friends and entering the social milieu of marihuana, users.

The Dynamics of Persistent Use

The cultural and social factors sketched above, in combination with the individual's somatic and psychic characteristics, determine the pattern of his drug behavior once he has chosen to experiment with it. The majority of individuals who reach this point progress no further and often discontinue marihuana use. The most common explanation for discontinuing use is loss of interest; the effect lost its novelty and became boring. Other less common reasons are fear of legal hazards, social pressure, and concerns over physical and mental drug effects. Among the infrequently noted reasons are: interference with other activities; replacement by alcohol; unavailability; cost; unpleasant experiences; fear of moral transgression; or progression to other forms of non-drug interests such as yoga, transcendental meditation, agrarian communes, esoteric religion and restrictive diets.

For those who continue use, psychosocial factors are important determinants of the use patterns. Many marihuana users are strongly committed to traditional society in which they desire to rise socially. They have chosen to participate fully in the traditional adult-oriented activities and the formal achievement-reward system. Their peer groups consist primarily of similarly oriented individuals. The infrequent use of marihuana by these persons is a social activity for fun and satisfies curiosity.

Those individuals who continue to use marihuana more frequently appear to be different types of people and oriented toward a different part of the social system. Most of them maintain stable career orientations and continue to function within the broader society. But they feel more burdened by the traditional system of social controls and more removed from contemporary society's institutions. These individuals tend to turn away from more traditional adult-oriented reward systems and intensify their peer-group orientation. Their interests and activities emphasize an informal "in-crowd," out-of-school or work orientation. The meaning of marihuana use by this peer group emphasizes the ideological character of usage. In contrast to the infrequent type of user, these individuals seem to build their self-identity around the marihuana-using peer group.

BECOMING A MULTIDRUG USER

The more one smokes marihuana, the more involved his interpersonal relationships are likely to become with his peers who share the experience with him. As he spends more time with this group, he begins to sever his contacts with conventional individuals and conventional routines. He may eventually view himself as a drug user and be willing to experiment with other drugs which are approved by his peer group. Only a small portion of the marihuana users who reach this stage are likely to become persistent, frequent users of these other drugs. The majority appear to experiment only.

Epidemiologic Studies

The Commission's studies have confirmed the association between marihuana usage and the consumption of other drugs for curiosity and pleasure. This association holds for all drugs, including over-thecounter and prescription pain relievers, tension relievers, sleeping pills, and stimulants as well as hashish, methamphetamines, cocaine, LSD and mescaline, and heroin. The National Survey showed that current marihuana users are about twice as likely to have used any illicit drugs than are those who have ceased using marihuana (Table

3).

Table 3.-ILLICIT DRUG USE BY ADULTS

Substance	Never used marihuana (percent)	Have used marihuana but no longer use marihuana (percent)	Currently using marihuana (percent)
Hashish	Less than 0.5 percent	28	63
LSD or mescaline	Less than 0.5 percent	11	28
Methamphetamine	Less than 0.5 percent	10	23
Cocaine	Less than 0.5 percent	4	10
Heroin	Less than 0.5 percent	1	4

The Commission additionally has contracted a study of 105 selected, middle class, young, working adults from California, who are marihuana smokers. Of this sample, 11% were daily marihuana users and 47% used it several times a week; 33% used it several times a month; 6% used it once to several times a year; and 3% had used it but were not currently using marihuana. The study indicates that while most of the subjects were frequent marihuana users, the incidence of other drug use was relatively low (Table 4).

Table 4.-FREQUENCY OF OTHER DRUG USE BY MARIHUANA USERS

Percent who use marihuana	Percent

Substance who	Once to	Several	Several
never	several times	times	Daily
used	times a month	a week	
marihuana	a year		
Hashish			
42			
31			
21			
5			
0			
LSD			
96			
4			
0			
0			
0			
Mescaline			
79			
19			
0			
0			
2			
Psilocybin			
96			
4			
0			
0			
0			
STP, DMT			
100			
0			
0			
0			
0			
Heroin			
98			
2			
0			
0			
0			

Codeine
87
11
0
0
2

Amphetamines
89
7
0
4
0

Barbiturates
86
10
4
0
0

Cocaine
75
19
2
4
0

Glue
100
0
0
0
0

With the exception of marihuana and hashish, no drug was used by more than 25% of this population and this use was almost exclusively experimental. Interestingly, the more exotic drugs, mescaline and cocaine were more frequently used (21% and 25% of this sample respectively) than the common dangerous drugs: LSD (4%), heroin (2%), codeine (11%), barbiturates (14%), and amphetamines (11%).

Among high school students, marihuana, is normally the, first illicit drug used, although several recent studies have suggested that a significant number of students initiate illicit use, with other drugs. Of the marihuana users, a majority have used no other illicit drug, and

they tend to be experimental or intermittent users of marihuana.

The more frequently the adolescent uses marihuana, the more likely he is to experiment with other drugs. For example, in one recent study of San Diego high school students of predominantly white middle socioeconomic background, 80% of the students who used marihuana weekly or more often had used other drugs, and 50% of this group had used LSD. In contrast, 33% of the less than weekly users bad used other drugs.

Profiles and Dynamics

The personality profile of the heavy marihuana user discussed earlier includes elements propelling him toward heavy involvement in the multiple-drug-using-subculture. Heavy drug use by these individuals may reflect and aggravate a total alienation and disaffiliation from American society and its institutions. This group hopes to find in drug use more than simple, fun or relief from boredom. The heavy use of drugs represents a shift into the drug subculture and an adoption of a totally new life style. Some observers feel that this shift provides a new identity which allows the individual to counteract his apathy and search for meaning in a society he views as unloving, lonely, and meaningless. He seeks to become involved with what he describes as the exciting, relevant, "real" experience of life. Additionally, he believes drug use provides new feelings and awareness needed to overcome barriers between himself, others, and the natural world.

The drug culture as a community also helps to meet the needs of the individual. It provides a ready supply of drugs, unites common experiences and secrets that enhance the drug experience, and protects the individual against undesired experiences and against "the outside world." Most important, the culture instills self-confidence by reassuring the individual that he has been wise in choosing this new identity.

Frequently, these are individuals who express feelings of loneliness, isolation and over-protection from their home and family. One frequent pattern involves an intimate, dominating mother and a