

Medical Aspects

BY S. ALLENTUCK, M.D.

I. SYMPTOMS AND BEHAVIOR

In Preliminary Group

The preliminary study of the five volunteer subjects had for its purpose the establishment of methods or procedures to be followed for the main group, and the obtaining of a general picture of the physical and mental effects induced by the drug. Having no knowledge of the safe limits of marijuana dosage, the dosage given to this group was restricted to from 1 to 4 cc, of the concentrate, and for smoking from one to three cigarettes.

When ingested, 1 cc. of marijuana was slightly effective, the multiples of this more so. There was noted in all subjects some increase in pulse rate and in blood pressure, dilated and sluggish pupils, dryness of the mouth and throat, ataxia, and some clumsiness and incoordination of movement. Symptoms distinctly disagreeable were dizziness in three subjects, a sense of heaviness of the extremities in two, nausea in two and faintness in two. Three showed motor restlessness. A state classed as euphoria, characterized by laughter, witticisms, loquaciousness, and lowering of inhibitions occurred in three subjects. This was not sustained but alternated with periods during which disagreeable symptoms were dominant. In one of the subjects (V.C.) there was no euphoric state, but a feeling of discomfort and depression throughout. Finally in one of the five (A.V.) with 2 cc. there was a state of depression with anxiety and with 4 cc. a psychotic episode with fear of death.

With the exception of the one individual during his psychotic episode, the subjects gave no evidence of abnormal mental content at any stage of the drug action, the only

change noted being a delay in focusing attention on questions asked and difficulty in sustaining mental concentration. While there was objection at times to carrying out repetitious tests, there was no definite refusal. There was no sexual stimulation giving rise to overt expression.

With the cigarette smoking, ataxia and changes in pulse rate, blood pressure and pupils corresponded to those following oral administration. In only one of the subjects, however, was there definite euphoria. The common symptoms were dizziness and drowsiness. Two of the subjects found it difficult to concentrate.

The duration of the effects of marijuana was variable. When it was ingested, the effects usually passed off in from two to four hours, but in one instance persisted for seven hours and in another for fourteen hours. After smoking, the duration of effects was from one to three hours.

In Main Group

The evidence of the effects of marijuana was obtained by the subject's statement of symptoms and sensations, by the nurse's reports and by the examiner's observations and interpretation of changes in the subject's mental state and behavior.

The dosage of the marijuana concentrate ranged from 2 to 22 cc. and in each subject the effects of more than one dose were studied. Dosage ranging from 2 to 5 cc. was used for the largest number of subjects, and that from 14 to 21 cc. on only seven occasions. It is known that marijuana intoxication may bring about a comatose state, but no attempt was made to determine the dosage required for this. The number receiving each of the selected doses is shown in Table 1.

TABLE 1

Dosage of marijuana

Dosage	Number of Subjects	Dosage	Number of Subjects	Dosage	Number of Subjects
2 cc.	37	8 cc.	4	14 cc.	1
3 cc.	6	9 cc.	6	15 cc.	2
4 cc.	20	10 cc.	8	17 cc.	1
5 cc.	16	11 cc.	5	18 cc.	1
6 cc.	8	12 cc.	5	19 cc.	1
7 cc.	7	13 cc.	4	22 cc.	1

While the duration of action and its intensity tended to increase with dosage, this was not always the case and equal doses did not bring about uniform effects in all those receiving them. Thus, 3 cc. produced a striking effect in one individual; much less in another; in still another, 10 cc. produced less effect than 5 cc. Such variations are to be explained by differences in the mental make-up of the subject, and the particular state of his responsiveness at the time when marijuana is taken.

The number of cigarettes smoked ranged from one to eleven. The smoking of a single cigarette took about ten minutes and up to eight could be smoked in an hour. In smoking, increasing the number of cigarettes usually increased the sensation described as "high," but here also there was no uniformity in individuals or groups.

When marijuana was ingested, in dosages from 2 cc. up, its actions became evident in one half to one hour. The maximum effects were seen in two to three hours. These subsided gradually, but the time of disappearance was variable, usually three to five hours, in some instances twelve hours or more.

When marijuana cigarettes were used the effects appeared almost immediately. After one cigarette, these had usually disappeared in an hour. After several cigarettes had been smoked the effects increased progressively in intensity and reached a maximum in about an hour. In most instances they disappeared in three to four hours.

The Concentrate

Behavior Symptoms. The effects on the general behavior of the subjects taking the concentrate were variable. If left undisturbed some remained quietly sitting or lying, showing little interest in their surroundings. Others were restless and talkative. Under the heading "Euphoria" there are listed those marijuana effects which give rise to pleasurable sensations or experiences. These are a sense of well-being and contentment, cheerfulness and gaiety, talkativeness, bursts of singing and dancing, daydreaming, a pleasant drowsiness, joking, and performing amusing antics. The drowsiness, daydreaming and unawareness of surroundings were present when the subject was left alone. Other euphoric expressions required an audience and there was much contagiousness of

laughing and joking where several of the subjects under marijuana were congregated. The occurrence of a euphoric state, in one or another form, was noted in most of the subjects. But, except for those who were allowed to pass the time undisturbed, the pleasurable effects were interrupted from time to time by disagreeable sensations.

Quite commonly seen, as with the preliminary group, was a difficulty in focusing and sustaining mental concentration. Thus, there would occur a delay in the subject's answers to questions and at times some confusion as to their meaning. There was, however, except in a few isolated instances, no abnormal mental content evident and the responses brought out by the examiner were not different from those in the pre-marijuana state.

Altered mental behavior which would give rise to more concern was seen in a relatively small number of subjects. In some this took the form of irritation at questioning, refusal to comply with simple requests and antagonism to certain of the examiners. There was, however, only verbal and no active opposition in any of these behaviors, caused by the subject's desire to be left undisturbed and his disinclination to carry out certain tests which in his pre-marijuana period he had considered tiresome and meaningless. With this came antipathy to those conducting the tests.

The occurrence of the disagreeable physical symptoms accompanying marijuana action would naturally lead to a feeling of disquietude and some alarm as to significance and consequences. This, however, was a prominent feature in relatively few instances. A pronounced state of anxiety reaching a panic stage, associated usually with fear of death or of insanity, was observed only in those subjects experiencing psychotic episodes and here the anxiety state led to pleas for escape and not to acts of aggression. Even in the psychotic states there were no uncontrollable outbursts of rage or acts of violence.

Some evidence of eroticism was reported in about 10 percent of the one hundred and fifty instances in which marijuana was administered to the group. The presence of nurses, attendants and other women associated with the study gave opportunity for frank expression of sexual stimulation, had this been marked. There was no such expression even during the psychotic episodes.

In some isolated instances there was evidence of marked lowering of inhibitions such as loud discharge of flatus, urinating on the floor instead of in the vessels supplied and in one instance frank exhibitionism. In the last instance the subject, who was not a regular marijuana user, had been arrested on three occasions for indecent exposure.

The frequency with which significant changes in behavior occurred is indicated in Table 2.

TABLE 2

Effects of varying doses of marijuana on behavior of users and non-users

<i>symptoms</i>	2-5 c.c.		6-10 c.c.		11-22 c.c.	
	Percent affected Users (41 trials)	Percent affected Non-users (43 trials)	Percent affected Users (25 trials)	Percent affected Non-users (12 trials)	Percent affected Users (17 trials)	Percent affected Non-users (3 trials)
Euphoria	92		92		100	
Excitement	19	32	8	41	24	33
Antagonism	7	11	0	16	6	0
Anxiety	7	27	4	41	6	33
Eroticism	4	11	4	16	12	0

As used in Table 2, anxiety means the subject's expressed worry concerning what might happen to him. Excitement, shown by physical restlessness, muscular twitchings and jerky movements, loud talking, and some degree of antagonism are known to be expressions of an "alarm" or "fear" state.

It is seen from this table that, except for euphoria, the effect of marijuana was definitely more pronounced on the non-users. This might be taken as evidence of a persisting tolerance to the drug in the user group, but, on the other hand, it may have as its basis a feeling of greater apprehension in the non-users. Such a feeling would undoubtedly arise among those who have had no previous experience with marijuana and are in a state of uncertainty as to its possible harmful effects.

Physical Symptoms. Of the subjective symptoms, a feeling described as lightness, heaviness, or pressure in the head, often with dizziness, was one of the earliest and occurred in practically all subjects, irrespective of dose. Dryness of the mouth and throat were reported by over half of the subjects as was also a floating sensation. Unsteadiness in movement and a feeling of heaviness in the extremities were commonly

experienced as was a feeling of hunger and a desire for sweets especially. Less commonly noted were nausea, vomiting, sensations of warmth of the head or body, burning of the eyes, and blurring of vision, tightness of the chest, cardiac palpitation, ringing or pressure in the ears and an urge to urinate or defecate.

From observation by the examiner, tremor and ataxia were present in varying degrees in practically all instances and in all dosages used, as were also dilation of the pupils and sluggish response to light. These effects were often present on the day following marijuana administration.

The frequency of the more common subjective symptoms and their relation to dosage is shown in Table 3. The figures are taken from the subjects' reports.

There is a tendency for the symptoms to be more frequent in the non-users than in the users but the differences are variable and in general not striking.

TABLE 3

Physical symptoms produced in users and non-users by varying doses of marijuana

<i>Symptoms</i>	2-5 c.c.		6-10 c.c.		11-22 c.c.	
	Percent Users (41 trials)	affected Non-users (42 trials)	Percent Users (25 trials)	affected Non-users (12 trials)	Percent Users (17 trials)	affected Non-users (3 trials)
Lightness in head, dizziness	83	97	80	85	100	100
Dryness of throat	69	72	48	67	76	100
Heaviness of extremities	46	51	32	41	41	67
Unsteadiness	41	39	20	33	41	33
Hunger, thirst High floating sensation	44	3.5	48	41	70	33
	60	63	72	66	64	33

The Cigarette

Smoking. When marijuana is smoked, there is, as has been stated, no such accuracy in dosage as is the case when it is ingested. The marijuana user acquires a technique or art in smoking "reefers." This involves special preparation of the cigarette and regulation of the frequency and depth of inhalations. In a group of smokers, a cigarette circulates from one to another, each in turn taking one or more puffs. The

performance is a slow and deliberate one and the cigarette, held in a forked match stick, is smoked to its end.

When the smoke comes in contact with the respiratory mucous membrane, the absorption of the active principle is rapid and the effects are recognized promptly by the subject. He soon learns to distinguish the amount of smoking which will give pleasant effects from the amount which will give unpleasant ones and so regulates his dosages. Providing there are no disturbing factors, as is the case in gatherings of small friendly groups or parties in "tea-pads," the regulated smoking produces a euphoric state, which accounts for continued indulgence.

The effect from smoking marijuana cigarettes was studied in thirty-two subjects. Of these, twenty were classed as users, that is, prior to their arrest they had more or less extensive experience in smoking. In the study the smoking was repeated by each subject several times, the number of cigarettes smoked within an hour ranging from one to eight.

In all of the user group the smoking produced a euphoric state with its feeling of well-being, contentment, sociability, mental and physical relaxation, which usually ended in a feeling of drowsiness. Talkativeness and laughing and the sensation of floating in the air were common occurrences. These effects were of short duration, from one to three or four hours after the smoking was concluded. In none of these subjects was there an expression of antagonism or antisocial behavior.

In the non-user group the effects were similar except that in one subject a state of mental confusion occurred and in another the main effect was a feeling of dizziness, unsteadiness and muscular weakness. Finally one subject showed effects entirely different from the others. He smoked one cigarette and became restless, agitated, dizzy, fearful of his surroundings, afraid of death. He had three short attacks of unconsciousness. At one period he had visions of angels, and for a few minutes a euphoric state. The entire episode lasted a little over an hour after which he went to sleep. This subject had a similar psychotic episode after taking 120 mg. of tetrahydrocannabinol. On seven other occasions he had been given the marijuana concentrate or tetrahydrocannabinol with no unusual effects.

Of the physical symptoms occurring with smoking, dryness

of the mouth and thorax, dizziness and a sensation of hunger were the most common. None of these or other symptoms seemed to lessen materially the pleasurable effects.

The effect of smoking on the seven females, six of whom were classed as users, corresponded to that on the male group. All showed euphoric effects. One of the subjects was nauseated and another was restless, irritable and contrary. These effects were observed in both of the subjects when marijuana was taken by stomach. One of the users, euphoric after smoking six and ten cigarettes, had a psychotic episode after 8 cc. of marijuana concentrate.

Tea-Pad Parties. * In addition to the quantitative data regularly obtained from the subject during the course of the testing program, the examiner had opportunity to make diverse observations of the subject's global reactions which threw interesting light on the general effect of the drug on the individual's personality.

When the subject became "high," his inclination was to laugh, talk, sing, listen to music, or sleep, but the requirement that he solve problems, answer questions, or remember drawings created an artificial situation, tending to bring him "down" and spoil his pleasure. In order, therefore, that the influence of the drug might be observed in less formal circumstances and in a set-up more nearly like the customary "tea-pad," two groups of men were given "parties" on the last night of their hospital sojourn. The men were consulted beforehand, and the stage was set according to their desires. They requested that nothing be done until it was really dark outside. They brought the radio into the room where the smoking took place and turned it to soft dance music. Only one shaded light burned, leaving the greater part of the room shadowy. The suggestion was made that easy chairs or floor cushions be procured but the party progressed without these.

The men were allowed as many cigarettes as they wanted. When the "reefers" were passed out they crowded around with their hands outstretched like little children begging for candy. The number of cigarettes the men smoked varied, the range being from two to twelve or thirteen. There were both users and non-users in these two groups. The users of course were highly elated at the prospect of getting much free "tea," and some of the non-users also smoked with genuine enjoyment.

* This section on "Tea-Pad Parties" was prepared by Mrs. Halpern.

In the beginning the men broke up into little groups of twos and threes to do their smoking, or in some instances went off by themselves. Smoke soon filled the atmosphere and added to the general shadowy effect. After the initial smoking there was some moving about; some men laughed and joked, some became argumentative, while some just stared out of the window. The arguments never seemed to get anywhere, although they often dealt with important problems, and the illogical reasoning used was never recognized or refuted by the person to whom it was addressed. Gradually, as though attracted by some force, all restlessness and activity ceased, and the men sat in a circle about the radio. Occasionally they whispered to one another, laughed a little, or swayed to the music, but in general they relaxed quietly in their chairs. A feeling of contentment seemed to pervade, and when one man suddenly got a "laughing jag" they were annoyed at the interruption.

In general, they gave the impression of adolescent boys doing something which was forbidden and thereby adding spice to the indulgence. Many of the adolescent personality patterns as they appear in group activities were clearly observable here. There was the eternal "wisecracker," the domineering "important" individual who tried to tell everyone what to do, the silly, giggling adolescent and the shy, withdrawn introvert. One forgot that these were actually adults with all the usual adult responsibilities. One could not help drawing the conclusion that they too had forgotten this for the time being.

Although urged to smoke more, no subject could be persuaded to take more than he knew or felt he could handle. After about an hour and a half of smoking, the men were given coffee and bread and jam, and the party broke up. They all went to bed and reported the next day that they had slept very well.

Another attempt at evaluating the effect of marijuana in less formal situations was made in the following manner. The examiner, one of the police officers and the subjects listened to Jack Benny on the Jello Program at seven o'clock Sunday evening. The police officer noted the number of times the audience laughed, and the length of time the laughter lasted. The examiner checked these items for the subjects. The first time this was done without marijuana; the following week

the subjects were given several "reefers" about fifteen minutes before the radio program started. The results were as follows: Without drug, the subjects laughed forty-two times as against seventy-two laughs in the radio audience. The total time for all laughs was sixty-three seconds as compared with one hundred and thirty-nine seconds for the radio audience. With cigarettes the subjects laughed forty-three times as compared with forty-seven laughs in the audience, the total laugh time being one hundred and twenty-nine seconds as compared with one hundred and seventy-three seconds of laughter in the audience. Without the drug, the subjects laughed, roughly speaking, only half as often and as long as the audience; while under the drug they laughed almost as often and the laugh time was about 75 percent that of the audience.

It is obvious that under marijuana the subject laughs more readily and for longer time intervals. This is probably due both to the fact that things seem funnier to him and because when under the influence of the drug he is less inhibited.

Differences between Concentrate and Cigarette

When marijuana was ingested, it was in the form of the concentrate, containing all the active principles which are soluble in the menstruum used. The relative proportions of the principles present are unknown, and the effects can be assumed to give a composite picture of different actions, the dominating one being that of tetrahydrocannabinol. There is no information available concerning the principles present in marijuana smoke, and it is possible that some of those found in the concentrate have been destroyed by the heat of combustion. The effects from smoking correspond *to* those induced by tetrahydrocannabinol taken by stomach, so it may be assumed that this principle is present in the smoke. The rapidity with which effects occur after smoking demonstrates the quick absorption of the cannabinol from the respiratory tract and the short duration of these effects indicates its prompt excretion or detoxification. When the concentrate is taken, the absorption from the intestinal tract is slower and more prolonged. For these reasons it is not possible to make a precise comparison between the effects of the two forms of administration.

In general, the subject's consciousness of unpleasant symptoms is more marked when the concentrate is taken and this may interrupt or obscure the pleasant effects. The long duration of action and the inability of the subject to stop it serve to accentuate the physical symptoms and to cause apprehension concerning what may happen. The result of all this readily accounts for the irritability, negativism and antagonism which occurs. The lessening of inhibitions is not peculiar to marijuana. For in a few subjects who were given alcohol in intoxicating doses, the behavior corresponded to that induced by marijuana.

After smoking, the main effect was of a euphoric type. Some dizziness and dryness of the mouth were generally present, but were not pronounced enough to distract from the pleasant sensations. The conditions described as "high" came on promptly and increased with the number of cigarettes smoked, but it was not alarming or definitely disagreeable, and did not give rise to antisocial behavior. On the contrary it prompted sociability. The marijuana was under the subject's control, and once the euphoric state was present, which might come from only one cigarette, he had no inclination to increase it by more smoking. When a considerable number of cigarettes were smoked, the effect was usually one of drowsiness and fatigue.

The description of the "tea-pad parties" brings out clearly the convivial effect on the groups and the absence of any rough or antagonistic behavior.

Psychotic Episodes

What has been referred to as psychotic episodes occurred in nine subjects, seven men and two women. A description of the happenings in each instance is given.*

A.V. Male. Non-user. Given 4 cc. of marijuana concentrate. About three hours later he became restless, tremulous, agitated, fearful of harmful effects, suspicious of examiners. For short periods he was euphoric. At one time he had visual hallucinations of figures making gestures suggesting harm. He talked continuously, mainly expressing fear. His answers to questions were delayed but intelligent.

W.P. Male. Occasional user. Given 3 cc., repeated two hours later. At first there was a euphoric state; later he became resistant and negativistic. He showed antagonism to the examiner, demanding to be left alone. He vomited twice. Throughout he was highly excited and talked to himself. The effects in general resembled those seen in a maniacal state. He returned to his normal state in about three hours after the second dose.

F.D. Male. **Occasional** user. Given 4 cc. Five hours later he became confused, disoriented and slow in answering questions. There were periods of elation and depression with laughter and weeping. The effects passed off in six hours.

R.W. Male. Non-user. Given 5 cc. Three hours later he became disoriented with continued talkativeness and rapid shifting of thought. He had fits of laughter and weeping, grandiose ideas, some paranoid trends. He answered questions clearly but without perseveration. He returned to normal after six hours.

I.N. Female. Occasional user. Also heroin addict for many years. Given 8 cc. Three hours later she became confused and anxious with periods of laughing and weeping. There were several short episodes resembling hysterical attacks with dyspnea, pallor and rapid pulse during which she felt that she was dying and screamed for the doctor and for a priest. Throughout, her response to questioning was intelligent but delayed. There was a return to her normal state in three hours.

E.C. Male. Non-user. Given 6 cc. Two hours later he developed a marked state of anxiety accompanied by a sensation of difficulty in breathing. This began during a basal metabolism test. In the Sanborn equipment used there is a nose clip occluding nasal breathing and a rubber mouthpiece through which the air is inspired and expired. During the test the subject became confused, panicky and disoriented as to time. The anxiety over breathing continued for four hours but could be interrupted by distraction. He was then given 4 cc. more. The breathing difficulty lasted five hours more.

The condition here had features seen in claustrophobia. Before the episode the subject had taken marijuana on five occasions in 2, 4, 5, 5, and 2 cc. dosage, without any

symptoms of respiratory distress. However, after the episode he took marijuana on three occasions in 2, 5, and 6 cc. dosage and each time the respiratory symptoms occurred. A certain degree of nervousness was present but there was no mental confusion. The subject realized that there was no physical obstruction to his breathing and had learned that by concentrating his thought on other lines he could keep his respiratory difficulties in abeyance and would not suffer from real anxiety. Smoking up to as many as thirteen marijuana cigarettes did not bring about the respiratory effect. It appeared then that the respiratory symptoms were precipitated by the wearing of the apparatus while under the influence of marijuana, and through suggestibility there resulted a conditioning to the marijuana concentrate which was given subsequently.

The description of these six psychotic episodes fits in with many others found in marijuana literature. They are examples of acute marijuana intoxication in susceptible individuals which comes on shortly after the drug has been taken and persists for several hours. The main features of the poisoning are the restlessness and mental excitement of a delirious nature with intermittent periods of euphoria and an overhanging state of anxiety and dread.

Three other subjects presented the features of marijuana psychosis.

R.H. Male. White. Age twenty-three. Non-user. In prison for the offense of living on prostitution. The family history was bad. His father never supported his wife or family and there was continual discord at home. When the subject was nine years old, the father deserted the family. Three brothers received court sentences, one for stealing a taxi, one for rape, and one for striking a teacher. R.H. was a problem child at school and on account of truancy and waywardness he was sent to the Flushing Parental School. He ran away from this school several times and was transferred to the House of Refuge on Randall's Island. At the age of sixteen he was discharged. Since that time he had had two jobs, one for three months in a factory, the other for four and one-half months in the W.P.A. When he was sixteen he was run over by a truck and unconscious for a time. After his return to the

Riker's Island Penitentiary from Welfare Hospital further questioning concerning his past revealed that he was subject to "fits" occurring once or twice every two months. During the attacks his body became rigid and his mouth felt stiff.

The subject was admitted to Welfare Hospital for the marijuana study on February 20th. After the usual program of examinations he was given 2 cc. of the concentrate on February 27th and February 28th. These doses brought on the symptoms of dizziness and tremor and heaviness of the head and the state called "high" which is characterized by periods of laughter and talkativeness. These effects passed off in a few hours and were followed by drowsiness and a sense of fatigue. On March 1st at 1 p.m. he smoked one marijuana cigarette. Immediately afterwards he became agitated and restless and suddenly lost consciousness. He recovered quickly and stated that he had a second short period of unconsciousness. During the afternoon he continued to be agitated and restless and had periods of laughing and weeping. After he was given phenobarbital he went to sleep. On the next day his only complaint was that he felt dizzy. Following this episode he was given 4 cc. of marijuana concentrate on March 3rd, 2 cc. on March 10th, 2 cc. of tetrahydrocannabinol on March 5th and 4 cc. on March 8th. The effects corresponded to those seen after the earlier administrations of 2 cc. doses of the concentrate.

On March 11th R.H. was given 5 cc. (75 mg.) of the tetrahydrocannabinol at 11 A.M. and 3 cc. at 2 P.M. No unusual effects were noted during the afternoon and he ate his supper with appetite at 4:30 P.M. At 6 P.M. he became restless, apprehensive and somewhat belligerent. He felt that something had happened to his mother, that everybody was acting queerly and picking on him. He continued to be agitated and fearful, refused medication and slept poorly. This condition persisted and on March 13th he was returned to Riker's Island. After four days there he became quiet and composed. The psychotic state cleared up completely. The resident psychiatrist's report was: Impression 1. Psychosis due to drugs. (Marijuana experimentally administered.) Acute delirium, recovered. 2. Convulsive disorder, idiopathic epilepsy. Petit mal on history.

H.W. Female. White. Age twenty-eight. Non-user. Drug peddler, serving a three-year indefinite sentence for **unlaw-**

fully possessing a drug. Her parents died when she was about ten years old and she was raised in an orphanage. At the age of nineteen she entered a training school for nurses, but gave this up after four months and supported herself by prostitution. Her sister and her sister's husband were drug addicts and through them she began taking morphine and heroin, being, according to her account, depressed and dissatisfied at the time. She continued using these drugs up to the time of her arrest, a period of eight years. In 1938 she married a man who was also a drug addict, and engaged in the drug traffic.

On May 7th she was given 2 cc. of marijuana. Aside from a headache and a feeling of muscular weakness and incoordination, the effect was to make the subject feel gay and very good-natured. On May 8th she was given 3 cc. of the concentrate and became somewhat confused and unsteady, irritated and upset at carrying out tests, and greatly worried about the physical symptoms. Five hours after she had taken the drug the effects had largely passed off. Six hours later, however, she became restless and agitated, moving about constantly, and worried about past conduct. This state continued for a few hours. On other occasions the subject was given marijuana in doses of 2, 3, and 4 cc. Twice after the administration of 3 cc. the general effect was of a euphoric type, and after 4 cc. had been given a state of sadness set in on two occasions and one of euphoria on a third. Toward the end of her stay the subject became depressed and moody, constantly dwelling on the belief that she had committed unpardonable sins.

She was returned to the House of Detention on June 2nd, transferred to the Psychiatric Division of Bellevue Hospital on June 9th, and from there was sent to Matteawan State Hospital on July 10th. On admission to the State Hospital she appeared confused, retarded, apprehensive, and depressed. She had a marked feeling of guilt. She began to improve in September and was discharged, cured, in January. Since her return to New York she reports at frequent intervals to the parole officer. She has secured employment in a food shop and is to be promoted to the position of manager of the shop.

The diagnosis made at the State Hospital was: Psychosis, due to drugs and other exogenous poisons (morphine and heroin).

D.P. Male. Colored. Age twenty-three. Occasional user. Sentenced for unlawful possession of drugs. Since graduation from high school at the age of sixteen he had had no occupation. His criminal record dated from his graduation. He was arrested in 1934 for disorderly conduct and in the same year sentenced to Elmira Reformatory for five years for second degree assault. He was paroled in 1936, but during the same and the following year was arrested three times for assault or robbery. He was returned to Elmira where he remained until his discharge in 1940: in August 1940 he was arrested for the possession of drugs and sentenced to a three-year indefinite term. He had served eight months of this sentence when he was admitted to Welfare Hospital as a subject for the marijuana study.

During his stay at Welfare Hospital, D.P. was given marijuana in the form of a concentrate and as cigarettes on numerous occasions. His symptoms and behavior corresponded to those usually seen, lasting a few hours with no after-effects. When the time came for his return to Riker's Island he urged that he be allowed to stay at the hospital and assist in the study. Two weeks after his return to the penitentiary he developed a psychosis characteristic of schizophrenia. He was transferred *to* Matteawan where the diagnosis made was: Psychosis with psychopathic personality.

These three cases are of special interest from the standpoint of the relationship of marijuana to the psychosis. The first subject, R.H., had a definite history of epileptic attacks. After smoking one marijuana cigarette he experienced an acute confusional state which lasted a few hours. In the second episode which lasted six days there was a more prolonged confusional state. Epileptics are subject to such attacks, epileptic or epileptic equivalents, which may be brought on by any number of upsetting circumstances. In this case marijuana is the only known factor which precipitated the attack.

The second subject, H.W., was a heroin addict of long standing. During her stay in the hospital, in her retrospective reports on her marijuana experiences there were usually included expressions of worry and remorse at her conduct, such as her failure to answer questions or perform tests honestly, informing on the other women in her group, and

denials concerning a syphilitic infection she thought she had had. Prior to this incarceration she had had no prison experience. The mental picture developed from the study at the hospital and at Matteawan and the subject's subsequent history represents a fairly typical example of what is termed a prison psychosis.

The third subject, D.P. did not develop his psychosis until two weeks after he had been returned to the Riker's Island Penitentiary. He had shown no unexpected effects from marijuana and had hoped to be allowed to stay on at the hospital instead of going back to prison to complete more than two years of an unexpired sentence. At Matteawan this subject was considered to have an underlying psychopathic personality. His case also may be taken as an example of prison psychosis. With both the second and third subjects, the exact role of marijuana in relation to the psychosis cannot be stated.

Dr. Peter F. Amoroso, Commissioner of Correction of the city of New York, has given us information concerning the prisoners sentenced to the penitentiary at Riker's Island from whom our subjects were drawn. During the year beginning July 1, 1941 and ending June 30, 1942, there were one thousand seven hundred and fifty-six inmates in this institution. They had received an indeterminate sentence, that is, from a minimum of a few months to a maximum of three years. Of this group, one hundred seventy-five were subjected to intensive study by the psychiatrist because they were considered possible psychotic cases, one hundred seventeen were sex offenders, and two hundred were miscellaneous cases referred for mental observation, making a total of four hundred ninety-two. Twenty-seven of these cases were committed to state institutions for the criminal insane, namely, twenty-five to Matteawan and two to Dannemora.

Commissioner Amoroso, after reviewing these cases, writes as follows: "This prison atmosphere may place a most severe strain on those who are physically or mentally abnormal upon commitment . . . Emotionally unstable persons find themselves during incarceration denied the assertion and enjoyment of the basic human urges and impulses and it is natural to expect, therefore, that prison life may result in various types of explosions, such as psychoses, neuroses, sex

perversion, and even physical and moral deterioration.

“I am indeed surprised that we had so little trouble with our volunteers upon completion of their study and sojourn at Welfare Hospital, and the few psychotic episodes that occurred are exactly what we would expect in the whole group without considering the administration and effects of excessive doses of marijuana.”

Summary

In the study of the actions of marijuana in respect to subjective and objective symptoms and behavior, the marijuana was given a number of times to each of the subjects in the form of the concentrate taken by stomach. The amount given ranged from 2 to 22 cc., in most cases from 2 to 5 cc. After marijuana was taken, the systemic action became evident in one-half to one hour and the maximum effects were seen in two to three hours. They passed off gradually, usually in three to five hours, although in some instances they did not completely disappear until twelve or more hours.

Of the symptoms occurring, a feeling of lightness in the head with some dizziness, a sensation of floating in the air, dryness of the throat, hunger and thirst, unsteadiness and heaviness in the extremities were the most frequent. Tremor and ataxia, dilation of the pupils and sluggishness in responsiveness to light were observed in all subjects.

From observations on the behavior and responses of the subjects, it was found that a mixture of euphoria and apprehension was generally present. If the subjects were undisturbed there was a state of quiet and drowsiness, and unawareness of surroundings, with some difficulty in focusing and sustaining mental concentration. If they were in company, restlessness, talkativeness, laughter and joking were commonly seen. A feeling of apprehension, based on uncertainty regarding the possible effects of the drug and strengthened by any disagreeable sensations present, alternated with the euphoria. If the apprehension developed into a state of real anxiety, a spirit of antagonism was shown. However any resistance to requests made to the subjects was passive and not physical and there was no aggressive or violent behavior observed. Erotic ideas or sensations when

present took no active expression.

Six of the subjects developed toxic episodes characteristic of acute marijuana intoxication. The dosage varied from 4 to 8 cc. of the concentrate, and the episodes lasted from three to six hours, in one instance ten hours. The effects were mixtures of euphoric and anxiety states, laughter, elation, excitement, disorientation and mental confusion.

The doses given were toxic to the individuals in question but not to others taking the same or larger ones. Once the drug had been taken the effects were beyond the subject's control. The actions described took unusual expression because for the particular subject at a particular time the dose was unusually effective. A corresponding toxicity did not occur from cigarettes. Here the effects came on promptly and on the appearance of any untoward effects, the smoking was stopped.

In three of the subjects a definite psychotic state occurred; in two shortly after marijuana ingestion, in one after a two-week interval. Of the first two, one was an epileptic and the other had a history of heroin addiction and a pre-psychotic personality. The third was considered a case of prison psychosis. The conclusion seems warranted that given the potential personality make-up and the right time and environment, marijuana may bring on a true psychotic state.

II. ORGANIC AND SYSTEMIC FUNCTIONS

The functions of the body organs and systems were studied in the manner common to hospital practice according to the methods and with the equipment in use at Welfare Hospital. The study was designed to show not only the effects of varying doses of marijuana but also whether subjects who had long been users of the drug gave evidence of organic damage. The tests were made before the drug was administered, during its action, and often in the after period. The heart and circulation, blood composition, kidney, liver and gastro-intestinal function, and basal metabolism received special consideration. The results of the study follow.

The Circulation

Pulse Rate

Coincident with the onset of marijuana symptoms, there usually occurred a rise in pulse rate. The peak was reached in

one and one-half to three and one-half hours. The maximum increase was from thirty to forty beats per minute in most instances but in some it was from fifty to sixty beats. The decline after the peak was at times sharp, at other times gradual. The rise and its extent appeared to be dependent upon the mental state induced by the drug, that is, it was greater in states of euphoria and talkativeness, laughter, and body movement. As these symptoms subsided the pulse rate fell correspondingly.

Blood Pressure

Blood pressure changes were variable. In general, there was a rise in blood pressure coincident with the increase in pulse rate. There was no consistency in this, however. Thus, in one instance, with an increase of thirty beats per minute in pulse rate, the blood pressure rose 20 mm. Hg.; in another, with a rise in pulse rate of fifty beats per minute, the blood pressure remained unchanged. The diastolic pressure in general followed the systolic. There was no consistent relationship between the degree of change and the size of dosage.

Circulation Time

In a number of instances, ether and saccharin were injected into the antecubital vein and the time intervals required for the recognition of ether in the expired air and of the taste of saccharin were measured. The measurements made before and during marijuana action showed no differences and it was concluded that marijuana has no effect on the arm to lung and arm to tongue circulation time.

Electrocardiograms

Electrocardiographic records were made of all subjects before the administration of marijuana and during the drug action. The dose ranged from 1 cc. upwards, going as high as 17 cc. for one subject. In a number of instances a preliminary dose was given in the morning and a second, usually much larger, later, the record being taken after the second dosage. The readings and interpretations were made by Dr. Robert C. Batterman.

In eleven of the subjects abnormal electrocardiograms were noted. A description of these follows:

A.B.	Control	P split in leads 2 and 3.
	Marijuana	same
T.E.	Control	P split in leads 2 and 3. Left axis deviation.
	Marijuana	same throughout
C.H.	Control	T diphasic in leads 1 and 2.
	Marijuana	T diphasic in leads 2, 3 and 4.
J.H.	Control	Normal PR interval .19
A.B.	Control	P split in leads 2 and 3.
	Marijuana	same
T.E.	Control	P split in leads 2 and 3. Left axis deviation.
	Marijuana	same throughout
C.H.	Control	T diphasic in leads 1 and 2.
	Marijuana	T diphasic in leads 2, 3 and 4.
J.H.	Control	Normal PR interval .18
	Marijuana	P split in leads 1, 2 and 3. PR interval .22
W.J.	Control	Elevated ST segment, lead 1 and 4. P split in leads 1, 2 and 3. T diphasic in 3. P diphasic in lead 4.
	Marijuana	LA deviation. P split in leads 1, 2 and 3. T inverted in lead 3.
J.P.	Control	P split in leads 1, 2 and 3. Diphasic in lead 4. T split in 2, diphasic in 3.
	Marijuana	P split in 2.
J.R.	Control	RA deviation, P split in lead 1.
	Marijuana	RA deviation, P split in leads 1 and 2.
C.S.	Control	Deep Q in lead 3. Inverted T in lead 3. Depressed ST segment lead 2.
	Marijuana	same throughout
L.V.	Control	Ventricular rate 120. RA deviation. P split in leads 1, 2, 3, and 4. PR interval .20
	Marijuana	Ventricular rate 120. No deviation. P split in leads 1, 2, 3, and 4. PR interval .24.
B.W.	Control	Normal
	Marijuana	Sinus tachycardia. T inverted in leads 3 and 4.
H.W.	Control	T split in leads 1, 2 and 3. P inverted in lead 3. Wassermann positive.
	Marijuana	same throughout

In nine of the subjects, seven users and two non-users, abnormal electrocardiograms were noted in both the readings taken before and those taken after the administration of marijuana. In four of these the tracings resemble the pattern of those seen in patients with rheumatic heart disease, but it is impossible to state what underlying pathological conditions were present in the group as a whole. In two users the control records were normal, the marijuana ones abnormal.

In six subjects not included in the list given, a sinus tachycardia, and in two a sinus bradycardia were seen after the ingestion of marijuana.

In all the remaining subjects no abnormalities were seen before or during marijuana action.

Hematology

Blood morphology and certain chemical constituents of the blood were studied before and during marijuana action on sixty-one subjects, the dosage ranging from 2 to 21 cc. Before the administration of marijuana the hemoglobin reading was between 80 and 90 percent in thirty-six subjects and over 90 percent in twenty-two; during marijuana action it was from 80 to 90 in nineteen subjects and over 90 percent in thirty-nine. Three showed a low hemoglobin percentage before, 65, 70 and 77 percent, but a rise to 79, 90, and 95 percent during the drug action.

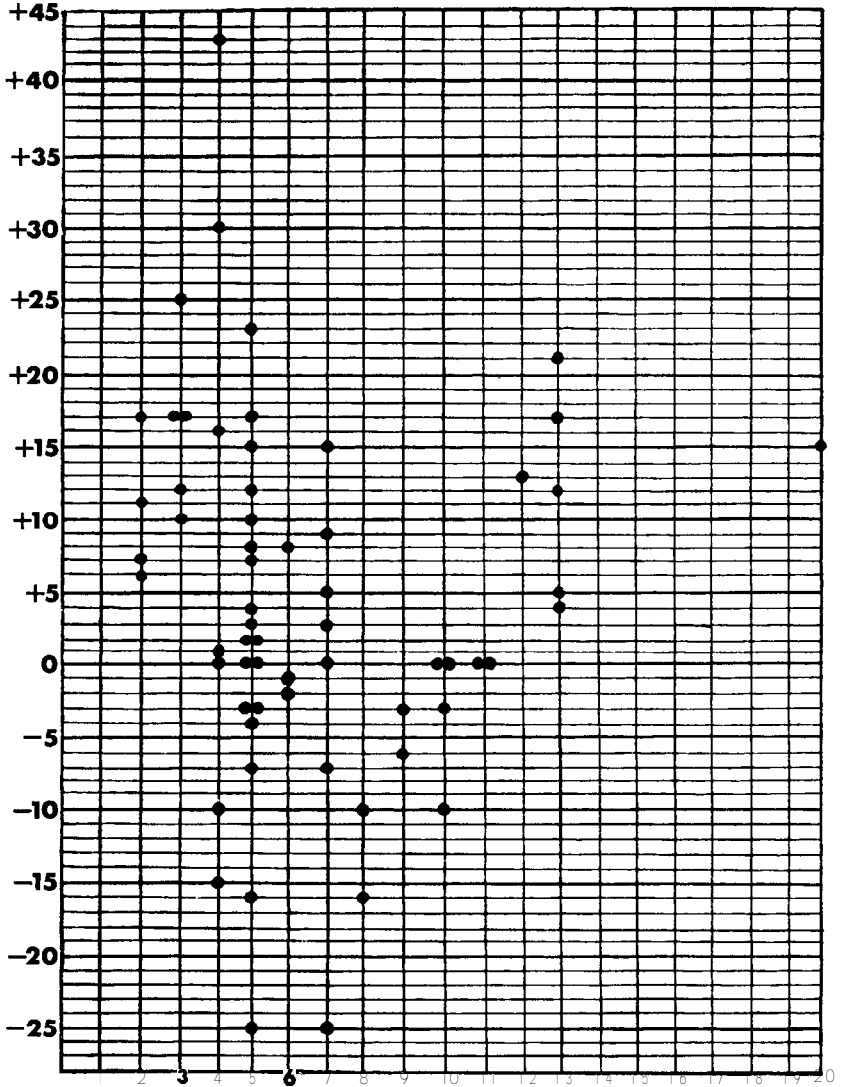
The blood counts showed the usual individual variations but the average counts for the sixty-one subjects were: before the administration of the drug, red blood cells 4,800,000 and white blood cells 8,900; during the drug action, 4,900,000 and 9,500 respectively.

The urea nitrogen, calcium and phosphorus blood concentration figures are given in Table 4.

TABLE 4
*Blood concentrations of urea nitrogen, calcium and phosphorus
(in milligrams percent)*

	Number of Subjects	Before Marijuana		After Marijuana	
		Average	Range	Average	Range
Urea nitrogen	63	12.2	6.9-24.9	12.2	8.5-20.7
Calcium	39	11.2	10.2-13.2	11.2	10.0-12.5
Phosphorus	36	3.9	2.6- 5.5	3.7	2.8- 5.0

Blood Sugar
Change
(in mg. %)



Dose
(in cc. of marihuana)

Figure 1. Increase or Decrease in Blood Sugar of Sixty-Two Subjects as a Result of Varying Doses of Marihuana.

From these blood studies it is seen that marijuana in the range of dosage stated produced no appreciable change in hemoglobin or cell count or in blood urea, calcium, and phosphorus. The blood examinations were made at varying periods during the subjects' stay at the hospital and in all instances marijuana had been given previously on a number of occasions. Thus, one subject had been given a total of 85 cc., another 143 cc., and a third 169 cc. The results show, therefore, that in addition to the lack of effect from a single dose, there was no cumulative effect from previous doses.

Blood sugar determinations were made on sixty-two subjects, forty-two users and twenty non-users. The blood samples for all tests were taken in the morning before breakfast. In the case of the tests made during marijuana action, the drug was administered two or three hours before the samples were taken.

The incidence of rise, fall, or no change in the blood sugar after the ingestion of marijuana is shown in Table 5, and the blood sugar changes in relation to dosage are shown in Figure 1.

TABLE 5

Changes in blood sugar determination Of 62 subjects following the ingestion of marijuana

Blood Sugar before Marijuana (in mg. %)	Number of subjects showing		
	Rise	Fall	No change
55- 59	1	0	0
60- 69	3	0	0
70- 79	7	1	0
80- 89	19	9	5
90- 99	5	6	2
100-1 10	1	2	1
Total	36	18	8

For thirty-eight subjects twenty-seven users and eleven non-users, the differences between the control and marijuana figures were within plus and minus 10 mg. percent. In five, four users and one non-user, there was a rise of from 11 to 14 mg. percent, in fourteen a rise of 15 mg. percent or more, and in five a fall of 1.5 mg. percent or more. The blood sugar figures for subjects showing a rise or fall of 15 mg. percent or more are given in Table 6.

TABLE 6
Blood sugar changes of 1.5 milligrams percent or more

15 mg. % or more rise				15 mg. % or more fall			
Dose	Before Marijuana	After Marijuana	Difference	Dose	Before Marijuana	After Marijuana	Difference
<i>Users</i>				<i>USERS</i>			
A.R. 20 c.c	85	100	15	J.W. 8 c.c.	90	74	-16
W.J. 13 c.c	91	108	17	J.H. 5 c.c.	98	73	-25
J.N. 13 c.c	91	112	21	I.B. 4 c.c.	85	70	-15
W.C. 5 c.c	55	78	23				
B.W. 5 c.c	73	90	17				
J.T. 5 c.c	85	100	15				
W.S. 4 c.c	89	105	16				
W.R. 4 c.c	60	90	30				
<i>Non-users</i>				<i>Non-users</i>			
E.F. 7 c.c	90	105	15	A.T. 7 c.c.	105	80	-25
L.V. 4 c.c	82	125	43	S.L. 5 c.c.	100	84	-16
C.C. 3 c.c	68	85	17				
W.H. 3 c.c	75	92	17				
P.B. 3 c.c	75	100	25				
J.T. 2 c.c	83	100	17				

From these tables it is seen that while there was a trend toward a rise in blood sugar levels during marijuana action, for the majority of the subjects there was no significant change from the control levels. In the instances where a rise or fall of 15 mg. percent or more occurred, a level of over 100 mg. percent was noted in only five subjects under marijuana; in the fourteen others the range kept between 70 and 100 mg. percent, which may be considered normal limits. Throughout there was no distinction between users and non-users in regard to blood sugar levels.

The Kidney

Routine examinations of twenty-four-hour urine specimens were made on all subjects for periods before and following marijuana administration. In no instance were albumin, sugar, casts, blood cells or other abnormal elements found.

Thirty-six subjects were given 1,000 cc. of water and the urine was collected for three one-hour periods. The procedure was repeated after the administration of marijuana in

doses varying from 2 to 13 cc. An analysis of the figures obtained gave no evidence of a diuretic or antidiuretic effect from marijuana.

It was observed that an urge to urinate was a not infrequent occurrence during marijuana action. Since this was not accompanied by any appreciable increase in the amount of urine output, it is probable that it was a psychological reaction.

The phenolsulfonphthalein test for kidney function was carried out on forty-nine subjects before and during marijuana action. The dose ranged from 4 to 17 cc. The results are shown in Table 7.

TABLE 7
Phenolsulfonphthalein Tests. Number of subjects excreting various percentages of injected solution in two hours

Period	Number of Subjects Excreting			
	Under 40%	40-49%	50-59%	Over 60%
Before Marijuana	13	13	15	8
After Marijuana	16	13	13	7

There was a decrease of 2.5 percent in the total amount excreted by the forty-nine subjects after the administration of marijuana as compared with the amount excreted under normal conditions. This difference is well within the limits of technical error.

The results of the examinations showed therefore that the administration of marijuana brought about no structural or functional change in the kidney as determined by the techniques employed.

The Liver

No clinical evidence of liver damage was observed in any of the subjects before or after marijuana had been administered. The bromsulfalein test was given to a number of the subjects. The dye was injected in amounts of between 2 and 3 mg. for each kilogram of weight and the blood examined after thirty minutes. In twenty instances where marijuana was given in dosages ranging from 2 to 10 cc. and in one instance where 20 cc. was administered, the dye was absent from the blood after the thirty-minute interval.

The Gastro-Intestinal Tract

As has been stated, a characteristic effect of marijuana is a sensation of hunger and an increased appetite. Disagreeable effects which may occur are nausea and vomiting. The frequency with which the symptoms were noted is given in Table 8.

TABLE 8
Gastro-intestinal symptoms

Dose	Number of subjects	Number of trials	Symptoms			
			Hunger	Nausea	Vomiting	Diarhea
<i>Concentrate</i>		Men				
1-3 c.c.	64	184	94	5	2	occurred in 4 of the psy- chotic episodes
4-5 c.c.	59	186	129	7	2	
6-8 c.c.	46	106	85	6	3	
9-22 c.c.	33	71	50	2	1	
		<i>Women</i>				
1-3 c.c.	7	28	17	6	1	
4-6 c.c.	7	35	25	1	0	
7-10 c.c.	4	5	3	0	0	
<i>Cigarettes</i>		<i>Men</i>				
1-8	37	54	40	3	1	
		<i>Women</i>				
1-8	5	7	5	2	1	
<i>Tetrahydrocannabinol (natural and synthetic)</i>		<i>Men</i>				
	34	93	61	7	5	
		<i>Women</i>				
	6	18	11	2	2	

As shown in the table, after the ingestion or smoking of marijuana more than half the subjects experienced hunger and increased appetites. A desire for sweets was especially strong, and users believe that the taking of candy or sweetened drinks lessens the "too high" effect which may follow marijuana smoking. The tendency toward a rise in blood sugar after the ingestion of marijuana indicates some need of the tissues for more sugar, but there is no explanation of the mechanisms involved.

While nausea and vomiting might be attributed to irritant effects of marijuana, on the other hand these symptoms occurred after smoking and in one instance after an intramus-

cular injection of tetrahydrocannabinol. The action here is presumably a central one.

The effects of marijuana on gastric motility and secretion were studied by Dr. Louis Gitzelter. A Miller-Abbott balloon attached to a Levine tube was passed into the stomach through one nostril and a Levine tube alone through the other nostril. The balloon was inflated with air to a pressure of approximately 10 mm. of water and connected with a tambour which registered gastric contractions on a kymograph. The other Levine tube was used to withdraw gastric contents at stated periods.

With the subjects in a fasting state, control records of gastric motility and measurements and analysis of gastric secretion were made throughout a period of an hour or more. The procedure was repeated on subsequent days following the administration of marijuana (6, 8, 6, 15, and 1.5 cc.) and at a time when the subjects were in a "high" state. A comparison of the two sets of findings gave no evidence that marijuana had any effect on motility or brought about any change in gastric secretion.

Roentgenograms, which were taken of the stomach of one of the subjects after a barium test meal, showed the emptying time of the stomach to be three hours both before and after the administration of marijuana. In another subject there was considerable delay in the emptying time during the marijuana action.

The Brain

Brain Metabolism

The effect of marijuana on the metabolic rate of the brain was investigated by studying the oxygen and carbon dioxide content of the arterial and venous blood drawn from the carotid artery and the internal jugular vein. The blood samples were obtained as simultaneously as possible, collected under mineral oil, and kept under anaerobic conditions until analyzed, Coagulation was prevented by the use of oxalate, and glycolysis was inhibited by the addition of fluoride. The blood samples were analyzed for oxygen and carbon dioxide by the method of Van Slyke and Neil.

For analyses made when the subjects were under the influence of marijuana, the blood samples were collected two and a half or three hours after the drug was given, at a time when the subjects were in a state classed as "high."

The results presented in Table 9 show no consistent change in the metabolism of brain tissue as measured by blood oxygen and carbon dioxide concentration in four subjects showing clinical evidences of marijuana intoxication. Circumstances prevented an extension of the study.

TABLE 9

Oxygen and carbon dioxide content of arterial and venous blood of four subjects before and after the administration of marijuana

		Oxygen content			Carbon dioxide content		
		Arterial blood (in volume percent)	Venous blood (in volume percent)	Difference	Arterial blood (in volume percent)	Venous blood (in volume percent)	Difference
Before Marijuana	R.S.	19.3	14.3	5.0	48.6	52.0	3.4
	M.G.	19.4	14.9	4.5	46.7	50.8	4.1
	A.B.	20.4	16.3	4.1	45.2	50.8	5.6
	W.S.	19.4	13.7	5.7	45.4	52.9	7.5
After Marijuana	R.S.	19.1	10.7	8.4	46.8	55.0	8.2
	M.G.	20.2	14.9	5.3	44.2	48.5	4.3
	A.B.	20.2	14.9	5.3	43.3	48.4	5.1
	W.S.	18.0	12.9	5.1	47.0	49.0	2.0

Electroencephalograms

Electroencephalographic records of fifteen subjects were made by Dr. Hans Strauss. There appeared to be a relationship between the typical euphoric reaction produced by marijuana and an associated increase in the alpha activity seen in the electroencephalogram. However, similar increase of alpha activity was observed in two subjects who received no marijuana. It is known that a high degree of alpha activity is suggestive of relaxation or perhaps the shutting off of any disturbing extraneous environmental stimuli and these findings merely suggest that marijuana is conducive to mental relaxation in some individuals.

Basal Metabolism

The basal metabolic rates of sixty-one subjects were determined before and during marijuana action. The Sanborn apparatus was used and the determinations were made in the morning before breakfast. The marijuana dosage ranged from 2 to as high as 20 cc. In the group of sixty-one subjects, forty-five were classed as users, sixteen as non-users. The accompanying table gives the data on forty-three subjects whose metabolic rates were within a range of +9 to -13

percent, both under normal conditions and while under the influence of marijuana. Of these, nineteen showed a rise in basal metabolic rate of 2 to 12 percent, twenty-three a fall of 2 to 13 percent, and in one the rate did not change.

TABLE 10
Metabolic rates (in percent) within a range of from + 9 to - 13 percent

Dose	Without Marijuana	Under Marijuana	Difference	Dose	Without Marijuana	Under Marijuana	Difference
<i>Users</i>				<i>Users</i>			
H.W. 10 c.c.	- 2	+ 5	+ 7	A.R. 20 c.c.	0	- 8	- 8
W.C. 8 c.c.	- 6	0	+ 6	E.T. 17 c.c.	- 7	- 11	- 4
C.J. 8 c.c.	+ 4	+ 5	+ 1	J.B. 13 c.c.	- 4	- 13	- 9
J.H. 8 c.c.	- 13	+ 4	+ 17	W.J. 13 c.c.	0	- 8	8
R.T. 7 c.c.	- 7	0	+ 7	R.S. 13 c.c.	0	- 4	- 4
L.C. 6 c.c.	- 12	- 10	+ 2	A.B. 11 c.c.	- 5	- 11	- 6
P.B. 6 c.c.	- 5	- 2	+ 3	J.W. 8 c.c.	3	- 5	- 2
F.W. 6 c.c.	- 11	- 7	+ 4	O.D. 7 c.c.	+ 4	- 6	- 10
M.N. 5 c.c.	- 9	- 5	+ 4	M.V. 6 c.c.	- 5	- 10	- 5
S.L. 5 c.c.	- 9	+ 2	+ 11	J.R. 5 c.c.	7	- 10	3
A.B. 4 c.c.	12	0	+ 12	W.B. 5 c.c.	- 6	- 13	- 7
W.S. 4 c.c.	- 5	+ 7	+ 12	H.W. 5 c.c.	- 9	- 13	- 4
R.S. 4 c.c.	- 9	- 5	+ 4	M.G. 5 c.c.	2	- 5	- 3
M.B. 2 c.c.	- 2	+ 5	+ 7	K.S. 4 c.c.	+ 9	- 5	- 14
C.D. 2 c.c.	- 12	0	+ 12	MS. 2 c.c.	- 2	- 7	- 5
<i>Non-users</i>				<i>Non-users</i>			
D.L. 10 c.c.	+ 5	+ 7	+ 2	WB. 7 c.c.	- 6	- 4	- 2
L.V. 6 c.c.	- 2	+ 6	+ 8	N.R. 6 c.c.	+ 2	- 9	- 11
ES. 6 c.c.	- 8	- 6	+ 2	J.T. 5 c.c.	+ 2	- 2	- 4
C.S. 5 c.c.	- 11	- 5	+ 6	P.B. 4 c.c.	+ 8	- 10	- 18
H.B. 4 c.c.	8	0	+ 8	W.H. 3 c.c.	- 2	11	9
				S.H. 3 c.c.	0	- 5	- 5
				J.B. 4 c.c.	- 13	- 13	0

The remaining eighteen subjects had a basal metabolic rate of plus or minus 15 percent or more either before or after marijuana was administered. Of these, there was a rise in fourteen and a fall in four following the ingestion of marijuana, but in only four of these subjects was the rise significant, the rates being +30, +32, +18, and +25, after doses of 20, 2, 8, and 6 cc. respectively. The figures for this group are shown in Table 11.

TABLE ii

Metabolic rates (in percent) outside a range of from + 9 to - 13 percent

Dose	Without Marijuana	Under Marijuana	Difference	Dose	Without Marijuana	Under Marijuana	Difference
<i>Users</i>				<i>Users</i>			
J.N. 13 c.c.	- 20	- 17	+ 3	C.B. 11 c.c.	- 7	- 18	- 11
T.R. 13 c.c.	- 17	- 8	+ 9	J.B. 5 c.c.	- 2	- 15	- 13
B.W. 8 c.c.	22	14	+ 8	J.K. 5 c.c.	- 9	- 17	- 8
J.P. 8 c.c.	- 15	- 4	+ 11				
F.G. 8 c.c.	- 12	+ 18	+ 30				
H.A. 8 c.c.	- 17	- 4	+ 13				
V.L. 6 c.c.	+ 9	+ 25	+ 16				
W.R. 4 c.c.	- 17	- 13	+ 4				
R.G. 2 c.c.	+ 4	+ 32	+ 28				
E.S. 2 c.c.	- 23	- 19	+ 4				
J.T. 2 c.c.	- 15	- 12	+ 3				
<i>Non-users</i>				<i>Non-users</i>			
H.B. 20 c.c.	+ 2	+ 30	+ 28	C.C. 3 c.c.	-19	-23	- 4
J.G. 3 c.c.	- 15	-144	+ 1				
W.D. 3 c.c.	- 16	-144	+ 2				

The control figures are lower than those commonly reported. Of the sixty-one subjects, the rate in eleven was on the plus side, in thirty-eight on the minus side within a range of +9 and -15 percent, while for four it was 0. In eight the rate was between -16 and -23 percent. It is possible that prison life is conducive to a lowering of metabolic processes but our study is too limited to allow any generalization.

From the figures shown, it may be concluded that in the majority of subjects, marijuana caused no appreciable change in metabolic rate, although in those having an initially low rate, there was usually a rise. What changes occurred had no relationship to marijuana dosage, and there was no distinction between users and non-users.

Vital Capacity

Along with the determination of the basal metabolic rate, the measurement of vital capacity was made on sixty-six subjects before and after marijuana was administered. There was a decrease in forty-one, an increase in eleven, and no change in fourteen. Such changes as occurred were insignificant. The average vital capacity during the control period was 3.6 liters (range 2.3-5.1); after marijuana 3.5 liters (range 2.1-4.9).

Summary

The most consistent effect of marijuana observed in this division of the study was an increase in pulse rate which began shortly after the taking of the drug, reached a peak in about two hours, and gradually disappeared. In a few instances a temporary sinus tachycardia or sinus bradycardia was noted, but except for these there were no abnormalities in rhythm. The increase in pulse rate was usually accompanied by a rise in blood pressure.

There was in general an increase in the blood sugar level and in the basal metabolic rate, quite marked in some subjects, but in the majority the levels reached did not exceed the high normal limits.

An increase in the frequency of urination was often observed. There was, however, no appreciable increase in the total amount of urine passed during the drug action.

Hunger and an increase in appetite, particularly for sweets, was noted in the majority of the subjects, and the taking of candy or sweetened drinks brought down a "too high" effect of the drug. Nausea and vomiting occurred in a number of instances, diarrhea only during psychotic episodes.

On the other hand, the blood showed no changes in cell count, hemoglobin percent, or the urea nitrogen, calcium and phosphorus figures. The figures for the circulation rate and vital capacity and the results of the phenolsulfonphthalein test for kidney function and the bromsulfalein test for liver function were not different from those of the control period. The electrocardiograms showed no abnormalities which could be attributed to a direct action on the heart. In the few observations on gastric motility and secretion no evidence of marijuana action on these functions was obtained.

The positive results observed, increase in pulse rate and blood pressure, increase in blood sugar and metabolic rate, urge to urinate, increased appetite, nausea and vomiting, and diarrhea, were not intensified by an increase in dosage, for they could occur in an equal degree after the administration of any of the effective doses within the range used. All the effects described are known to be expressions of forms of cerebral excitation, the impulses from this being transmitted through the autonomic system. The alternation in the functions of the organs studied come from the effects of the drug

on the central nervous system and are proportional to these effects. A direct action on the organs themselves was not seen.

