

Marihuana and Mood in Human Volunteers¹

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ROSSI, A. M., J. C. KUEHNLE AND J. H. MENDELSON. *Marihuana and mood in human volunteers*. PHARMAC. BIOCHEM. BEHAV. 8(4) 447-453, 1978. — Fifteen adult male marihuana smokers volunteered to live on a hospital research ward for a 31-day study which included a five-day baseline, a 21-day marihuana smoking period and a concluding five-day baseline. Subjects rated their moods and level of intoxication each day at scheduled occasions. Analyses of variance indicated a significant trend in the mood ratings which increased slightly in the euphoric direction just before smoking marihuana (compared to routine ratings) and further increased slightly after smoking marihuana. Level of intoxication ratings and mood ratings were not significantly correlated, but an intoxicated subject's mood ratings were significantly correlated with the average mood ratings of other subjects intoxicated or not. The results suggest that marihuana may increase a person's susceptibility to the moods of others and the feeling of being in harmony with others may be a positive reinforcer.

Marihuana-mood

MARIHUANA users commonly report that they smoke marihuana to induce pleasant subjective mood states [8, 12, 22, 27]. However, data from controlled studies indicate that mood change following marihuana use may vary widely from euphoria to dysphoria [3, 16, 23, 26, 31, 32, 38, 42]. This variation in mood change has been attributed to a number of variables including dose, route of administration, environment, personality, previous marihuana experience and expectations of the subject [11, 14, 39, 41]. Many investigators stress the influence of set and setting in interpreting the results of their studies [9, 18, 19]. However, self-ratings of marihuana intoxication were found to be unaffected by whether subjects watched television, listened to rock music or engaged in conversation following marihuana smoking [34] or by whether subjects smoked in neutral or psychedelic environments [4]. The presence or absence of music was found to have no influence on either Subjective Drug Effects Questionnaire responses or observer ratings of mood following oral ingestion of THC [40]. Similarly, self-ratings on a sadness-happiness scale obtained from subjects smoking marihuana in neutral and favorable environments were non-differentiable [15].

One group of investigators studied the interactive effects of several variables on self-ratings of intoxication obtained from experienced marihuana users [5]. The variables were dose level of THC in marihuana cigarettes (0, 7.5, 15 mg), subject expectancy (placebos which purportedly either inhibited or potentiated the effects of marihuana), and the modeling behavior of an experimenter accomplice who smoked a placebo marihuana cigarette and acted either intoxicated or unaffected in the presence of subjects. The results of the study indicated that the self-ratings of intoxication were affected by modeling behavior and

subject expectancy at the moderate dose level (7.5 mg) but not at the zero dose and high dose (15 mg) levels. However, in a later study by the same investigators which employed only the zero and moderate dose (7.5 mg) levels, the self-ratings of intoxication obtained from naive marihuana users were found to be unaffected by the modeling behavior of the accomplice at either dose level [6]. A tentative hypothesis was offered attributing the difference in results obtained from naive and experienced users to a socialization process by which individuals learn to discriminate and label their subjective drug experiences.

A summary of this area of research indicates that physical environment and activities may have little or no influence on the subjective effects of marihuana while cognitive sets may have some influence under some conditions. The importance of cognitive sets in psychopharmacological research has been underscored in a conceptual model developed by Schacter and Singer [36]. This model, which has been found useful in interpreting results in some recent marihuana research [4,34], predicts that subjective effects of psychotropic drugs will be outcomes of an interaction between pharmacological effects and situationally determined cognitions.

The present research was carried out to study the effects of marihuana on mood and to evaluate the influence of group atmosphere on mood following marihuana use. From the research literature on marihuana and mood it was expected that no consistent specific mood changes would be found following marihuana use in a repeat measures design. From the Schacter and Singer model [36] it was expected that subjects' moods following marihuana use would be related to the prevailing moods of other subjects whether or not they were also using marihuana at the same time. The latter expectation was based on the assumption

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that the prevailing mood atmosphere created by other subjects would be an important situational influence in determining an intoxicated subject's self-perceptions regarding moods.

METHOD

Subjects

A total of 16 male subjects were recruited by newspaper advertisements and employed in four separate but identically designed studies with four different subjects in each study. One subject terminated his participation before the conclusion of the study, so the data analyses are based upon 15 subjects. All subjects were fully informed about the nature of the study and provided informed consent. The mean ages of subjects was 23.2 years (range 21 to 27). They had smoked marihuana for a minimum of two years and averaged 42 smoking sessions per month prior to the study. Almost all subjects had previously used or experimented with other psychotropic drugs, but none admitted to regular use of drugs other than alcohol and marihuana at the time of their recruitment for this study.

Setting

Subjects lived on a hospital research ward for 31 days. Their living conditions were made as comfortable as possible consistent with security and experimental requirements. The research ward area included individual bedrooms for subjects, facilities for providing snacks and preparing meals (food carts were brought to the ward from a central hospital kitchen), and a dayroom with TV, hi-fi, reading materials and game materials. Twice a day subjects had the opportunity to leave the ward for a total of two and one-half hours for either a supervised walk around the hospital grounds or use of the hospital's gym and recreation rooms. Movies were shown in the ward dayroom several nights a week.

Marihuana

Marihuana cigarettes used in this study were obtained from the National Institute of Mental Health in a lot standard dosage form. The cigarettes were machine rolled to insure maximal standardization in dosage and draw characteristics. Each cigarette contained approximately 1 g marihuana with a delta-9 THC content of 1.8 to 2.3 percent and less than 0.1 percent delta-8 THC, 0.1 percent cannabinal and 0.1 percent cannabidiol (as assayed by the NIMH).

Marihuana Administration

Each of the 31-day studies was divided into three consecutive periods: An initial five-day predrug period, when subjects did not have access to marihuana; a 21-day drug period, when subjects were permitted to purchase and smoke marihuana on a free-choice basis; and a final five-day postdrug period when marihuana was not available. Throughout each study, subjects had the unrestricted opportunity to work at an operant task (button pressing). Subjects were provided a portable operant manipulandum which they could work at anytime day or night. Data derived from the studies of operant responding for marihuana reinforcement have been presented elsewhere [24]. Points could be used to purchase marihuana during the 21-day drug period or exchanged for money at the

conclusion of the study. The purchase price of a marihuana cigarette was 1800 points which required approximately 30 min of work at the operant task and had a monetary exchange value of 50 cents.

Subjects were permitted to purchase and smoke marihuana cigarettes whenever they chose during the 21-day drug period with two conditions: (1) all smoking of marihuana was to be done under the observation of a staff member; (2) the unsmoked portion of the cigarette was to be returned to the staff upon completion of smoking. These conditions were established both to insure security and to permit accurate recordings of observations relating to smoking behavior. Subjects smoked an average of 5.7 (± 1.7) marihuana cigarettes daily during the drug period, consuming an average of 92 percent ($\pm 8\%$) of each cigarette.

A number of biological, behavioral and social assessments were carried out during the study under the supervision of a multidisciplinary research staff. Data derived from these studies have been reported in previous publications [24, 25, 35]. The results reported in this paper are limited to assessments of mood.

Mood Assessments

Subjects were required to rate their moods: (1) routinely at 10 a.m., 2 p.m. and 9 p.m. each day; (2) before smoking marihuana; (3) 30 min after smoking marihuana; and (4) before beginning work at the operant task when more than 15 min had elapsed since last working at the task.

An automated mood-rating instrument based upon the semantic differential scale (30) was used in this study. A metal panel 20.32 cm \times 27.94 cm containing eight rows of buttons with seven buttons in each row was wall-mounted in each subject's bedroom. Paired mood adjectives were placed at the ends of each row: Sad-Happy; Tense-Relaxed; Afraid-Calm; Friendly-Hostile; Clear-Confused; Depressed-Elated; Worried-Carefree; Stoned-Straight. Subjects rated their moods by pushing one button in each row. The placement of each selected button in relation to the paired adjectives constituted the mood rating. For example, subjects selected the button closest to the adjective "Sad" to rate themselves as being very sad, the button closest to the adjective "Happy" to rate themselves as being very happy, and the appropriate intermediate button to rate themselves as experiencing a degree of sadness or happiness.

The placements of the paired adjectives on the panel were changed daily to minimize the effects of position response biases by subjects. The changes included changing the row placements of the paired adjectives and reversing the order of the adjectives. The one exception to these daily changes was that the paired adjectives Stoned-Straight, in that order, always were placed at the ends of the last row.

Automatic control devices insured that subjects made ratings on all eight scales before the task was recorded as completed. The results of the ratings were automatically recorded on a magnetic tape along with the time and date of the rating and a code number indicating the occasion for the rating (e.g., 1 = routinely schedule, 2 = before smoking marihuana, etc.).

RESULTS

The results were first analyzed for evidence of: charac-

TABLE 1
RATING SCALE MEANS FOR EACH RATING OCCASION DURING 20 MARIHUANA SMOKING DAYS
(STUDY DAYS 6 THROUGH 25)

Rating Scale	Occasion for Rating			<i>p</i> *
	Routine	Before Smoking	After Smoking	
Straight (1) – Stoned (7)	2.62	3.11	5.40	<0.001
Sad (1) – Happy (7)	5.33	5.37	5.45	<0.05
Worried (1) – Carefree (7)	5.32	5.37	5.46	<0.025
Depressed (1) – Elated (7)	4.99	5.04	5.18	<0.025
Afraid (1) – Calm (7)	5.76	5.80	5.88	<0.05
Hostile (1) – Friendly (7)	5.39	5.48	5.51	<0.05
Tense (1) – Relaxed (7)	5.14	5.19	5.25	<0.05
Confused (1) – Clear (7)	5.29	5.35	5.27	N.S.

**p* values are of *F* ratios for Occasions obtained in an analysis of variance (see text).

teristic moods when subjects requested a marihuana cigarette; and, systematic changes in mood after subjects smoked marihuana. Ratings made on the 21st (last) day of the smoking period were omitted from this analysis because marihuana smoking increased to atypical levels on this day. For example, subjects smoked an average of approximately 14 marihuana cigarettes on the 21st smoking day as compared to a daily average of 5.3 on the first 20 smoking days. In order to attenuate diurnal and daily variance in the data and to secure an equal number of data entries for each subject, ratings made during the first 20 smoking days were separately averaged over each successive 5 days for each subject, each rating scale, and each of the following rating occasions: (1) routine; (2) before smoking marihuana; and (3) after smoking marihuana.

A three-way analysis of variance design (occasions \times days \times subjects) was used in separately analyzing the data obtained on each of the eight rating scales. The results of the analyses indicated significant rating occasion effects on seven of the eight rating scales: Straight–Stoned, $F(2,28) = 75.98$, $p < 0.001$; Sad–Happy, $F(2,28) = 3.77$, $p < 0.05$; Worried–Carefree, $F(2,28) = 4.71$, $p < 0.025$; Depressed–Elated, $F(2,28) = 4.59$, $p < 0.025$; Afraid–Calm, $F(2,28) = 3.64$, $p < 0.05$; Hostile–Friendly, $F(2,28) = 3.29$, $p < 0.05$; Tense–Relaxed, $F(2,28) = 3.28$, $p < 0.05$; Confused–Clear, $F(2,28) = 1.05$, N.S. The mean ratings for each rating occasion indicate that there was a consistent trend toward increased euphoria ratings over the routine, before smoking, and after smoking rating occasions (Table 1).

The results of the analyses of variance indicated significant day effects on four of the eight rating scales: Straight–Stoned, $F(3,42) = 3.02$, $p < 0.05$; Sad–Happy, $F(3,42) = 5.35$, $p < 0.005$; Worried–Carefree, $F(3,42) = 3.95$, $p < 0.025$; and, Confused–Clear, $F(3,42) = 3.84$, $p < 0.025$. This finding is difficult to interpret because no consistent pattern of difference is discernible among the

five-day mean ratings on these four scales (Table 2), and no significant day effects were found on the remaining four scales. A significant occasion \times day interaction effect was found on only the intoxication scale: Straight–Stoned, $F(6,84) = 4.40$, $p < 0.01$. The latter finding indicates that the significant differences found in the intoxication ratings made on different occasions (routine, before smoking and after smoking marihuana) apparently varied significantly on different days of the study.

Although significant differences were found among the ratings made on different rating occasions on six of the seven mood scales, the actual quantitative differences were small compared to the differences found on the intoxication scale (Table 1). Therefore, a second analysis of the data was conducted to examine the strength of the relationship between level of intoxication and mood ratings. For this analysis correlations were computed separately for each subject between ratings on the Straight–Stoned scale and ratings on each of the seven mood scales. Ratings from all rating occasions (routine, before smoking, after smoking, before working) were used in order to insure a sufficient variance in the Straight–Stoned ratings for computing correlations.

The obtained correlation coefficients for individual subjects were transformed into *Z* scores, averaged across subjects for each mood scale, and tested for significance by *t*-test [13]. Only one of the averaged *Z* scores (Hostile–Friendly) was significantly different from zero ($Z = .30$, $r = .29$, $p < 0.05$). The results of transforming the average *Z* scores into average correlation coefficients are presented in Table 3.

A third analysis of the data was carried out to determine whether there was a relationship between the mood ratings made by subjects when they were intoxicated and the mood ratings made by other subjects at the same time regardless of whether or not the other subjects also were intoxicated. For this analysis, mood ratings made each day

TABLE 2
FIVE-DAY RATING SCALE MEANS OBTAINED DURING 20 MARIHUANA SMOKING DAYS
(STUDY DAYS 6 THROUGH 25)

Rating Scale	Marihuana Smoking Days				<i>p</i> *
	1-5	6-10	11-15	16-20	
Straight (1) - Stoned (7)	3.85	3.53	3.64	3.81	<0.05
Sad (1) - Happy (7)	5.61	4.79	5.33	5.79	<0.005
Worried (1) - Carefree (7)	5.54	5.57	4.91	5.52	<0.025
Depressed (1) - Elated (7)	5.14	5.15	5.09	4.89	N.S.
Afraid (1) - Calm (7)	6.00	5.64	6.01	5.60	N.S.
Hostile (1) - Friendly (7)	5.50	5.32	5.46	5.55	N.S.
Tense (1) - Relaxed (7)	5.32	4.82	5.37	5.26	N.S.
Confused (1) - Clear (7)	5.58	4.88	5.40	5.35	<0.025

**p* values are of F ratios for Days obtained in an analysis of variance (see text).

TABLE 3
CORRELATIONS BETWEEN SELF-RATINGS ON INTOXICATION SCALE AND SELF-RATING ON 7 MOOD SCALES*

Ratings on Intoxication Scale	Ratings on Mood Scales						
	Sad-Happy	Depressed-Elated	Tense-Relaxed	Hostile-Friendly	Confused-Clear	Afraid-Calm	Worried-Carefree
	0.17 ± 0.20	0.11 ± 0.20	-0.03 ± 0.24	0.29 ± 0.12†	-0.12 ± 0.13	0.14 ± 0.13	0.10 ± 0.09

*Mean ± SD of 15 Individual Subject Correlations †*p*<0.05

of the 21-day smoking period were averaged separately for each subject, on each rating scale, for each 2-hr time block between 8 a.m. and midnight and for the 8-hr time block between midnight and 8 a.m. The time blocks in which a subject had an average rating greater than 2 on the Straight-Stoned scale were coded, and the subject's average ratings on the mood scales made during these coded time blocks were then correlated with the combined average mood ratings of other subjects in the same study which were made within the same time blocks. This procedure resulted in 15 correlation coefficients (one for each subject) for each of the seven mood scales. These coefficients were transformed into Z scores, averaged across subjects for each mood scale, and tested for significance by *t*-test [13]. The average Z scores for six of the mood scales were significantly different from zero. The results of transforming the average Z scores into average correlation coefficients are presented in Table 4 along with their levels of statistical significance.

A fourth analysis was carried out to examine the relationship between subjects' mood ratings when they

were not intoxicated. The number of time blocks during the 21-day smoking period in which all subjects in the same study were not intoxicated was too small to permit a reliable analysis. Therefore, mood ratings obtained during the 5-day pre- and 5-day post-smoking periods were used in this analysis. Mood ratings made during each of these ten days were averaged separately for each subject, on each mood scale for each of the same time blocks used in the previous analysis. The average mood ratings made by each subject during each time block were then correlated with the combined average mood ratings of other subjects in the same study which were made within the same time blocks. The correlation coefficients were transformed into Z scores, averaged across subjects for each mood scale and tested for significance by *t*-test [13]. None of the Z scores reached significance. The results of transforming the average Z scores into correlation coefficients are presented in Table 4. Differences between the correlations obtained when subjects were intoxicated and when they were not intoxicated were significantly different by correlated *t*-test for all mood scales except the Confused-Clear scale (Table 4).

TABLE 4

CORRELATIONS BETWEEN MOOD RATINGS OF INDIVIDUAL SUBJECT AND AVERAGE MOOD RATINGS OF OTHER SUBJECTS WHEN SUBJECT WAS INTOXICATED AND WHEN SUBJECT WAS NOT INTOXICATED*

	Other Subjects						
	Sad-Happy	Depressed-Elated	Tense-Relaxed	Hostile-Friendly	Confused-Clear	Afraid-Calm	Worried-Carefree
Subject Intoxicated	0.65 ± 0.17‡	0.58 ± 0.24	0.60 ± 0.17§	0.53 ± 0.26	-0.04 ± 0.35	0.62 ± 0.19§	0.55 ± 0.24
Subject Not Intoxicated	0.18 ± 0.19	0.23 ± 0.26	0.29 ± 0.26	0.20 ± 0.26	0.08 ± 0.13	0.21 ± 0.21	0.19 ± 0.23
Difference† Intoxicated-Not Intoxicated	0.53 ± 0.07‡	0.40 ± 0.06‡	0.37 ± 0.06†	0.36 ± 0.06‡	0.12 ± 0.08	0.47 ± 0.05‡	0.39 ± 0.06‡

*Mean ± SD of 15 Individual Subject Correlations

†Reported mean differences may not be equal to difference between correlation means because all statistical operations were performed on Z transformations.

‡ $p < 0.001$ § $p < 0.01$ || $p < 0.05$

DISCUSSION

A synthesis of the results of previous investigations fails to document the existence of a consistent relationship between marijuana use and specific antecedent or consequent mood states [3, 16, 23, 26, 31, 32, 38, 42]. The results of an analysis of variance of grouped data in the present study indicated that there was a small increase in ratings in a euphoric direction before subjects began smoking marijuana (compared to routine ratings) and a further small increase 30 min after smoking marijuana. One possible interpretation of this finding is that subjects may experience a rise in euphoric mood in anticipation of smoking marijuana, and this may be one of the reasons that consistent before-after differences have not been found in previous studies.

Although statistically significant, the actual quantitative increase in euphoric mood ratings between each rating occasion was small compared to the increase in level of intoxication ratings. This suggested the possibility that the increase in euphoric mood ratings was not linearly related to the increase in level of intoxication. The results of a subsequent analysis of the correlations between intoxication ratings and mood ratings for individual subjects provided a further indication that intoxication level and mood ratings were not statistically related. This apparent lack of a linear relationship suggests that whatever effect marijuana use may have on moods, the effect cannot be attributed solely to the pharmacologic action of the drug and that other variables, yet to be identified, are involved.

The social learning theories have suggested the identity of one class of variables that may be involved [29, 36, 39]. The common thread in these theories is a belief that social expectations and definitions, rather than pharmacological factors, are primary determinants of subjective effects of drugs. Applied to marijuana, these theories hold that marijuana users learn from others to associate the various cues emanating from marijuana use with pleasant sub-

jective feelings. These theories help explain why naive users often do not experience the euphoric high even with high doses of THC, while experienced users may experience the high even with placebo marijuana [18] or with small doses of THC (reverse tolerance) [41]. However, although these theories provide an explanation of why marijuana users describe the marijuana experience as pleasant, it does not explain why their description of specific mood effects is not more uniform. Further, these theories seem to imply that marijuana has no unique pharmacological effects and that a similar euphoric feeling may become associated with any mild drug through the social learning process.

In the present study a significant relationship was found between the moods of subjects when intoxicated and the moods of other subjects whether or not the other subjects also were intoxicated. The interpretation of this finding would have been facilitated by a demonstration that this relationship, though significant, was stronger when subjects were intoxicated than when they were not intoxicated on the same days. However, the number of time blocks during the drug period when all subjects were non-intoxicated was too small to permit a reliable analysis. As a substitute, an analysis was made of the relationship between subjects' mood ratings during the pre- and postdrug periods when all subjects were non-intoxicated. The results of this analysis indicated that the relationships between mood ratings during the latter periods when subjects were not intoxicated were not as strong as when subjects were intoxicated during the drug period. However, since the data used in these analyses were collected during different study periods, interpreting the differences in the strength of the relationships during the two conditions can only be done with caution.

Keeping this caution in mind, the results can be interpreted as indicating that a subject's mood states when intoxicated more closely approximate the mood states of other subjects than when the subject is not intoxicated.

This interpretation raises the intriguing possibility that while marihuana use does not lead to either a specific configuration of mood states or consistent changes in specific moods, it may lead to a greater harmony of mood with the prevailing mood of others in the same social setting. As a conjecture, it may be that this harmony gives rise to a feeling of oneness with others (of being sympatico), and this feeling is the euphoric reinforcer for marihuana use. This conjecture is consistent with the suggestion that marihuana is sociogenic [10] in that it is used primarily in group settings by close friends who perceive the use of marihuana as a pleasurable social activity [1, 7, 12, 17, 20].

However, since the mood effects of several other drugs have been reported to be influenced by the mood atmosphere created by subjects studied in groups (e.g., secobarbital [28], alcohol [21,33]) marihuana cannot be considered unique in apparently increasing a person's susceptibility to the moods of others. It remains for future research to determine whether or not this susceptibility is greater, or in any other way different, with marihuana than with other drugs, and whether or not this susceptibility is a positive reinforcer in the use of marihuana.

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