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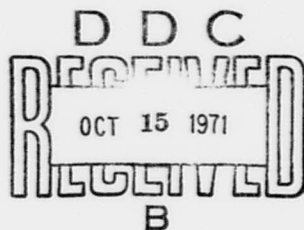
**EDGEWOOD ARSENAL  
TECHNICAL REPORT**

**EATR 4554**

**THE EFFECT OF PERSONALITY ON REACTIVITY  
TO A TETRAHYDROCANNABINOL**

by

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**DEPARTMENT OF THE ARMY  
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## FOREWORD

The work described in this report was authorized under Task 1B662706AD2503, Medical Defense Against Chemical Agents, Prophylaxis and Therapy for Incapacitating Agents. The experimental work was started in 1963 and completed in 1968. The present report is a retrospective evaluation of individual case reports.

The volunteers in these tests are enlisted US Army personnel. These tests are governed by the principles, policies, and rules for medical volunteers as established in AR 70-25.

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## DIGEST

Case records of 40 US Army volunteers given a synthetic tetrahydrocannabinol (THC) compound similar in structure and physiological activity to the active compound of marijuana were reviewed. Significant relationships were found between the personalities of these volunteers, as measured by the Minnesota Multiphasic Personality Inventory (MMPI) and the Army General Intelligence Test (GT), and performance on cognitive tests following administration of this compound. The Hs (hypochondriasis) and Pd (psychopathic deviant) scale scores and the GT score were more strongly correlated with performance than was the dose level.

MMPI and GT test interpretation of subjects resistant to the performance impairment caused by this compound showed them to be more intelligent and adventurous but more hostile and aggressive than sensitive subjects. A possible explanation for continued use of marijuana by certain personality types is offered.

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## THE EFFECT OF PERSONALITY ON REACTIVITY TO A TETRAHYDROCANNABINOL

### I. INTRODUCTION.

In recent years the relationship between personality and psychotic reactions to marijuana has been of great interest. Heavy users of marijuana who experience psychotic reactions associated with use of this drug often have underlying personality disorders. Heiman<sup>1</sup> found that six of eight patients who were heavy smokers and had "acute schizophrenic reactions" were later diagnosed as having personality disorders. Talbott<sup>2</sup> also noted personality disorders in "pot reactions" of seven chronic users. Colbach and Crowe<sup>3</sup> felt that marijuana-associated psychosis often remitted to a personality disorder when there was a history of heavy use. In contrast to the findings with heavy users, Talbott and Teague<sup>4</sup> reported that only 2 of 12 subjects who experienced acute toxic psychosis following their first exposure to marijuana in Vietnam had personality disorders.

Brill, Crampton, and Grayson<sup>5</sup> recently examined personality differences between chronic and casual users of marijuana. They found that chronic users had significantly higher scores on the Pd (psychopathic deviant) scale of the Minnesota Multiphasic Personality Inventory (MMPI) and scored higher on a stimulus-seeking scale. Further differences in chronic users were found by Weil, Zinberg, and Nelsen,<sup>6</sup> who concluded that chronic users "do not show the same degree of impairment of performance on psychometric tests as do naive subjects." Mirin et al.<sup>7</sup> reported greater hostility in chronic users. Hollister<sup>8</sup> found that subjects' self-estimates of aggression diminish after injection of  $\Delta^1$ -THC (tetrahydrocannabinol), and the Mayor's Committee on Marijuana<sup>9</sup> reported that marijuana use enabled subjects to admit feeling more aggressive while their behavior remained quite placid. Allen and West<sup>10</sup> suggested that marijuana may serve as "an effective medication for the relief of feelings of anger, resentment, and aggression." Clark and Nakashima<sup>11</sup> noted "marked individual variation" in the performance of naive subjects on psychometric tests following marijuana.

In an attempt to investigate personality differences that might explain varied response to this drug, case records of US Army volunteers given a THC compound during the period 1963 to 1968 were recently reviewed. The compound administered was a  $\Delta^3$ -THC with a 1,2-dimethylheptyl aliphatic substitution in the side chain of the aromatic moiety. This compound was found to be between 60 and 500 times as active as the parent compound,<sup>12</sup> depending on the isomeric mixture.

<sup>1</sup>Heiman, E. M. Marijuana Precipitated Psychoses in Patients Evacuated to CONUS. *USARV Med. Bull.* May-June, 75-77 (1968).

<sup>2</sup>Talbott, J. A. Pot Reactions. *USARV Med. Bull.* Jan.-Feb., 40-41 (1968).

<sup>3</sup>Colbach, E. M., and Crowe, R. R. Marijuana Associated Psychosis in Vietnam. *Mil. Med.* 135, 571-573 (1970).

<sup>4</sup>Talbott, J. A., and Teague, J. W. Marijuana Psychosis. *J. Amer. Med. Ass.* 210, 299-302 (1969).

<sup>5</sup>Brill, N. O., Crampton, E., and Grayson, H. M. Personality Factors in Marijuana Use. *Arch. Gen. Psychiat.* 24, 163-166 (1971).

<sup>6</sup>Weil, A. T., Zinberg, N. E., and Nelsen, J. M. Clinical and Psychological Effects of Marijuana in Man. *Science* 162, 1234-1242 (1968).

<sup>7</sup>Mirin, S. M., Shapiro, L. M., Meyer, R. E., Pillard, R. C., and Fisher, S. Casual Versus Heavy Use of Marijuana, a Redefinition of the Marijuana Problem. *Amer. J. Psychiat.* 127, 1134-1140 (1971).

<sup>8</sup>Hollister, L. E. Recent Research on the Effects of Marijuana in Man. *Problems of Drug Dependence*. National Academy of Sciences-National Research Council, Washington, D.C. 1969.

<sup>9</sup>Mayor's Committee on Marijuana. *The Marijuana Problem in the City of New York*. Jaques Cattell Press, Lancaster, Pennsylvania. 1944.

<sup>10</sup>Allen, J. R., and West, L. J. Flight from Violence: Hippies and the Green Rebellion. *Amer. J. Psychiat.* 125, 364-374 (1968).

<sup>11</sup>Clark, L. D., and Nakashima, E. N. Experimental Studies of Marijuana. *Amer. J. Psychiat.* 125, 3 (1968).

<sup>12</sup>Loewe, S. Active Principles of the Cannabis and the Pharmacology of Cannabinols. *Arch. Exp. Pathol. Pharmacol.* 210, 175 (1950).

Symptoms produced by  $\Delta^3$ -THC in this study included conjunctival injection, dizziness, euphoria, tachycardia, sedation, paranoid ideation, perceptual alterations, and postural hypotension. These symptoms compare with those reported for  $\Delta^1$ -THC by Isbell et al.<sup>13</sup> with the exception of postural hypotension.

Significant relationships were found between personality, as measured by the MMPI and the Army General Intelligence Test (GT), and drug reactivity, as measured by three performance tests.

## II. METHOD.

The subjects were adult male servicemen between the ages of 18 and 29 who were screened to exclude psychiatric and physical abnormalities. Three groups of men received different isomeric mixtures of  $\Delta^3$ -THC by either the oral, intramuscular, or intravenous route. Eleven men received 10 to 60  $\mu\text{g}/\text{kg}$  of a racemic mixture of isomers 1 through 8 of  $\Delta^3$ -THC<sup>14</sup> orally. Fourteen subjects received from 1.0 to 10  $\mu\text{g}/\text{kg}$  of isomer 3 intramuscularly. Fifteen subjects received from 1.5 to 2.8  $\mu\text{g}/\text{kg}$  of isomer 2 by the intravenous route. The tests were conducted in a hospital ward setting. Vital signs and performance measures were obtained at approximately 1-hour intervals for at least 12 hours after drug administration.

The standard measure of cognitive performance was the Number Facility (NF) test.<sup>15</sup> (Hollister and Gillespie<sup>16</sup> have reported that this test is sensitive to marijuana.) In addition, the subjects who received the racemic mixture were given the Speed of Closure (SC)<sup>15</sup> and the Purdue pegboard (PB) tests.

The NF test consists of 18 sets of 90 addition problems of approximately equal difficulty.<sup>15</sup> The subject's score is the number of problems solved correctly in 3 minutes. The subjects receiving the drug by the oral route were given 10 practice trials to establish a baseline, whereas the rest of the subjects had 20 practice trials. The baseline was defined as the mean of the five highest scores on the practice trials. Baseline procedures for the SC and PB tests were identical to those described for NF.

Two methods of data analysis were used. To determine overall performance for those receiving the compound by the intravenous or intramuscular routes, the mean of all NF scores for the initial 8 hours of postdrug testing was calculated as a percentage of the baseline value. For those getting the compound orally, the mean of all NF scores for the initial 12 hours was used because the effects of this route took longer to occur. (Clark and Nakashima<sup>11</sup> have pointed out the necessity of performing repeated measures because of the variability of performance under THC.) To determine correlations based on the greatest performance decrement, the mean of the three lowest NF scores was used as a percentage of baseline.

The MMPI was administered prior to a subject's acceptance into the program. Individuals with two standard scale scores greater than 70 or five scores greater than 65 were excluded. All MMPI scores are reported as T scores with K. Although 14 MMPI scale scores were investigated, only those showing significant or nearly significant correlations will be reported.

<sup>13</sup>Isbell, H., Gorodetzky, C. W., Jasinski, D., Claussen, U., Spulak, F., and Korte, F. Effects of (-)Delta-9-Trans-Tetrahydrocannabinol in Man. *Psychopharmacologia* 11, 134-188 (1967).

<sup>14</sup>Aaron, H. S., and Ferguson, C. P. Synthesis of the 8 Stereo Isomers of a Tetrahydrocannabinol Congener. *J. Org. Chem.* 33, 684 (1968).

<sup>15</sup>Moran, L. I., and Mefford, R. Repetitive Psychometric Measures. *Psychol. Rept.* 5, 269-275 (1959).

<sup>16</sup>Hollister, L. E., and Gillespie, H. K. Marijuana, Ethanol, and Dextro-Amphetamine. *Arch. Gen. Psychiat.* 23, 199-203 (1970).

### III. RESULTS.

The correlations between the mean of the three lowest NF scores and the mean of NF scores for the first 8 or 12 hours after drug administration were significant beyond the 0.01 level (0.82, 0.90, and 0.97 for the oral, intramuscular, and intravenous routes, respectively). However, there were some differences between these methods of NF calculation in their relationship to dose level and personality variables. The correlations between the dose level and the mean of the three lowest NF scores were significant beyond the 0.05 level for all three routes of drug administration, whereas the correlations between dose and the mean of all NF scores failed to reach significance for any of the routes (see table I). Table I also shows the correlations between the personality measures (MMPI scales and GT) and performance measures (NF, SC, and PB). Ten correlations between overall NF means and personality variables reached the 0.05 level of significance, and five significant correlations were obtained with the mean of the three lowest NF's.

Table I.  $\Delta^3$ -THC Correlations: Performance Versus MMPI Scale and GT Scores

Test	N	Dose <sup>a</sup>	GT <sup>a,b</sup>	MMPI scale <sup>a,c</sup>										
				L	K	Hs	D	Hy	Pd	Pa	Sc	Ma	Si	Es
$\Delta^3$ -THC po														
NF (Mean) <sup>d</sup>	11	-0.32*	0.84**			0.85**	0.53'			0.60*				
NF (Low) <sup>e</sup>	11	-0.72*	0.96**			0.58'				0.55'			-0.63*	0.57'
PB (Mean) <sup>d</sup>	11				0.53'	0.63*			0.77*			0.58'	-0.59'	0.54'
SC (Mean) <sup>d</sup>	11											0.53'	-0.59'	0.55'
													-0.63*	0.55'
$\Delta^3$ -THC im														
NF (Mean) <sup>f</sup>	14	-0.34	0.58*	0.50'	0.68**	0.55*				0.57*			-0.46'	
NF (Low) <sup>e</sup>	14	-0.56*	0.51'		0.70**	0.51'			0.53*	0.49'				0.47'
$\Delta^3$ -THC iv														
NF (Mean) <sup>f</sup>	15	-0.48'	0.48'			0.45'			0.44'		0.51*	0.51*	0.46'	
NF (Low) <sup>e</sup>	15	-0.81**	0.48'			0.44'					0.47'	0.66*	0.56*	

<sup>a</sup>Symbols are defined as follows:

- '  $P < 0.1$
- \*  $P < 0.05$
- \*\*  $P < 0.01$

<sup>b</sup>Three subjects did not have GT scores.

<sup>c</sup>L = lie scale

K = positive test-taking attitude scale

Hs = hypochondriasis scale

D = depression scale

Hy = conversion hysteria scale

Pd = psychopathic deviant scale

Pa = paranoia scale

Sc = schizophrenic scale

Ma = manic scale

Si = social introversion scale

Es = ego strength scale

<sup>d</sup>Based on mean of all scores for initial 12 hours after drug administration.

<sup>e</sup>Based on mean of three lowest NF scores.

<sup>f</sup>Based on mean of all NF scores for initial 8 hours after drug administration.

Each subject was assigned to either a "drug resistant" group or a "drug sensitive" group on the basis of whether his overall mean NF score was above or below the mean for all subjects given the same compound regardless of dose. In order to form clearly differentiated drug sensitive and drug resistant groups, the 10 subjects whose NF scores were particularly near the means of their respective groups were excluded from the "T" test comparisons. The results of these comparisons are shown in table II.

Table II. "T" Tests

Measure	Resistant (n = 15)	Sensitive (n = 15)	"T" value <sup>a</sup>
GT	123.0	106.6	3.0**
MMPI <sup>b</sup>			
K	59.4	55.1	1.7'
Hs	50.8	44.3	4.1**
Hy	57.6	51.6	2.4*
Pd	60.6	54.8	2.3*
Pa	56.0	46.0	3.5**
Pt	55.5	50.8	2.0*
Sc	54.0	47.1	3.2**
Es	61.9	56.1	2.4*

<sup>a</sup>See footnote a at the end of table I.

<sup>b</sup>Pt = psychasthenia scale. For listing of the other MMPI scales, see footnote c at the end of table I.

To determine if drug sensitive subjects had a greater reaction to these compounds as measured by heart rate, blood pressure, and temperature, they were compared with the same group of resistant subjects by means of "T" tests. No significant differences were found.

#### IV. DISCUSSION.

The mean of the lowest three scores on the NF test was more closely related to the dose given than was the mean of all NF scores for the initial 8 or 12 hours. For personality variables, the reverse seemed to be true, with overall NF performance showing more significant correlations with MMPI scale scores and GT scores. However, as can be seen in table I, the personality correlates with overall NF means were similar to those based on the three lowest NF's.

For both methods of NF calculation, some of the correlations for personality measures and NF scores are higher than those between dose and NF. This result illustrates the importance of personality factors in reactivity to these compounds. In addition, GT score and 8 of the 14 MMPI scales investigated were significantly different in drug resistant subjects when compared to drug sensitive subjects.

The interpretation of these MMPI differences in sensitive and resistant subjects requires some discussion. Sensitive subjects have a mean MMPI score on the Hs (hypochondriasis) scale below the average of the Minnesota normative group, whereas resistant subjects have a mean that is nearly the same. Low Hs scorers among normal subjects were described by Gough, McKee, and Yandell<sup>17</sup> as "alert, cheerful, capable, good-looking, responsible, and warm."

<sup>17</sup>Gough, H. G., McKee, M. G., and Yandell, R. J. Adjective Check List Analyses of a Number of Selected Psychometric and Assessment Variables. Officer Education Research Laboratory, Technical Memorandum OERL-TM-55-10. May 1955.

Higher Hy (conversion hysteria), K (test-taking attitude), and Pa (paranoia) scores were found in drug resistant subjects. In the study of Gough, McKee, and Yandell,<sup>17</sup> raters describe high Hy scale scorers as clever, enterprising, enthusiastic, imaginative, impatient, thankless, and infantile. The raters were impressed by the high degree of intellectual ability of these subjects. High K scores in normal subjects were found by Berger<sup>18</sup> to be positively related to the degree of self-acceptance, and by Gough, McKee, and Yandell<sup>17</sup> to occur in individuals described as enterprising, ingenious, resourceful, aggressive, clear-thinking, energetic, rational, versatile, and high in initiative. The finding of higher scores on the Es (ego strength) scale suggests<sup>5</sup> somewhat greater ego strength in our resistant subjects. High scorers on the Pa scale were found by Dahlstrom and Welsh<sup>19</sup> to be associated with intelligence and initiative, while low scorers were described by these authors as "mild, self-centered, and wary, with narrow interests," and by Anderson<sup>20</sup> as "underachievers and non-achievers." This suggestion of higher intellectual ability in resistant subjects is consistent with the finding of significantly higher GT scores in this group.

Significantly higher Pd and Sc (schizophrenic) scores were found in the resistant group. High Pd scorers have been described as adventurous, courageous, and sociable,<sup>19</sup> while Gough, McKee, and Yandell<sup>17</sup> found that raters described these subjects as hostile and aggressive. Dahlstrom and Welsh<sup>19</sup> found high Sc scorers to be versatile, verbal, and enthusiastic, whereas Gough, McKee, and Yandell<sup>17</sup> found them to be hostile and irritable. Low scorers were described by Gough, McKee, and Yandell as submissive, cautious, dependable, mild, and restrained.

A picture emerges of drug resistant subjects as being more intelligent and adventurous but more hostile and aggressive than sensitive subjects. The sensitive subjects appear to be less intelligent and more controlled, and to have narrow interests. The finding of MMPI scale scores suggesting hostility and aggression in resistant subjects is interesting in light of the report of Mirin et al.<sup>7</sup> of greater hostility in chronic users, and the finding of Brill, Crampton, and Grayson<sup>5</sup> of higher Pd scores and higher scores on a stimulus-seeking scale in chronic users.

The following is a summary of our findings and those cited in the literature.

1. Chronic users of marijuana have more hostility, higher Pd scores, and higher stimulus-seeking scores and are more resistant to cognitive impairment caused by this compound.<sup>5,7</sup>
2. Subjects in our experiment who were defined as drug resistant had MMPI scale scores that have been described as occurring in adventurous, hostile, and aggressive subjects.
3. Marijuana has a hostility-reducing property.<sup>8-10</sup>

It is attractive to speculate that the type of person who might have a problem with hostile and aggressive feelings is more resistant to cognitive impairment by THC compounds and might continue using this drug for its hostility-reducing effect.

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<sup>18</sup>Berger, T. M. Relationships Among Acceptance of Self, Acceptance of Others, and MMPI Scores. *J. Counsel. Psychol.* 2, 279-283 (1955).

<sup>19</sup>Dahlstrom, W. G., and Welsh, G. S. *An MMPI Handbook*. University of Minnesota Press, Minneapolis, Minnesota, 1960.

<sup>20</sup>Anderson, W. The MMPI: Low Pa Scores. *J. Counsel. Psychol.* 3, 226-228 (1956).

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