The Effect of Δ⁹-Tetrahydrocannabinol on Sleep

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Abstract. Five volunteers slept 8 to 15 consecutive nights in the laboratory with
electroencephalogram, chin electromyogram, and eye movements monitored by the
method originated by Dement and Kleitman. Δ⁹-tetrahydrocannabinol (THC), 20 mg
administered at bedtime decreased the amount of time spent in the REM or para-
doxical phase of sleep. Abrupt withdrawal of THC after 4 to 6 consecutive nights of
use produced a mild insomnia characterized by difficulty in falling and staying
asleep but did not produce a marked REM rebound.

Key words: Δ⁹-Tetrahydrocannabinol — THC — Marihuana — Sleep — REM
State — EEG.

Introduction

All-night polygraphic studies have shown that many psychoactive
drugs have a characteristic effect on sleep. Acutely these agents depress
the percentage of the total sleep time spent in the REM or paradoxical
stage of sleep. With chronic administration of these agents this REM
suppression is lost and the REM percentage climbs back to its baseline
levels. When these drugs are abruptly discontinued after chronic adminis-
tration sleep becomes characterized by frequent awakenings, a long sleep
latency, and a marked increase in the REM percentage, the so-called REM
rebound. When given for one night Δ⁹-tetrahydrocannabinol (THC), the
major psychoactive agent of marihuana, causes a moderate REM sup-
pression (Pivik et al., 1972). The present study reports the effect on
polygraphically monitored sleep of the chronic administration of THC. A
number of abstracts concerning the chronic effect of marihuana in human
sleep have appeared (Karacan et al., 1972; Kales et al., 1972; Freemon,
1972a; Gillin et al., 1972; Pranikoff et al., 1973).

Method

Subjects. Six paid volunteers between the ages of 21 and 29 slept in the labora-
tory in pairs. Previous experience with marihuana consisted of occasional social use
except for subject F who had used marihuana heavily, almost daily, between ages
16 and 18. This subject had also used LSD during this period; no other subject had
used illegal drugs other than marihuana. Subjects A and B, who smoked marihuana
about one Saturday night per month, abstained from its use for six weeks prior to
the study. Other subjects professed they had not used marihuana for over one year.

Procedure. Polygraphic monitoring of electroencephalogram, eye movements
and chin electromyogram was performed by the methods developed by Dement and
Kleitman (1957) and codified by Rechtschaffen and Kales (1968). All subjects slept in the laboratory for at least one night prior to the beginning of the study for acclimation to the technical apparatus. During the experiment, subjects A and B slept 8 consecutive nights in the lab; the other subjects slept 14 consecutive nights. On each night the subjects reported to the laboratory between 2200 and 2230 and were prepared and in bed by 2300. They drank 20 ml of juice while in bed just before the lights were turned off and the experiment begun. For subjects A and B this carrier was prune juice; for the others it was Lipomul (Upjohn), a mixture of corn oil and other fatty substances. On certain nights, indicated in the tables by asterisks, 20 mg of THC was dissolved in the carrier. The subjects and the technician were unaware of the schedule of active and inactive substances. As a control for consecutive night effects, subject C received no THC though she believed herself to be receiving THC on some nights.

After discarding the first night in the series, the records were scored by rigorous observation of the scoring criteria of Rechtschaffen and Kales (1968) without knowledge of experimental conditions. Because REM sleep is not homogeneously distributed, sleep stage percentages were calculated for the first 6 h of sleep (see Freemon, 1972b).

**Drug.** The Δ⁹-tetrahydrocannabinol was supplied by the Center for Studies of Narcotic and Drug Abuse, National Institute of Mental Health. The project had the approval of the Milwaukee County Institutions Research Committee, the Wisconsin Dangerous Substances Control Committee, the Tennessee Department of Mental Health, the Food and Drug Administration, The United State Bureau of Narcotics and Dangerous Drugs, and the FDA-NIMH Psychotomimetic Agents Advisory Committee.

**Results**

In each of the five subjects who received THC, the percentage of sleep spent in the REM state was less on the first THC night than on baseline nights. In the two subjects who took THC for four consecutive nights, the REM percentage remained depressed throughout this period. In the three subjects who took THC for six consecutive nights, the REM percentage remained depressed in subject D but in the other two the REM percentage returned to baseline levels, actually somewhat above baseline levels, while the THC was still being administered. Table 1 summarizes these results.

The post-THC or THC withdrawal period was not associated with a REM rebound; that is, the REM percentage during the first few post-THC nights was not generally greater than baseline REM percentages. Subject A had a very early onset REM period, only 6 min after the first sleep spindle announced sleep onset, on the second post-THC night but no other subject showed such a short REM latency. The only evidence for a withdrawal effect was the tendency in some subjects for an increased sleep latency (time from lights out and the subject saying “good night” to the first sleep spindle) and time awake (awake time as defined by polygraphic criteria between the first onset of sleep and the conclusion of the experiment after 6 h of sleep). Subject B had a sleep latency of 30 min and subject E of 40 min on the first or second withdrawal nights. All five of subject F’s withdrawal nights had a greater sleep latency than