

Chronic marijuana smokers show reduced coding into long-term storage

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Chronic high-frequency marijuana users were compared to nonusers on a task involving short-term retention of three words. Forced processing (reading) of an additional 2, 6, or 10 words was interpolated between initial presentation and recall. Mean proportion of words recalled was significantly reduced for chronic users, and this reduction was especially pronounced with more forced processing between initial presentation and recall. This pattern of impairment indicates that chronic marijuana smokers show a reduction in the transfer of information from short-term storage to a more permanent level of information storage.

Memory impairments in humans under the influence of marijuana have been documented in a large number of studies (Abel, 1970, 1971a; Dornbush, Fink, & Freedman, 1971; Drew, Kiplinger, Miller, & Marx, 1972; Melges, Tinklenberg, Hollister, & Gillespie, 1970). Further, at least one study shows "recent" memory deficits in rhesus monkeys trained to smoke marijuana cigarettes (Zimmerberg, Glick, & Jarvik, 1971). It is now possible, however, to apply more sensitive measures to diagnose the immediate effects of marijuana smoking on different aspects of information processing. Such studies have agreed that marijuana intoxication interferes with encoding of information from short- to long-term storage (Darley, Tinklenberg, Roth, Hollister, & Atkinson, 1973; Dornbush, 1974) and not retrieval from permanent memory (Abel, 1971b, c; Hollister & Atkinson, 1973).

The present study differs from other marijuana and memory studies in that it compares chronic smokers with nonsmokers. While this variable is subject defined and not manipulated, thereby reducing the logical strength of the conclusions, there must be great social concern if enduring memory impairments are associated with chronic usage.

The task used is a modification of the Peterson and Peterson (1959) paradigm which lends itself to separate interpretation for effects on short- and long-term storage (Glanzer, 1972). Three to-be-recalled words are followed by a postlist task. Peterson and Peterson and others whose work followed their model, such as Keppel and Underwood (1962), interpreted this task as one affecting short-term memory, apparently on the basis of the brevity of the overall task. Accordingly, one of the early marijuana and memory studies (Dornbush, Fink, & Freedman, 1971) used this task and concluded that marijuana affects short-term memory.

Dr. Arnold Hyman sponsors this paper and takes full editorial responsibility for its content.

"Short-term memory," however, is a gross term referring to many aspects of information processing, including short-term storage and coding into long-term storage. Thus, by operationally defining short-term memory in terms of experimental paradigms, previous investigators in marijuana and memory have failed to identify which of the underlying processes (mechanisms) have been affected by dose manipulations.

The present modification of the task substitutes word reading for arithmetic as the postlist task. These words displace the to-be-recalled words from short-term storage (Glanzer, Gianutsos, & Dubin, 1969) so that recall must be from long-term storage, if it is to occur at all. The critical variable is the number of words processed, not the duration of the postlist task. Consequently, the more words to be read following presentation of the to-be-remembered words, the less short-term storage will be reflected in the curves. The standard curve for this task shows recall as a function of the number of postlist task words, or, in the original version of the task, the duration of the postlist arithmetic task.

In studies where differences appear only at the longer postlist tasks, such as the Keppel and Underwood (1962) classic and the Dornbush, Fink, and Freedman (1971) marijuana study, the effect is on entering information into long-term storage, not short-term storage.

METHOD

Subjects

Fifty undergraduate university students participated in the experiment. They were recruited from classrooms, dormitories, and meeting places of two college campuses. All were naive as to the purpose of the experiment and participated on a voluntary basis. Prior to the experiment, 73 people filled out a questionnaire which served as a basis for group assignment. Fifty were selected for participation in the experiment to obtain similar distributions in the two experimental groups on such variables as sex, age, year in school, major, and grade average.

Two groups were established according to marijuana-smoking

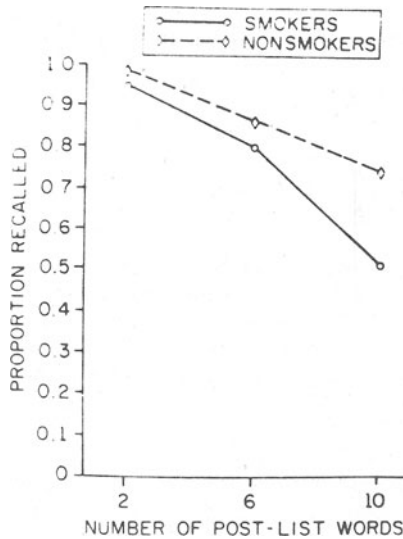


Figure 1. Recall in chronic smokers and nonsmokers of marijuana, as a function of postlist task.

habits. The first group, "nonsmokers," was made up of 25 people who reported never having smoked the substance. The second, "smokers," was made up of a matched sample of 25 who reported having smoked for from 2 to 6 years. Since frequencies of use change from time to time in all long-term users, only those who had smoked fairly regularly, twice a week and more, in the last 3 months were selected.

Materials

The words were high-frequency (AA, Thorndike & Lorge, 1944) monosyllabic nouns. They were assembled into random sequences with the restrictions that: (1) no word was used more than once, and (2) no two words beginning with the same letter or phonetically sounding the same followed each other. The sequences were prepared in lengths of 5, 9, and 13 words, with the first 3 words being the to-be-recalled list and the remaining 2, 6, or 10 words being the postlist reading task words. Each word was printed boldly on a 5 by 8 orange card.

Procedure

Each subject was asked if he/she were presently under the influence of marijuana, i.e., had smoked recently. All reported in the negative. (They had been asked not to smoke before the experiment.)

The experimenter and subject were seated opposite each other at a desk with minimal noise and distraction. The subject was given a pencil and score sheet and was instructed as follows: "I'm going to present words to you at a rapid rate. As soon as you see a word, read it out loud, but do not rehearse it in your mind. There are 12 groups of words here corresponding to the number of blanks on your score sheet. Following each group of words will be a blank card. This will be your cue to recall the first three words of the list and write them down on the line. Remember you only have to recall the first three words of each group. If you aren't sure of an answer, put down what you think it is, or leave it blank. You do not have to make up words. Any questions? . . . Then begin." The words were presented as fast as the subject could read and the experimenter could change cards: a new word was presented approximately every 3 sec.

RESULTS

The proportion of items recalled as a function of the number of postlist words is presented in Figure 1.

Overall, chronic smokers recalled less than the nonsmokers, $F(1,48) = 35.81$, $p < .05$. More importantly, the reduction in recall associated with smoking was greatest when the most postlist words were read, interaction $F(2,96) = 16.57$, $p < .05$. This divergence indicates that the effect is on the transfer of information from short- to long-term storage. The smokers also provided more intrusion errors in their recall ($p = .06$) than did the nonsmokers ($p = .14$), $t(48) = 6.61$, $p < .05$, as did the subjects given marijuana by Miller, Drew, and Kiplinger (1972).

DISCUSSION

The major finding, that the chronic smokers showed deficits with increased numbers of postlist words, confirms the recent reports (Darley, Tinklenberg, Roth, Hollister, & Atkinson, 1973; Dornbush, 1974) that marijuana interferes with the transfer of information into long-term storage. The early studies which simply pointed to a memory impairment have proved too gross. This study shows that short-term storage is not impaired in its function in chronic marijuana smokers. As Glanzer (1972) has pointed out, short-term storage is rather robust and is effected by few variables other than displacement.

A most important conclusion of the present study is the suggestion that the effects of marijuana on memory can be enduring. Chronic users who, by their own report, were not "high" during the experiment have shown a pattern of memory impairment previously observed in subjects with a marijuana-induced high. Indeed, most previous studies of the effects of marijuana have used experienced smokers. The present study suggests that the differences observed in those studies may be somewhat dampened because some effects of chronic marijuana smoking resemble the effects of an ongoing high.

Finally, the somewhat informal techniques of the present study, together with its social import, cause us to invite replication by other experimenters who have access to such populations of subjects.

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(Received for publication November 10, 1975.)