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Effects of Smoked Marijuana on Food Intake and Body Weight of Humans Living in a Residential Laboratory

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Six adult male research volunteers, in two groups of three subjects each, lived in a residential laboratory for 13 days. All contact with the experimenter was through a networked computer system and subjects' behaviors, including food intake, were continuously recorded. During the first part of the day, subjects remained in their private rooms doing planned work activities, and during the remainder of the day, they were allowed to socialize. Two cigarettes containing active marijuana (2·3% Δ^9THC) or placebo were smoked during both the private work period and the period of access to social activities. Smoked active marijuana significantly increased total daily caloric intake by 40%. Increased food intake was evident during both private and social periods. The increase in caloric intake was due to an increased consumption of snack foods as a consequence of an increase in the number of snacking occasions. There was no significant change in caloric consumption during meals. The principal increase within the category of snack foods was in the intake of sweet solid items, e.g., candy bars, compared to sweet fluid, e.g., soda, or savory solid items, e.g., potato chips. Increases in body weight during periods of active marijuana smoking were greater than predicted by caloric intake alone.

Introduction

Numerous anecdotal accounts indicate that marijuana increases appetite and food intake in humans (Siler *et al.*, 1933; Allentuck & Bowman, 1942; Haines & Green, 1970; Tart, 1970; Halikas *et al.*, 1971). Laboratory studies have confirmed this effect of marijuana in both single (Abel, 1971; Hollister, 1971; Noyes *et al.*, 1976; Gross *et al.*, 1983) and repeated-dose experiments (Williams *et al.*, 1946; Foltin *et al.*, 1986; Greenberg *et al.*, 1976). One of these previous studies investigated the behavioral mechanism(s) responsible for this increase in food intake (Foltin *et al.*, 1986) by studying adult male research volunteers living in a residential laboratory for up to 25 days. Smoked active marijuana significantly increased snack food intake, specifically in the evening by increasing the number of snacking occasions. Marijuana smoking occurred more often later in the day than during the morning, and increases in food intake during the evenings may have represented a time-of-day effect or a dose-dependent effect. The present study, in which marijuana was smoked at equal intervals

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throughout the day, was designed to test whether increased food intake late in the day following active marijuana smoking was due to an increase in dose or an interaction between time-of-day and dose.

Anecdotal accounts also suggest that marijuana specifically increases intake of sweet foods (Allentuck & Bowman, 1942; Halikas *et al.*, 1971; Tart, 1970). In the previous study from this laboratory described above (Foltin *et al.*, 1986) there was no evidence of a specific increase in sweet food intake. However, in that study the variety of sweet food items was limited. The second purpose of the present study was to determine the effect of smoked active marijuana on sweet food intake under conditions which provided a greater variety of sweet foods than in previous experiments.

In the present study, subjects lived, continuously, in groups of three, in a residential laboratory for 13 days under conditions which involved close monitoring of all food intake. A wide variety of snacks and meals were available, and the effects of smoked placebo and active marijuana on caloric intake was examined.

METHOD

Subjects

Two groups of three healthy, adult, male, research volunteers ranging in age from 19 to 30 years participated in separate 13-day experiments. All six subjects had histories of marijuana use, ranging from 2 to 3 cigarettes per week to 2 to 3 cigarettes per day. Five of the six subjects (all except Experiment 1: S1) smoked 10 to 20 tobacco cigarettes per day and continued to do so during the experiment. Subjects received complete medical and psychiatric examinations, signed consent forms detailing all aspects of the research, and were paid for participation.

Laboratory

Experiments were conducted in a residential laboratory designed for continuous observation of human behavior over extended time periods. The facility consisted of six rooms connected by a common corridor. Three identical private rooms were similar to small efficiency apartments with kitchen, bathroom, desks and sleeping areas. A common social area had a recreation room, an exercise room and a bathroom. The recreation room contained kitchen facilities, lounge furniture, games, puzzles, a video game system, and a television monitor used for displaying video taped movies. The exercise room containing exercise equipment and laundry facilities. A detailed description of the laboratory has been published elsewhere (Brady *et al.*, 1974).

Output from video and audio equipment located throughout the residential facility was projected to an adjacent control room. Subjects were continuously monitored except while in private dressing and toileting areas. A computerized observation program (Bernstein & Livingston, 1982) provided the structure for continuous recording of each subject's behavior in categorical form. Communication between subjects and the experimenters occurred only via a networked computer system. Communications between subjects and experimenters were limited to food consumption and protocol maintenance, and as such, were kept to a minimum. No communication outside of the laboratory was permitted.

Standard Day

The day was divided into two periods: a private work period and a period of social access. Subjects were awakened at 0900 hrs, weighed, and given an opportunity for breakfast. The private work period lasted from 0945 to 1700 hrs followed by a social access period which lasted from approximately 1700 to 2345 hrs. During the private work period, subjects were required to engage in structured-work tasks. They were allowed to eat during this period, but had to do so while concurrently performing a work task. An optional 30-min break period during which no work was required could be requested once during this period. During the social access period, each subject was permitted to remain in his own private room engaging in private recreational activities (e.g. reading) or to enter the social area and participate in social activites including watching videotapes of popular movies. Subjects were not allowed in each other's rooms, and social activities were available only in the social area during social access periods.

Food Monitoring

Food access was controlled. At 0900 hrs, a box of food was placed in the food drawer of each of the three private rooms. This box contained a wide variety of foods including some meal items, liquid items and conventional snack food items (see Table 1) which could be consumed at any time during the day (0900–2345 hrs). Each snack item portion size was designed to contain a roughly equivalent caloric content. A minimum of two of each of the snack items was placed in the food box, and subjects were free to request additional units of any items *ad libitum*. The variety of cookies, cereal and frozen food entrees was changed daily. In addition, subjects had free access to instant coffee, tea and water at all times. Consumption of items was closely monitored. Subjects were told that their food intake was continuously monitored by independent observers and were instructed to inform the research monitors via the computerized communication system whenever they ate or drank something, specifying substance and portion. Wrappers for each food were color coded by subject to facilitate data collection. Trash was removed and measured daily to validate the accuracy of the verbal reports and observer records of food intake, and to control for the possibility of food hoarding. Previous studied indicate that these procedures have no effect on total daily intake and are sensitive to manipulations affecting daily amount and patterning of food intake (Foltin *et al.*, 1986, 1988).

An eating occasion (snack or meal) was defined by the reported consumption of any item or series of items. This could be the consumption of a single bag of potato chips or an entire meal with beverage and dessert. The consumption of coffee and tea alone, or in combination with milk and sugar, was not classified as an eating occasion. A snack was defined as the consumption, between meals, of any item contained within the box of food. A meal was defined as the consumption of any of the items that required preparation time (see Table 1), including frozen foods and sandwiches, alone or in combination with any of the snack food items. For example, cookies consumed individually were a snack item, but when cookies were consumed with any item requiring preparation time, the combination was classified as a meal. Snack items were further divided into sweet and savory items. Sweet fluid items consisted of carbonated beverages and fruit juices, sweet solid items consisted of the candy bars, cake items and cookies, while savory solid items consisted of potato chips, doritos, and peanut butter crackers.

TABLE 1

Food items

Item	Caloric content per portion	Snack group
Fluid:		
Milk	150	
Sprite	192	Sweet fluid
Coca Cola	192	Sweet fluid
Fruit juice	90–100	Sweet fluid
Snack:		
Banana	80–100	Sweet solid
Cookies	120–180	Sweet solid
Cakes	120–170	Sweet solid
Candy bars	75–84	Sweet solid
Fruit cup	86	Sweet solid
Chocolate pudding	180	Sweet solid
Doritos	80	Savory solid
Potato chips	75	Savory solid
Peanut butter crackers	190	Savory solid
Meal:		
Cold cereal	70–110	
Warm cereal	100–170	
Tuna fish	150	
Bologna	88	
American cheese	83	
Swiss cheese	72	
White bread	62	
Stouffer's Pizza	800	
Swansen's "Hungry Man" entrees	680–880	
Stouffer's entrees	330–440	
Other:		
Salad dressing	100–121	
Mayonnaise	71	
Sugar	16	
Non-dairy creamer	11	
Margarine	33	

Drug Administration

Cigarettes containing 0% (weight/weight; placebo), 1·3 or 2·3% (weight/weight) Δ^9-tetrahydrocannabinol, supplied by The National Institute on Drug Abuse, were smoked using a uniform puff procedure cued by stimulus lights located in each private room and in the main social room. This paced smoking procedure for marijuana administration produces reliable increases in heart rate (Foltin *et al.*, 1987 b) food intake (Foltin *et al.*, 1986) and social interaction (Foltin *et al.*, 1987 a). Onset of the first light signalled that subjects should light the cigarette with minimum inhalation, and then wait for 30 sec. A series of four lights signalled a 5-second "ready" period, a 5-sec inhalation followed by a 10-sec breath hold, an exhalation, and a 40-sec rest. This procedure was repeated once a minute for five inhalations, and in most cases resulted in pyrolysis of the entire cigarette. Subjects smoked placebo or active marijuana cigarettes

in their individual rooms at 0945 and 1315 hrs, and together in the social area at 1700 and 2030 hrs. Subject 3 in Experiment 2 was more sensitive to active marijuana than the other subjects and, on active drug days, he smoked cigarettes containing 1·3% (w/w) Δ^9-tetrahydrocannabinol, while the remaining five subjects smoked the higher potency cigarettes. The design of the experiments was identical, with counterbalanced placebo and active marijuana dosing. Following a single no-smoking day, active marijuana cigarettes were smoked on days 5 to 7, and 11 to 13 in Experiment 1, and on days 2 to 4 and 8 to 10 in Experiment 2. Placebo cigarettes were smoked on the remaining days in both experiments.

Data Analysis

Day 1 served as an acclimation day and, although food intake was measured, data collected were not included in the analysis. Food intake prior to the smoking of the first placebo or drug cigarette, i.e., at 0945 hrs, was not included in the statistical analysis. Data analysis was accomplished using repeated-measures analyses of variance. Caloric intake from snacks and meals, caloric intake from each snack food type, and the number of snack and meal eating occasions were analyzed using five-factor ANOVAs. The first four factors were the same for each analysis with drug type (placebo vs. active marijuana), period of the experimental day (private work vs. social access), drug administration period (first vs. second), and day within each drug administration period (one to three) as the four factors, respectively. The remaining factor varied among each analysis. Body weight was analyzed using a three factor ANOVA with drug type, drug administration period, and day within each drug administration period as the three factors, respectively. Results were considered statistically significant if $p < 0{\cdot}05$.

RESULTS

All subjects adapted readily to the residential facility. Figure 1 presents the daily total caloric intake (including calories consumed between 0900 and 1000 hrs) for each subject in Experiment 1 (top panel) and Experiment 2 (bottom panel) as a function of drug administration and day of the experiment. Daily intake ranged from 2000 to 5300 kcal under placebo conditions and from 2100 to 6000 kcal under active marijuana conditions. Smoking active marijuana significantly increased mean total daily caloric intake by 1095 kcal [$F(1, 5) = 26{\cdot}27$, $p < 0{\cdot}004$]. There was a significant effect of period of drug administration [$F(1,5) = 15{\cdot}23$, $p < 0{\cdot}01$], and day within each period of drug administration [$F(2,10) = 8{\cdot}43$, $p < 0{\cdot}007$]. Total intake decreased during the second period of administration of both placebo and active marijuana compared to the first period of administration of both drugs. Within each period of administration of either drug there was a significant decrease in intake on the third day compared to the second day as determined using a Tukey *post hoc* comparison.

Figure 2 compares the mean daily cumulative intake under placebo baseline and active marijuana conditions for each subject in both experiments. Caloric intake increased over the course of the day with the greatest rate of change during the social period in five of the six subjects. In four of the six subjects, differences in caloric intake under placebo and active marijuana conditions are evident even after the first cigarette of the day (0945 hrs).

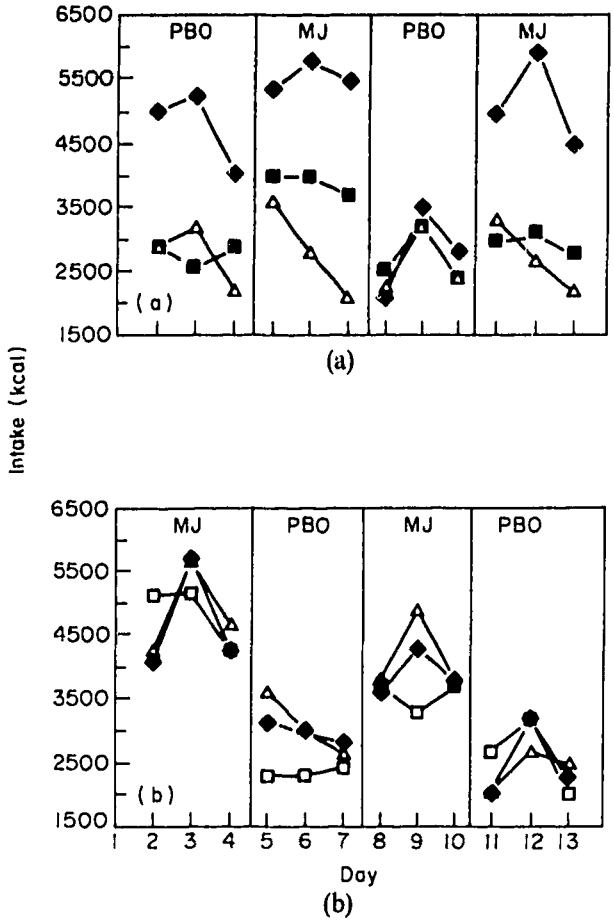

FIGURE 1. (a) Total daily caloric intake for each subject in Experiment 1 as a function of day of the experiment. Placebo (PBO) and active marijuana (MJ) administration periods are indicated at the top of the figure. No data are presented for Day 1 which served as an acclimation day. ■, Subject 1; ◆, Subject 2; △, Subject 3. (b) Total daily caloric intake for each subject in Experiment 2 as a function of day of the experiment. Placebo (PBO) and active marijuana (MJ) administration periods are indicated at the top of the figure. No data are presented for Day 1 which served as an acclimation day. □, Subject 1; ◆, Subject 2; △, Subject 3.

Daily caloric intake was divided into intake from snacks and meals. Figure 3 compares the total caloric intake from snacks and meals in the private and social periods following the first cigarette smoked during the day. Caloric intake from snacks and meals was analyzed using a five-factor, repeated-measures ANOVA. The first four factors were described in the data analysis section and the fifth factor was type of food (snack vs. meal). There was no difference in caloric intake between the private and social periods, and there was no difference in the effects of active marijuana on food intake in these two periods. Finally, there was a significant period of day by type of food interaction [$F(1,5)=13{\cdot}03$, $p<0{\cdot}02$]. During the private period (left portion of the figure) under placebo baseline conditions, caloric intake from snacks and meals did not differ, while during the social period (right portion of the figure) caloric intake from meals was greater than caloric intake from snacks. A planned comparison analyzed the effect of placebo and active marijuana on the type of food consumed (Keppel, 1982). Active marijuana significantly increased caloric intake from snack foods

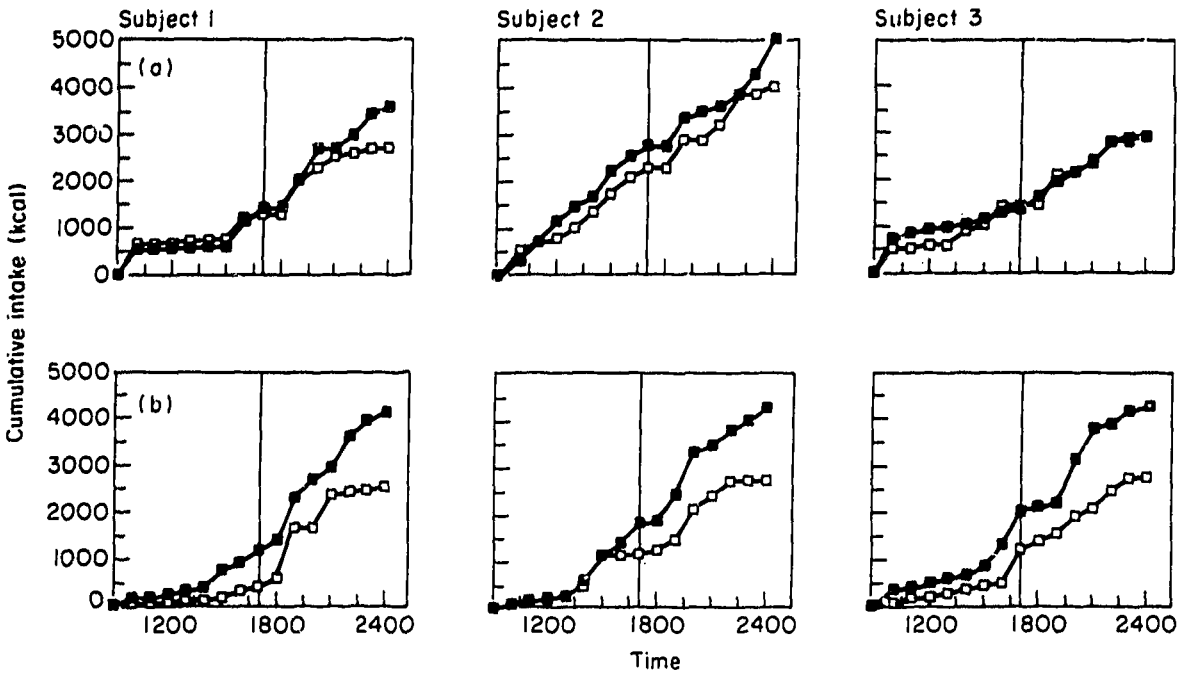

FIGURE 2. Mean cumulative daily caloric intake for each subject in (a) Experiment 1 and (b) Experiment 2, following placebo (□) and active marijuana (■) administration. Left hand panels, private work periods, right hand, panels social access periods.

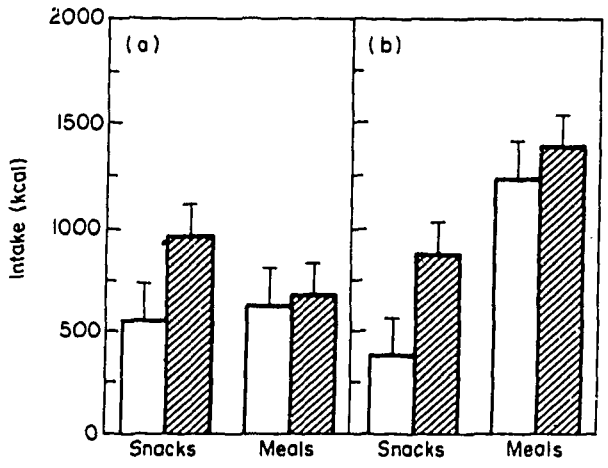

FIGURE 3. Mean daily caloric intake of six subjects from snacks and meals during the private work period (a) and social access period (b) following placebo (□) and active marijuana (▨) administration. Error bars indicate *SEM*.

[$F(1,5)=34{\cdot}47$, $p<0{\cdot}002$] without changing caloric intake from meal foods. Subject 3 in Experiment 1 was the only subject who did not increase his total daily caloric intake during active marijuana administration. However, analysis of his caloric intake from snacks and means indicates that active marijuana did change the pattern of intake. Under placebo conditions this subject consumed on average 1011 kcal from snack foods and 1800 kcal from meal foods, while under active marijuana conditions snack food intake increased by 1108 to 2119 kcal, and meal food intake decreased by 995 to 805 kcal.

Caloric intake from snack foods was further divided into intake from (1) sweet fluid (2) sweet solid and (3) savory solid foods, with this division serving as the fifth factor in the repeated-measures ANOVA. Figure 4 compares the intake from each of these three snack food types collapsed across period of the day following placebo and active marijuana administration. Although active marijuana increased consumption of the three types of snack foods, there was a significant type of snack food by drug interaction [$F(2,10)=6{\cdot}63$, $p<0{\cdot}01$]. The results of Tukey *post hoc* comparison tests indicate that the only significant increase in snack food consumption was the 531 kcal increase in intake of sweet solid items. The increase in caloric intake of sweet solid food items was smaller during the second period of drug administration compared to the first period of drug administration. There was also a significant effect of type of snack food [$F(2,10)=4{\cdot}95$, $p<0{\cdot}03$], with more solid snack food consumed when this factor was collapsed across drug. Finally, there was a significant drug by period of drug administration by type of snack food interaction [$F(2,10)=6{\cdot}18$, $p<0{\cdot}02$], with the increase in sweet solid snack food consumption being smaller during the second period of marijuana administration.

Figure 5 presents the results of an analysis of the number of eating occasions. The left portion compares the effects of placebo and active marijuana on number of snack and meal eating occasions during the private period, and the right portion presents the data similarly for the social period. The results of the five-factor, repeated-measures

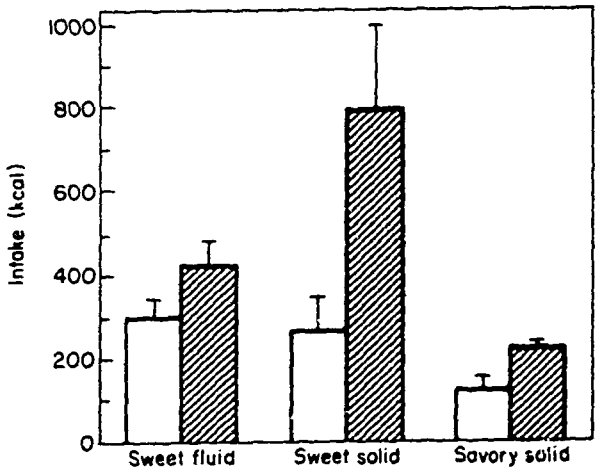

FIGURE 4. Mean daily caloric intake of six subjects from sweet fluid, sweet solid and savory solid snack items following placebo (□) and active marijuana (▨) administration. Error bars indicate *SEM* mean.

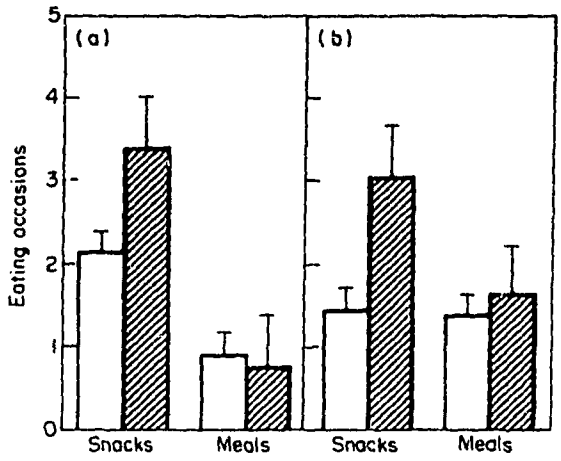

FIGURE 5. Mean number of snack and meal-eating occasions of six subjects during the private work period (a) and social access period (b) following placebo (□) and active marijuana (▨) administration. Error bars indicate *SEM*.

ANOVA identical to the one used in comparing caloric intake from snack and meal items indicated that smoked active marijuana significantly increased the number of eating occasions [$F(1,5)=109{\cdot}8$, $p<0{\cdot}001$]. There was a significant main effect of type of food [$F(1,5)=73{\cdot}78$, $p<0{\cdot}004$], and significant interactions between period of the day and food type [$F(1,5)=7{\cdot}74$, $p<0{\cdot}04$], and drug administration and food type [$F(1,5)=20{\cdot}48$, $p<0{\cdot}006$]. The period of day by type of food interaction is clearly presented on the figure by the larger number of snack occasions compared to meal occasions in the private period (two snacks vs. one meal) compared to the snack and meal occasions during the social period which do not differ (1·5 occasions each) under placebo conditions. Smoked active marijuana nearly doubled the number of snack occasions in both private and social periods without affecting the number of meal occasions.

Figure 6 presents the morning body weights for each subject in both experiments. Due to the fact that the body weights reflect the effect of the previous days' drug administration, the headings indicating placebo and active marijuana days are shifted to the right by one day compared to Figure 1. Smoking active marijuana significantly increased body weight [$F(1,5)=25{\cdot}25$, $p<0{\cdot}004$], and there was a significant interaction between drug condition and day of administration [$F(2,10)=12{\cdot}28$, $p<0{\cdot}002$]. This interaction is clearly shown in the figure by the increase in body weight as a function of day of active marijuana administration compared to the decrease in body weight as a function of day of placebo administration.

Total daily caloric intake from each of the macronutrients was estimated using Atwater factors (McLaren, 1976). Under placebo conditions the distribution of caloric intake was 56% carbohydrate, 33% fat and 11% protein, while under active marijuana conditions the distribution of caloric intake was 59% carbohydrate, 32% fat and 9% protein.

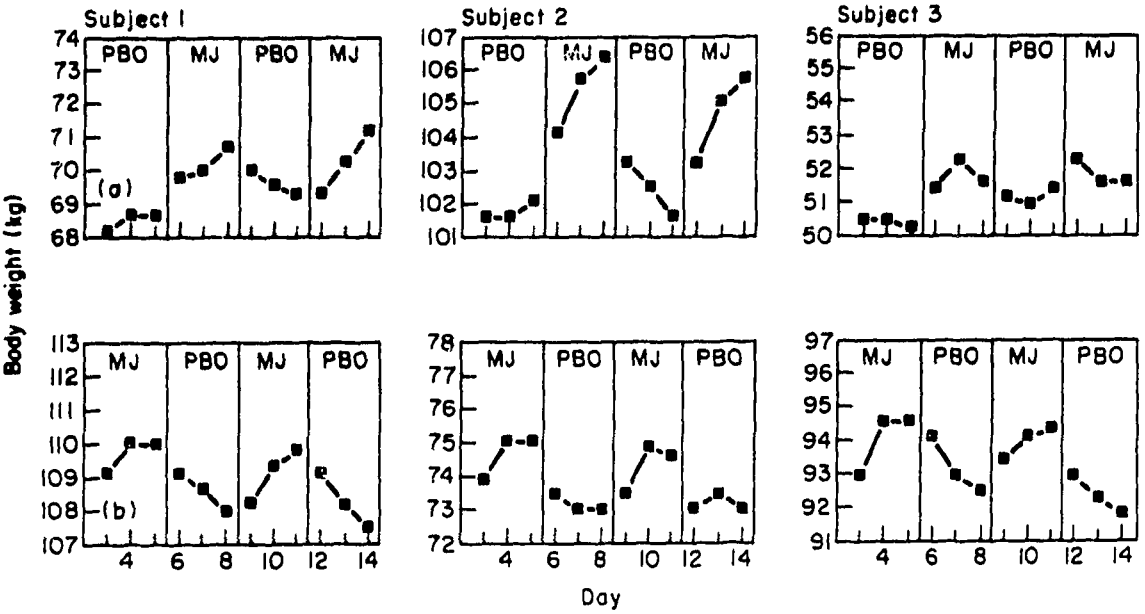

FIGURE 6. Morning body weight for each subject in both experiments as a function of day of the experiment (a) Experiment 1, (b) Experiment 2. Placebo (PBO) and active marijuana (MJ) administration periods are indicated at the top of the figure. However, due to the fact that the body weights reflect the effect of the previous days' drug administration, these headings are shifted to the right by 1 day compared to Fig. 1.

DISCUSSION

The results of this experiment clearly show that smoked active marijuana significantly increases mean daily caloric intake in normal male volunteers living continuously in a residential laboratory. These findings supply controlled verification of previous anecdotal reports of marijuana-induced increases in food intake (Siler *et al.*, 1933; Haines & Green, 1970; Tart, 1970; Allentuck & Bowman, 1971) as well as replicating previous studies on the effects of single-dose (Hollister *et al.*, 1968; Abel, 1971; Hollister, 1971) and repeated-dose marijuana administration (Greenberg *et al.*, 1976; Foltin *et al.*, 1986) on food intake.

Five of the six subjects had significant increases in caloric intake following marijuana smoking demonstrating the robustness of this effect of marijuana. However, the increases were about 50% larger in the second group of subjects compared to the first. There were no differences between the groups in terms of reported marijuana consumption. In addition, although Subject 1 in the first group did not smoke tobacco cigarettes, marijuana increased his food intake, eliminating differences in tobacco and reported marijuana consumption as an explanation of the discrepancy between the two groups. Thus, the difference between groups is either a random effect, or a consequence of the dosing procedure.

Although the active constituents of marijuana smoke are lipophilic and sequestered in fat, there is no evidence of this sequestered drug having behavioral effects (Harvey, 1987). This was true in the present study as the increases in caloric intake following marijuana smoking did not last beyond the period of smoking, i.e. intake decreased

during the first day of each placebo period following marijuana periods. Greenberg *et al.* (1976), and Foltin *et al.* (1986), have both reported, that in some individuals, caloric intake decreased below original baseline levels following prolonged, i.e. 6- to 21-day, periods of marijuana smoking. In the present experiment, the periods of marijuana smoking were only 3 days long, limiting the possibility of rebound decreases in food intake. However, it is still possible that food intake during placebo periods may reflect some rebound change in eating behavior.

In a previous study from this laboratory (Foltin *et al.*, 1986) a single cigarette containing 0 or 1·8% Δ^9 THC was smoked prior to the private work period and two or three cigarettes were smoked during the social access period. Under those conditions active marijuana increased the mean daily caloric intake of volunteers by 20% by increasing caloric intake during the social access period. Active marijuana had no effect on caloric intake during the private work period. In the present study smoking four regularly-spaced marijuana cigarettes containing 2·3% Δ^9 THC increased mean daily caloric intake by nearly 40%. In addition, by holding the dosing constant between private and social period in the present study, it was possible to determine if the difference in private and social food intake in the previous study was a function of dose, time-of-day, or available activities. Smoking active marijuana significantly increased food intake during both private and social periods in the present study. Thus, the seemingly specific effect of active marijuana on food intake during the social period of the previous study was reflective of a dose effect rather than social facilitation.

The present data also provide indications of the behavioral mechanism(s) of the marijuana-induced increase in caloric intake. The increase in caloric intake under active marijuana-conditions was a consequence of increased consumption of calories consumed as snack items during both private and social periods. This increase in the consumption of calories from snack items was due to an increase in the number of snack-eating occasions during both periods rather than an increase in the mean size of each snack occasion. This specific increase in caloric intake of snack items and number of snack occasions replicates the findings of the previous study, although in that study, significant effects of active marijuana were limited to the social access period (Foltin *et al.*, 1986).

Anecdotal accounts suggest that marijuana specifically increases intake of sweet foods (Allentuck & Bowman, 1942; Tart, 1970; Halikas *et al.*, 1971). In order to investigate this possibility, caloric intake of snack foods was divided into three categories: sweet fluid (e.g. carbonated beverages, fruit juice), sweet solid (e.g. cakes and candy bars), and savory solid (e.g. potato chips, peanut butter crackers). This categorization of snack food items was based on sensory properties, rather than macronutrient content of the items (Fernstrom, 1987). All of the energy content of the sweet fluid items were derived from carbohydrates, while 60% of the energy content of all of the sweet solid items were derived from carbohydrates, with the exception of the candy bars which had similar amounts of energy derived from carbohydrates and fat. In contrast, all of the savory snack items had similar amounts of energy derived from carbohydrates and fat. Although caloric intake of each of these three categories of snack food items did not differ under placebo baseline conditions, smoked active marijuana significantly increased consumption of only sweet solid snack items. These results confirm the anecdotal reports (Allentuck & Bowman, 1942; Tart, 1970; Halikas *et al.*, 1971) and suggest that marijuana specifically increases appetite for sweet solid foods. The preference for sweet solid foods is not based on macronutrient content alone, but reflects palatability factors as well (e.g. Booth, 1987). A similar pattern of

changes in reports of snack food preference has been described by Fernstrom *et al.* (1987). Depressed patients reported a specific increase in preference for sweet high-carbohydrate, high-fat items relative to savory high-carbohydrate, high-fat items.

It is interesting to note that this specific increase in sweet snack food consumption under active marijuana conditions is in contrast to the effects of smoked nicotine which specifically decrease consumption of sweet food items (Grunberg, 1982; Grunberg *et al.*, 1985). In a previous study from this laboratory (Foltin *et al.*, 1986) there was no evidence of a specific increase in sweet food intake. However, in that study sweet food items were limited to candy, fruit and cookies, while in the present study a wider variety of sweet snack foods including all of the above items plus pudding and three types of cake items were available. The overall greater increase in caloric intake observed in the present study compared to the previous one from this laboratory (Foltin *et al.*, 1986) is probably due to the combination of the larger dose in the private period and availability of a wider variety of sweet snack foods in the present study.

Alternatively, the specific increase in snack food intake compared to meal intake may reflect an interaction between response cost and marijuana effects. As defined here, meals contain foods that require preparation time as well as any snack item reported consumed with that item. It may take up to 1 hour to cook a frozen dinner, while it may only take seconds to unwrap a candy bar. Support for a specific effect of marijuana on snack food intake can be drawn from the specific increase in consumption of sweet solid snack foods compared to sweet fluid or savory solid snack foods. If ease of access was the only factor influencing choice of food items, it is unlikely that marijuana would have specifically increased intake of only one variety of snack food. By using meal items that could be rapidly prepared in a microwave oven, and inserting a delay between choice and consumption of a food item it should be possible to control for response cost differences between snack and meal items to further clarify the issue of the specificity of the effects of smoked active marijuana on food intake.

Body weight changed dramatically as a function of placebo and active marijuana administration. Body weight increased an average of 3 kg over the 3-day, active marijuana periods and subsequently decreased by nearly 3 kg over the 3-day, placebo periods. Changes in caloric intake over the same periods were not large enough to account for the changes in body weight: caloric intake increased on average 3300 kcal over the 3-day, active marijuana periods and subsequently decreased similarly over the 3-day, placebo periods. This increase in body weight greater than predicted by the increase in caloric intake replicates previous reports (Williams *et al.*, 1946; Greenberg *et al.*, 1976). In addition, the rapid decrease in body weight following cessation of active marijuana administration has also been reported (Benowitz & Jones, 1981; Greenberg *et al.*, 1976). In the previous study on the effects of marijuana on food intake in this laboratory, daily body weights were not obtained, but there were no differences in body weight before and after each experiment (Foltin *et al.*, 1986).

The fluctuations in body weight during periods of placebo and active marijuana administration are significantly greater than those predicted by the corresponding changes in caloric intake. It has been argued (Benowitz & Jones, 1981) that increased body weight during active marijuana administration is a consequence of increased fluid retention. However, previous studies reported no changes in either urinary volume (Greenberg *et al.*, 1976), or plasma fluid volume (Williams *et al.*, 1946), as a function of active marijuana administration. Smoking active marijuana reduces physical activity level (Babor *et al.*, 1976) and increases sleeping time (Williams *et al.*, 1946). This decrease in activity levels may account for some of the variation in body weight

reported above. Marijuana also engenders hypothermia in rodents (e.g. Kosersky *et al.*, 1973; Bhargava, 1980; Taylor & Fennessy, 1981), but these results have not been replicated in humans (Williams *et al.*, 1946; Stefanis *et al.*, 1977). Weight gain following marijuana administration appears to be a temporary phenomenon, however, as chronic cannabis users maintain body weights significantly below that of control groups (Tart, 1970; Rubin & Comitas, 1976; Carter, 1980).

Smoking active marijuana significantly increases total daily caloric intake by specifically increasing caloric intake of sweet solid snack items by increasing the frequency of snack occasions. In addition, body weight increases during active marijuana administration are greater than expected from the analysis of caloric intake. Further studies on the effects of smoked active marijuana on food intake and body weight under conditions of continuous residence in the laboratory will provide valuable information about both the specific effects of marijuana and basic mechanisms in human feeding behavior.

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