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**PROJECT REPORT
COMMITTEE ON FOOD RESEARCH**

U.S. QUARTERMASTER FOOD AND CONTAINER INSTITUTE
FOR THE ARMED FORCES
CHICAGO ILLINOIS

RESEARCH AND DEVELOPMENT BRANCH
MILITARY PLANNING DIVISION
OFFICE OF THE
QUARTERMASTER GENERAL

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| COOPERATING INSTITUTION Permanente Foundation | | LOCALITY Oakland, California | |
| DIVISION Permanente Foundation Hospital | | DEPARTMENT Medical Research | |
| OFFICIAL INVESTIGATOR Franz R. Goetzl, Ph. D., M. D. | | COLLABORATORS Freya Stone, B. A. | |
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"HUMAN APPETITE"

SUMMARY

Experiments were described which demonstrate that sugar produces a decrease in olfactory acuity and a sensation of satiety, only if ingested after having stimulated oral taste nerve endings.

Neither ingestion without preceding stimulation of taste nerve endings nor stimulation of taste nerve endings without following ingestion, was capable of producing a decrease in olfactory acuity and a sensation of satiety.

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INTRODUCTION

In previous reports it was stated that in normal human subjects, freely selected meals are preceded by a period of increasing and followed by one of decreasing acuity of olfaction. It was suggested that these changes in olfactory acuity may be related to the conversion of the sensation of appetite into one of satiety. The hope was expressed that by continuing studies along these lines, it may be possible to find ways and means by which to evaluate the intensity of the sensation of appetite, and also the ability of food to produce the sensation of satiety.

In the present experiments the influence of table sugar upon olfactory acuity was investigated. A study of this type appeared desirable, particularly in view of the important role sweets seemingly play in meals, producing the sensation of satiety.

METHODS

The method employed for determining olfactory threshold values has been described in previous reports.

The present experiments were carried out with the cooperation of five female individuals in apparently good health, ranging in ages from 20 to 30 years.

They held clerical positions in this institution and worked daily from 9 o'clock in the morning until 5 o'clock in the evening. As a rule, they had breakfast and dinner at home, at customary hours, but ate lunch in the hospital cafeteria which offered a variety of dishes so as to permit reasonably free selection of food. Lunch was served between 12 and 1 o'clock in the afternoon. On test days, olfactory thresholds were determined between 9:30 and 10 o'clock, and between 11:30 and 12 o'clock in the morning, between 12:45 and 1:15 o'clock in the afternoon, and between 4 and 5 o'clock in the afternoon. On these days, the subjects' statements regarding hunger and appetite were recorded as well as the caloric values of the freely selected meals. On test days the subjects were requested to abstain from taking food between meal-times. There were 21 test days for every subject.

On 10 days, for purpose of control, customary food habits were observed. On 3 days, the subjects ingested 10 gelatin capsules containing a total of 10 gm. of table sugar instead of their lunch. On 4 days they rinsed their mouth at lunch time, with 10 to 25 gm. of sugar in a 50% water solution. The solution was not ingested, and their customary noon meal was omitted. On the remaining 4 test days, making a total of 21,

the subjects rinsed their mouth as before, but on these days, ingested the sugar solution, instead of their lunch.

The experiments were arranged in such a manner, that control days preceded and followed the days on which the effects of sugar were investigated.

RESULTS AND OBSERVATIONS

The results for the entire group obtained from the tests in which coffee was used as test material, are shown in Figure I. The results are expressed in terms of average changes in olfactory threshold values taking the average value obtained between 9:30 and 10 o'clock in the morning as point of reference. This presentation of results was justified because the results of each type of test were uniform for all subjects on all occasions. The illustration shows:

- 1.) that sugar, when ingested in taste-less capsules, instead of lunch, did not produce an increase in threshold values of olfaction.
- 2.) that rinsing the mouth with the sugar solution was not followed by an increase in threshold values of olfaction.

3.) that the sugar solution, when ingested, in addition to rinsing the mouth, did produce a significant increase in threshold values of olfaction.

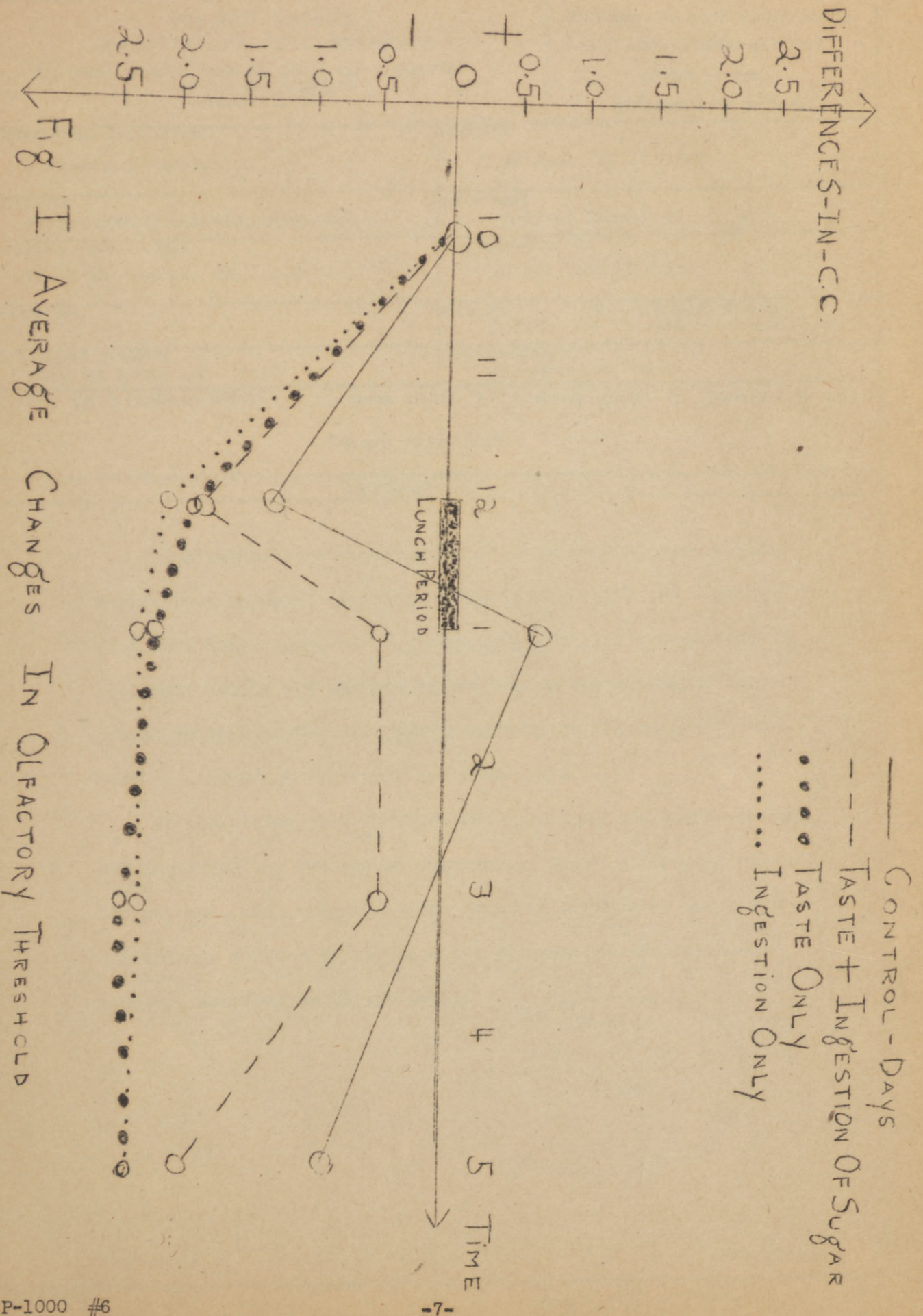
Statements obtained from the subjects indicated that neither ingestion of the capsules, containing sugar, nor rinsing the mouth with the sugar solution produced the sensation of satiety. However, this sensation was experienced when the sugar solution had been ingested in addition to rinsing the mouth with that solution.

COMMENT

Changes in threshold values for the sense of olfaction indicate changes in olfactory acuity. Thus, decreasing threshold values signify an increase, increasing threshold values, a decrease in olfactory acuity.

The experiments described indicate that sugar, in the amounts tested, in order to produce a decrease in olfactory acuity and a sensation of satiety has to be ingested after having stimulated oral taste nerve endings. Neither ingestion without preceding stimulation of taste nerve endings nor stimulation of taste nerve endings without following ingestion, is capable of producing a decrease in olfactory acuity and a sensation of satiety.

The observations made cannot yet be discussed in detail. Neither can an explanation be given for the phenomenon described. Further studies are being conducted along these lines, particularly because it is felt that they may contribute to a better understanding of the properties food must possess in order to produce the sensation of satiety, upon its ingestion. They may also contribute to a better understanding of the mechanisms responsible for the sensation of satiety.



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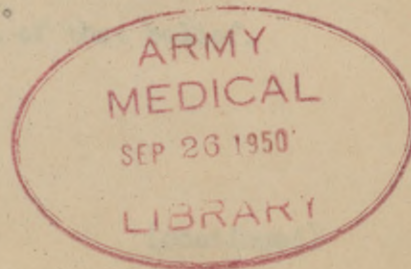
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"Human Appetite"

SUMMARY

Experiments were described which demonstrated that bitter tonics when ingested during freely selected meals are capable in normal human subjects of preventing postcibal decrease in olfactory acuity and capable of preventing conversion of the sensation of appetite into one of satiety as are normally produced by ingestion of freely selected meals.

It was stated that further investigations are being carried out regarding the mechanisms involved in these effects of bitter tonics, and, also, regarding the question whether or not these effects are related to the appetite stimulating effectiveness commonly ascribed to bitter herbs.



INTRODUCTION:

Experiments were reported previously which demonstrated the existence in human subjects of diurnal variations in olfactory acuity. The pattern of these variations was found to be remarkably uniform and intimately connected with ingestion of food. Meals were preceded by a period of increasing and followed by one of decreasing acuity of olfaction. In discussing these observations the suggestion was made that precibal increase and post cibal decrease in olfactory acuity may represent measures of intensity of the sensation of appetite and satiety respectively.

In subsequent studies it was shown that benzedrine sulfate is capable of simultaneously producing a decrease in olfactory acuity, a decrease in intensity of the sensation of appetite, a decrease in caloric value of freely selected meals and, also, of producing a sensation of satiety. These observations are in agreement with clinical experience in regard to the usefulness of benzedrine sulfate in subduing the sensation of appetite and diminishing caloric intake.

In the present experiments the influence of "bitter tonics" upon olfactory acuity was investigated. The usefulness of these agents for creating or increasing desire for food is a widespread, popular belief. Scientific investigations of the past, however, have failed to produce evidence in support of that belief.

METHODS:

Threshold determinations for the sense of smell were performed by means of a method described in detail in previous reports.

The present experiments were carried with the cooperation of 5 female individuals of apparently good health, ranging in age from 20 to 30 years. They held clerical positions in this institution and worked daily from 9 o'clock in the morning until 5 o'clock in the evening. As a rule they had breakfast and dinner at home at customary hours, but ate lunch in the hospital cafeteria which offered a variety of dishes so as to permit reasonably free selection of food. Lunch was served between 12 and 1 o'clock in the afternoon. On test days olfactory thresholds of the subjects were determined between 9:30 and 10 o'clock, and between 11:30 and 12 o'clock in the morning, and between 12:45 and 1:15 o'clock and between 4 and 5 o'clock in the afternoon. On these days the subjects' statements regarding hunger and appetite were recorded as well as caloric values of the freely selected meals. On test days the subjects were requested to abstain from taking food between meals.

There were 24 test days for every subject. On ten days the subjects were given 2 teaspoons of "Angostura Bitters" at the beginning of lunch. "Angostura Bitters" is a commercially prepared extract of bitter herbs containing 45% alcohol.

On 4 days, for purpose of control, the subjects were given 2 teaspoons of 45% alcohol at the beginning of lunch and on 10

days they were tested, observing customary food habits without drug administration. Care was taken to avoid repeating ingestion of "Angostura Bitters" or that of alcohol on successive days.

RESULTS AND OBSERVATIONS:

The results for the entire group obtained from tests, coffee as test material, are shown in Figure I. The results are expressed in terms of average changes in olfactory threshold values taking the average value obtained between 9:30 and 10 o'clock in the morning as point of reference. This presentation of results was justified because the results of each type of test were uniform for all subjects on all occasions.

As can be seen from the illustration, the postcibal increase in olfactory threshold values failed to occur when bitter tonics had been ingested with the meal. On these days the threshold values remained low throughout the afternoon. The figure also shows that alcohol in the amounts tested did not alter the expected postcibal change in olfactory threshold values.

With regard to caloric intake it can be stated that bitter tonics and alcohol did not influence the caloric values neither of the freely selected noon-meals supplemented by them nor of the succeeding evening meals. From the subjects' statements it was learned that the ingestion of noon-meals when supplemented by bitter tonics were not followed by the sensation of satiety expected to follow ingestion at meal time of food freely selected in regard to

quantity and quality. The absence of the sensation of satiety was noted by the subjects as something unusual, particularly during the early afternoon hours, but occasionally, also during the latter part of the afternoon.

COMMENT:

Changes in threshold values for the sense of olfaction indicate changes in olfactory acuity. Thus decreasing threshold values signify an increase, increasing threshold values a decrease in olfactory acuity.

Prior to beginning the experiments as were described an attempt had been made to demonstrate directly by means of the method in use the ability of bitter tonics to increase the intensity of the sensation of appetite. It had been felt that bitter tonics when administered 30 to 60 minutes prior to a freely selected meal may possibly act to exaggerate the precibal increase in olfactory acuity, to intensify the sensation of appetite, and, also, to bring about the ingestion at succeeding meal time of increased amounts of food. These suggested effects of bitter tonics, however, could not be demonstrated experimentally.

The failure of bitter tonics to produce exaggeration of precibal increase in olfactory acuity and intensification of the sensation of appetite may be explained by assuming refractoriness to further augmentation in normal human subjects of precibal increase in olfactory acuity and intensity of the sensation of

appetite, both presumably of optimal magnitude. Considerations along these lines led to the notion that in normal human subjects effects of bitter tonics upon olfactory acuity and intensity of the sensation of appetite may become demonstrable if these agents were permitted to unfold their effectiveness during a period of decreasing olfactory acuity and of vanishing desire for food.

The present experiments are designed accordingly, the bitter tonics having been administered during rather than before the freely selected noon meal. Under these conditions bitter tonics were found capable in normal human subjects of preventing the postcibal decrease in olfactory acuity and, also, of preventing the sensation of satiety as are normally produced by ingestion of freely selected meals. In other words, freely selected meals when supplemented by bitter tonics no longer were able to bring about the expected conversion of the sensation of appetite into one of satiety. Since bitter tonics were administered during the course of the freely selected noon meals they were not expected to influence caloric intake at the time. On the other hand, it was thought possible that bitter tonics ingested at lunch time may influence caloric values of succeeding evening meals, likewise freely selected. This, however, was not the case; caloric values of evening meals were found unaffected by bitter tonics ingested at preceding lunch times.

The similarity of caloric values of freely selected evening meals conspicuously coincided with similarity of olfactory acuities and similarity of the subjects' statements regarding appetite as were noted during the latter part of afternoons regardless whether or not bitter tonics had been ingested with preceding noon meals. These observations may be regarded as supporting the suggestion previously made, namely, that the magnitude of olfactory acuity may represent a measure of intensity of the sensation of appetite.

To summarize, it can be stated, that bitter tonics when ingested between meals were found incapable in normal human subjects of exaggerating precibal increase in olfactory acuity and incapable of intensifying the sensation of appetite; when ingested during freely selected meals, however, they were found capable of preventing postcibal decrease in olfactory acuity and capable of preventing conversion of the sensation of appetite into one of satiety as are normally produced by ingestion of freely selected meals.

The question whether these effects are related to appetite stimulating effectiveness commonly ascribed to bitter tonics as well as the mechanisms involved in these effects are being subjected to further investigation.

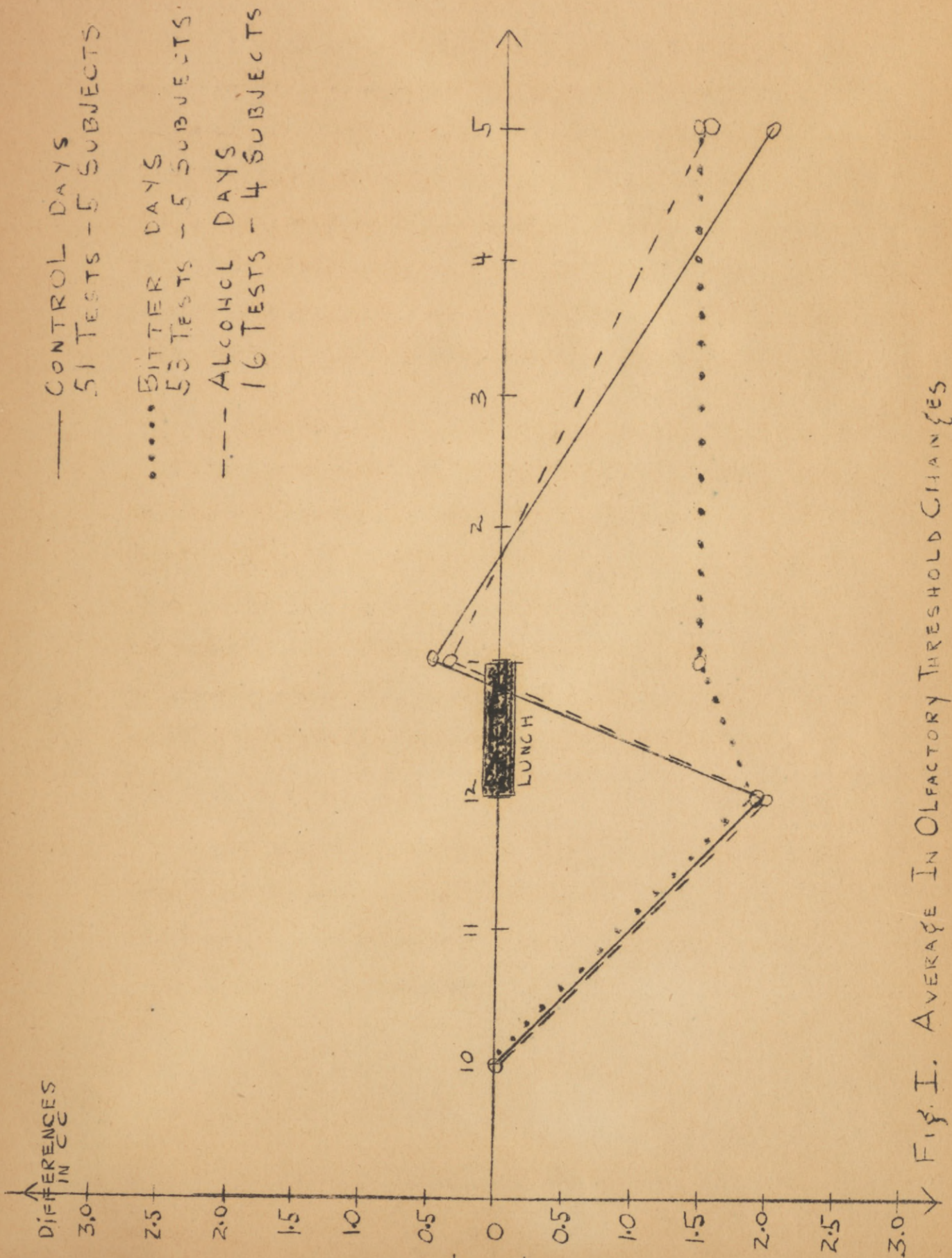


FIG. I. AVERAGE IN OLFACTORY THRESHOLD CHANGES