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Diurnal Variations in Acuity of Sense of Taste for Sodium Chloride.* (19291)

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In normal individuals, diurnal variations exist in acuity of olfaction(1,2) and in acuity of the sense of taste for sucrose(3). The pattern of these variations is remarkably uniform and intimately connected with food intake. Freely selected meals are preceded by a period of increasing and followed by one of decreasing acuity of the senses mentioned. When a meal has been omitted a decrease in acuity cannot be demonstrated. The precibal increase in acuity of olfaction and precibal increase in acuity of the sense of taste for sucrose may represent measurable accompaniments of sensations interpreted as desire for food and the postcibal decrease in acuity of olfaction and postcibal decrease in acuity of the sense of taste for sucrose may represent measurable accompaniments of sensations interpreted as satiety afforded by food. The demonstration of the existence of diurnal variations in acuity of the sense of taste for sucrose made it appear desirable to determine whether or not like variations exist with respect to other taste qualities. The present experiments were undertaken with the purpose of determining whether or not such variations exist with respect to the sense of taste for sodium chloride.

Method and procedure. Gustatory thresholds for sodium chloride were determined by

placing a measured volume (0.5 cc) of sodium chloride solution on the tip of the subject's extended tongue. The solutions used had been made up with tap water and contained sodium chloride in concentrations ranging from 0.05% to 0.55% in steps of 0.05%. The lowest concentration of sodium chloride which just sufficed to permit instantaneous recognition of saltiness was interpreted as the measure of threshold for this taste quality for the subject at the time. At each determination the threshold value accepted for the subject was the lowest concentration of sodium chloride which produced the sensation of saltiness 3 times in succession. Before and between successive trials the subjects were requested to rinse their mouths with tap water. In this manner gustatory thresholds for sodium chloride were determined at 10:00 and 11:30 in the morning and at 1:30, 3:00 and 4:30 in the afternoon. Subjects exhibiting coating of the tongue or taking medicine for any reason were excluded temporarily from the experiment. During tests the subjects were kept uninformed as to the concentration of the sodium chloride solutions used. There were 8 individuals, 7 females and 1 male, who served as subjects. They were in apparently good health and ranged in age from 23 to 45 years. They held clerical positions in this institution and worked daily from 9:00 in the morning until 5:00 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 1:00 in the afternoon. On

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test days the subjects were requested to abstain from taking food between meals. Their statements regarding their desire for food as well as their freely selected caloric intake were recorded.

Results. The results presented are those of gustatory threshold determinations performed in all subjects on days (108 test days) on which the subjects observed normal food habits and those of gustatory threshold determinations performed in 5 of the subjects on days (25 test days) on which the subjects omitted their noon meals. Fig. 1 shows the

averages of gustatory threshold values for sodium chloride obtained at different hours of test days. The illustration demonstrates that the gustatory threshold values decreased during the morning hours, increased following ingestion of lunch and decreased during the later afternoon. In addition, the illustration shows that the increase of gustatory threshold values failed to occur on days on which lunch had been omitted.

Statistical analysis of the results obtained for individual subjects revealed that the average decrease of gustatory threshold values as occurred during the morning hours was significant for all but one of the subjects; that the average increase of gustatory threshold values as occurred following ingestion of lunch was significant for all but one of the subjects; and that the decrease of gustatory threshold values as occurred during the later afternoon on days on which lunch had been ingested, was significant for all subjects. In addition to this analysis of results an inquiry was made as to whether or not the differences between averages of gustatory threshold values obtained for a subject immediately before and 30 minutes after lunch time on days on which lunch was ingested differed significantly from the differences between like averages of gustatory threshold values obtained on days on which lunch was omitted. The results of these calculations are presented in Table I. The values in columns B_1 and B_2 of this table represent the average differences expressed as percentage concentration of solution between threshold values obtained at 11:30 in the morning and 1:30 in the afternoon on days on which lunch was ingested (B_1) and on days on which lunch was omitted (B_2). The values in column P indicate the probability (calculated by means of Student's t value) (4) that the differences between the differences referred to is not significant. Statistical convention justifies the assumption that a difference is significant if the probability that it is not significant is 0.05 or less. The table shows that the difference under discussion was found to be significant for all subjects.

The subject's statements revealed that noon meals were preceded regularly by a period of an increasing desire for food denoted variously

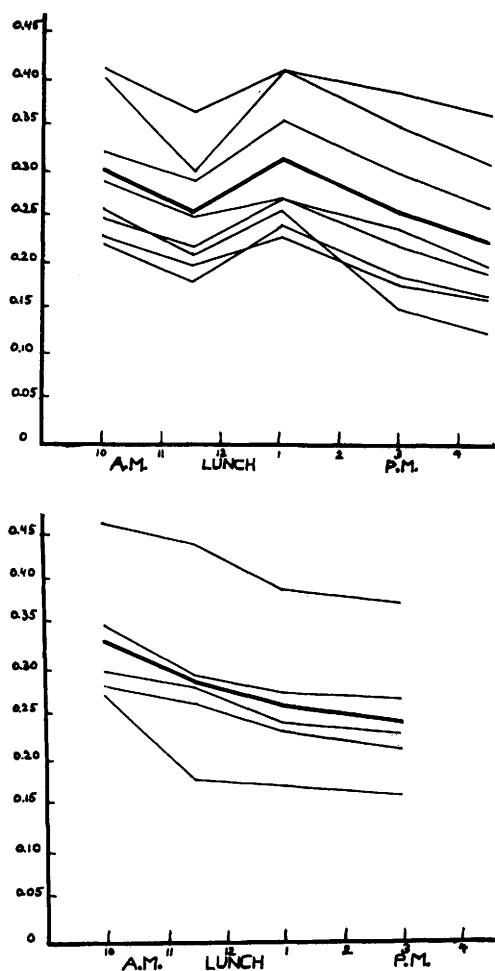


FIG. 1. Upper: Avg gustatory threshold values for NaCl obtained on days when lunch was ingested. Lower: Avg gustatory threshold values for NaCl obtained on days when lunch was omitted. Light lines: for individuals; heavy lines: for the groups. Ordinates: threshold values in % concentration.

TABLE I. Average Differences Between Gustatory Threshold Values Obtained Before and After Lunch Time (5 Subjects).

Days on which lunch was ingested	Days on which lunch was omitted	Difference B ₁ (increase)	Difference B ₂ (decrease)	P
19	5	+.04	— .05	<.01
10	5	+.06	— .01	<.01
15	5	+.07	— .02	<.01
13	5	+.02	— .03	<.01
12	5	+.04	— .05	<.01

Expressed as % conc. of NaCl in solution.

by the subjects as a sensation of hunger or one of appetite. Following ingestion of the freely selected noon meals a sensation of satiety developed in all instances while the desire for food vanished. The noon meals selected by the subjects ranged in their caloric value approximately between 300 and 1100 calories. In most instances dessert was eaten by the subjects at the end of the noon meals.

Comment. Changes in threshold values for the sense of gustation indicate changes in gustatory acuity. Thus, decreasing threshold values signify an increase, increasing threshold values a decrease in acuity. Therefore, the observations described reveal that the acuity of the sense of taste for sodium chloride increases during the morning, decreases following ingestion of freely selected noon meals and increases again during the later afternoon. The increase in gustatory acuity during the morning, was noted on 102 (94%), the decrease in acuity following ingestion of noon meals on 86 (79.5%) and the increase in acuity during the later afternoon on 104 (96.3%) of the 108 test days. The analysis of average gustatory threshold values obtained for the individual subjects at different hours of test days shows that the increase in gustatory acuity during the morning was statistically significant in all but one subject, that the decrease in gustatory acuity following ingestion of noon meals was statistically significant in all but one subject and that the increase in gustatory acuity during the later afternoon was statistically significant in all subjects. That the decrease in acuity of the sense of taste for sodium chloride was dependent upon ingestion of food becomes evident from the analysis of results obtained on days on which noon meals had been omitted. This analysis

shows for all subjects so tested that the changes in gustatory acuity noted after lunch time on days on which lunch had been ingested differed significantly from those noted at the same time of the day but on days on which lunch had been omitted. It should be noted that this was found to be true also for the one subject for whom the decrease in gustatory acuity following ingestion of lunch was noted to be insignificant.

The evidence presented justifies the conclusion that there exist in normal individuals diurnal variations in acuity of the sense of taste for sodium chloride. Since the freely selected noon meals upon ingestion brought about a conversion of sensations interpreted as a desire for food into sensations interpreted as satiety afforded by food the observations described may be regarded as indicating that the precibal increase in acuity of the sense of taste for sodium chloride may be related to the sensations constituting one's desire for food and that the postcibal decrease in acuity of that sense may be related to the sensations constituting satiety. This interpretation of results is supported by the fact that the decrease in acuity of the sense of taste for sodium chloride failed to occur when conversion of sensations had been prevented by omission of noon meals. The mechanisms by means of which food produces a decrease in acuity of the sense of taste for sodium chloride are being subjected to further investigation.

Summary. Experiments are described demonstrating the existence in normal individuals of diurnal variations in acuity of the sense of taste for sodium chloride. Freely selected meals were found to be preceded by a period of increasing and followed by one of decreasing acuity of that sense. When meals

had been omitted the decrease in acuity failed to occur.

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Sweat Sodium Levels in Congestive Heart Failure. (19292)

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Evidence has been presented suggesting that overactivity of adrenal cortical electrolyte hormone may be partially responsible for the sodium retention characteristic of congestive heart failure. Biological methods have indicated increases in corticoids(1) and DOCA-like material(2) in the urines of congestive failure patients. Salivary sodium concentrations have been reported to be low in congestive failure(3), also suggesting adrenal hyperactivity. On the other hand Lasche, Perloff, and Durant found low urine 11-oxysteroid and 17 ketosteroid concentrations in the majority of 23 cardiac failure patients(4).

The work of Conn indicates that the activity of the adrenal "electrolyte-influencing" steroids can be correlated with the sweat sodium or chloride concentration(5). Low sweat sodium concentrations (below 10 meq/L) are found in hyperadrenal cortical states such as Cushing's syndrome and high concentrations (above 80 meq/L) in Addison's disease. Merrill in 1949 stated that several of his congestive failure patients had low sweat sodium concentrations(6); this appears to be the only published reference to the use of the sweat test in evaluating adrenal salt hormone activity in congestive heart failure. In the following study sweat sodium concentrations were investigated by a method applicable to patients with heart failure.

Methods. A plastic jacket with tight elastic neck, arm, and waist bands ensures collection

of sweat on the trunk without evaporation. The subject, whose back has been thoroughly cleansed with distilled water, sits in the Fowler position in bed, and is heated by immersing one arm to the elbow in a tub of hot water and by placing several blankets over the body. In from 15 to 90 minutes sufficient sweat will be present on the back to ensure the collection of from 3 to 5 cc when the jacket is opened. A tablespoon is used to transfer the sweat to a test tube. To avoid evaporation it is necessary to wait until enough sweat has accumulated so that the desired amount can be obtained the first time the jacket is opened. Two cubic centimeters are usually sufficient for sodium and potassium determination. The jackets, towels, test tubes, and spoons are prepared by soaking in 3 changes of distilled water, which is sufficient to lower the concentration of sodium in the final wash-water to a negligible level. Blood eosinophil counts using Randolph's stain, were done immediately before the sweat tests. Sodium and potassium were determined with the flame photometer using lithium as the internal standard.

Material. The patients tested were in obvious, severe, congestive failure without evident complicating factors such as infection. All had gross pitting edema. Their ages ranged from 37 to 83 years. The majority of the patients had hypertensive or rheumatic heart disease or cor pulmonale. Some were studied immediately after admission to the hospital for symptoms of congestive failure. Others were studied towards the end of a 24-hour control period designed to standardize as far as

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