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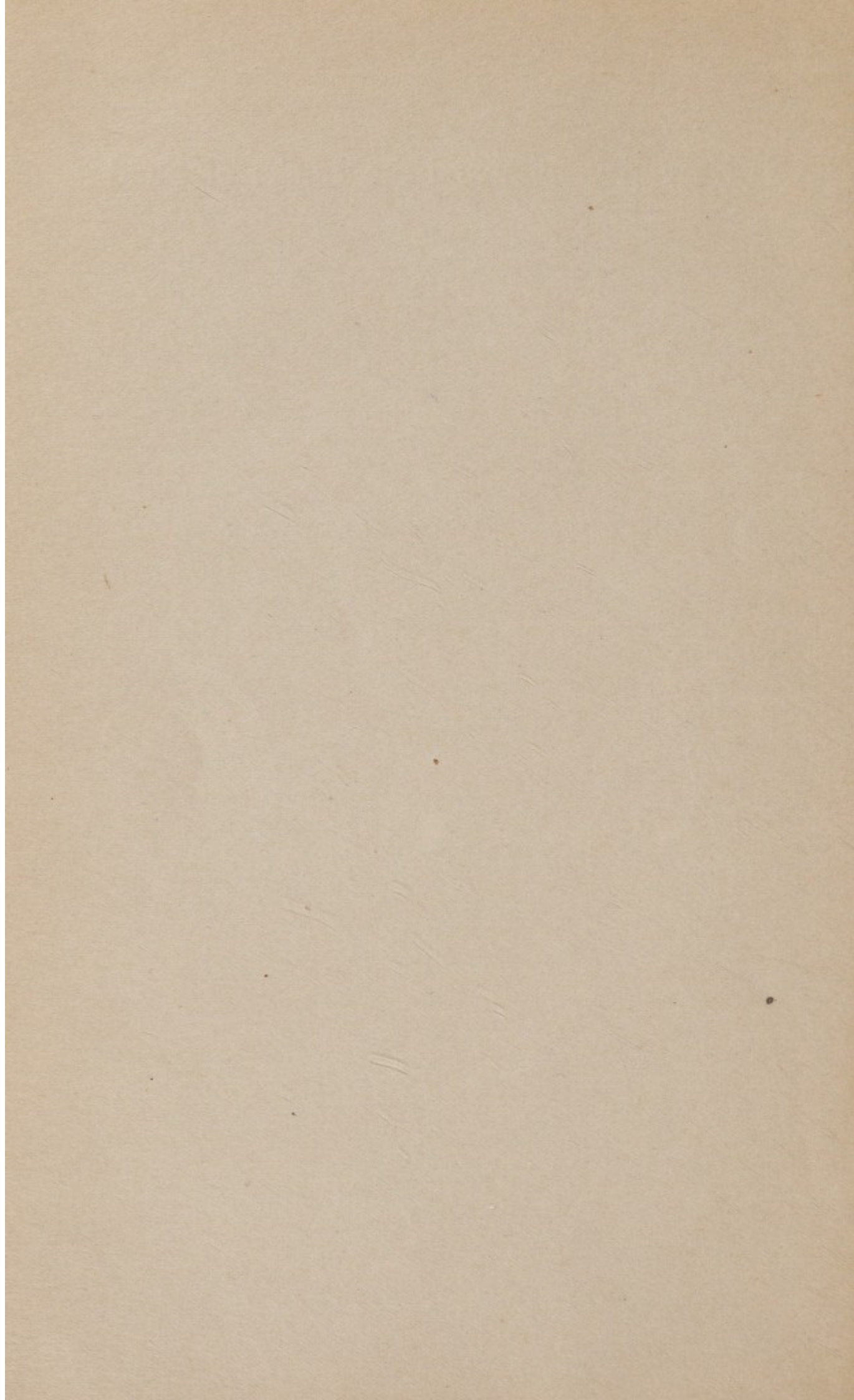
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## SALIVARY SECRETION AND THE INTAKE OF FLUID\*

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It is well known that the various processes in the body may be influenced by changes in its metabolism. In regard to the salivary glands, Savitch in Pavlov's laboratory, working with dogs, and Krasnogorsky, working with children, have proved that overfeeding causes inhibition of the conditioned reflexes to the substances that are fed in abnormal amount and augmentation of the conditioned reflexes to other foods.

The object of these experiments was to determine whether thirst bears any relation to the secretion of saliva. It has already been shown in the laboratory of Pavlov that the gastric secretion in dogs may be greatly diminished when the intake of fluids is insufficient. The salivary and gastric secretions, however, are not always parallel.

I used two children in these researches, one for the investigation of the parotid and the other for the investigation of the submaxillary secretion. Krasnogorsky discovered that there are some differences between the functions of these two glands: the parotid gives a larger unconditioned reflex, and the submaxillary a larger conditioned reflex, as might be expected from their anatomic position; for it is the submaxillary gland that first encounters substances introduced into the mouth.

### METHOD

The experiments were done under three sets of conditions: (a) with normal intake of fluids, (b) with forced intake of fluids and (c) with the production of thirst by a withholding of all fluids for twelve hours. In each case, the child was given an ordinary breakfast at 9 a. m., and experimentation was begun three hours later. With breakfast, the child received about 1,000 cc. of liquid, and when the intake of fluid was forced the child drank as much as from 2,000 to 3,000 cc. When fluid was withheld and thirst became great, it was difficult to get one of the children to accept salt herring, though she ate lemon with avidity.

A suction cup was applied over the opening of the parotid gland or of the submaxillary glands, respectively, and the saliva was collected in a graduate.<sup>1</sup>

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\* From the laboratory of Prof. N. I. Krasnogorsky for Conditioned Reflexes in Children at the Filatov Hospital.

1. Krasnogorsky, N. I.: Die weitere Fortschritte in der Metodik der Erforschung der unbedingte und bedingte Reflexe bei Kindern, *Jahrb. f. Kinderh.* **114**: 255, 1926; 1928, vol. 120.

The conditioned reflex was measured after showing the food to the child for thirty seconds, and again after one minute, and then the food was immediately given to her to eat. She was directed to chew on the side of the mouth from which the saliva was being collected, as it has been noted in this laboratory that the secretion is greater on that side.<sup>2</sup> The collection was made from the submaxillary glands on both sides, as their openings are close together. Twenty grams of each of various foods were given to the child to eat and so timed that it was well chewed and swallowed during the course of three minutes, and the saliva was measured for each minute. The foods employed were: dry bread crumbs, ham, salt herring and lemon cut in slices; these were administered at intervals of ten minutes.

#### PAROTID SECRETION

"Lydotchka," in whom we tested parotid secretion, was an epileptic idiot, aged 11, who was having one or more violent convulsions daily. The results set forth in table 1 were typical.

TABLE 1.—*Effect of Forced Intake of Fluids on the Salivary Secretion of the Parotid Gland*

| Time                | Stimulus                     | Amount of Parotid Secretion per Minute       |
|---------------------|------------------------------|----------------------------------------------|
| 9 a.m.              | 2,900 cc. fluid given        |                                              |
| 11:21 to 11:23 a.m. | 20 Gm. dry bread crumbs..... | 2.2, 2.4, 2.3 = 6.9 cc.                      |
| 11:36 to 11:39 a.m. | 20 Gm. ham.....              | 2.9, 2.0, 1.7 = 6.6 cc.                      |
| 11:49 to 11:52 a.m. | 20 Gm. salt herring.....     | 3.4, 2.6, 1.5 = 7.5 cc.                      |
| 12:04 p.m.          | Sight of lemon.....          | 11 drops in 30 seconds as conditioned reflex |
| 12:05 to 12:08 p.m. | 20 Gm. lemon.....            | 4.3, 2.8, 2.3 = 9.4 cc.                      |

TABLE 2.—*Comparison of Amounts of Parotid Secretion Following on Different Degrees of Intake of Fluids*

| Stimulus          | Amount of Parotid Secretion                           |         |         |       |                                          |         |         |       |                                     |         |         |       |
|-------------------|-------------------------------------------------------|---------|---------|-------|------------------------------------------|---------|---------|-------|-------------------------------------|---------|---------|-------|
|                   | Forced Intake of Fluids (Average of Five Experiments) |         |         |       | Normal Intake of Fluids (One Experiment) |         |         |       | Thirst (Average of Two Experiments) |         |         |       |
|                   | 1st Min.                                              | 2d Min. | 3d Min. | Total | 1st Min.                                 | 2d Min. | 3d Min. | Total | 1st Min.                            | 2d Min. | 3d Min. | Total |
| Dry bread.....    | 1.95                                                  | 2.0     | 1.95    | 5.8   | 1.3                                      | 1.3     | 2.0     | 4.6   | 1.5                                 | 0.7     | 0.5     | 2.8   |
| Ham.....          | 2.7                                                   | 1.9     | 1.5     | 6.1   | 3.4                                      | 2.6     | 1.7     | 7.7   | 1.3                                 | 0.6     | 0.4     | 2.4   |
| Salt herring..... | 2.7                                                   | 2.0     | 2.0     | 6.7   | 2.4                                      | 2.0     | 1.6     | 6.0   | 1.4                                 | 1.0     | 0.7     | 3.1   |
| Lemon.....        | 3.6                                                   | 2.8     | 2.4     | 8.8   | 2.6                                      | 2.4     | 3.0     | 8.0   | 1.9                                 | 2.1     | 2.0     | 6.0   |

Table 2 shows the three minute salivary secretion on a normal intake of fluids, on a diminished intake and on an increased intake. With each food there was a marked diminution of secretion in the case of thirst. The secretion on a forced intake fluid was only slightly more than on a normal intake.

2. Krasnogorsky, N. I.: Ueber die Wirkung mechanischer und chemischer Reizungen verschiedene Teile der Mundhöhle auf die Tätigkeit der Speicheldrüsen bei Kindern, *Jahrb. f. Kinderh.* **114**:268, 1926.

We found that the epileptic fit tended to decrease markedly the unconditioned salivary secretion. The results recorded in table 3 show that the flow of saliva was much less when the experiment was done immediately after the child recovered consciousness from the convulsion, whether fluid had been forced or withheld.

TABLE 3.—*Effect of Epileptic Convulsion on Salivary Secretion (Parotid)*

| Stimulus          | With Forced Intake of Fluids                                                |                                                                    | With Thirst                                |                                                |
|-------------------|-----------------------------------------------------------------------------|--------------------------------------------------------------------|--------------------------------------------|------------------------------------------------|
|                   | (Average of Four Experiments)<br>Amount of Secretion Before Convulsion, Cc. | (One Experiment)<br>Amount of Secretion Soon After Convulsion, Cc. | Amount of Secretion Before Convulsion, Cc. | Amount of Secretion Soon After Convulsion, Cc. |
| Dry bread.....    | 6.3                                                                         | 4.5                                                                | 3.9                                        | 1.8                                            |
| Ham.....          | 6.3                                                                         | 4.6                                                                | 3.8                                        | 0.9                                            |
| Salt herring..... | 7.4                                                                         | 5.7                                                                | 3.1                                        | Refused; defensive reaction                    |
| Lemon.....        | 8.5                                                                         | 9.2                                                                | 6.6                                        | 5.4                                            |

#### SUBMAXILLARY SECRETION

My experiments with the submaxillary gland, which were made in a hysterical girl of 11, also show that the secretion is much lessened during a deficient intake of water. In table 4, it is shown that not only the unconditioned reflex but the conditioned reflex was decreased in the state of thirst.

TABLE 4.—*Effect of Different Degrees of Intake of Fluids on Submaxillary Secretion*

| Stimulus     | Normal Intake             |                 |                                    | Thirst                    |                 |                                    | Forced Intake             |                 |                                    |
|--------------|---------------------------|-----------------|------------------------------------|---------------------------|-----------------|------------------------------------|---------------------------|-----------------|------------------------------------|
|              | Conditioned Reflex, Drops | Viscosity, Sec. | Unconditioned Reflex, Cc. (3 Min.) | Conditioned Reflex, Drops | Viscosity, Sec. | Unconditioned Reflex, Cc. (3 Min.) | Conditioned Reflex, Drops | Viscosity, Sec. | Unconditioned Reflex, Cc. (3 Min.) |
| Ham.....     | 6                         | 12              | 9.3                                | 10<br>3                   | ..<br>12        | 3.9<br>3.4                         | 22                        | 19              | 9.8                                |
| Herring..... | 30                        | 20              | 10.8                               | 16<br>1                   | ..<br>20        | 3.4<br>4.7                         | ..                        | 20              | 10.1                               |
| Lemon.....   | 66                        | 17              | 11.4                               | 60<br>7                   | ..<br>27        | 9.3<br>7.6                         | ..                        | 40              | 11.9                               |
| Bread.....   | 34<br>(dry bread)         | 20              | 7.5<br>(ordinary bread)            | 22<br>0                   | ..<br>..        | ...<br>...                         | ..                        | 22              | 7.1                                |

These experiments, conducted with four different foods and with both the parotid and the submaxillary glands, prove that the intake of fluids bears a definite relation to the quantity of saliva secreted. This fact is in agreement with that previously shown for the glands of the stomach, and may probably hold for all the glands of external secretion. It is therefore of prime importance for digestion that the fluid intake be sufficient. Furthermore, in work with conditioned reflexes, a state of thirst should not be present.

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