THE ROLE OF THE STOMACH RECEPTORS IN GASTRIC SECRETION

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It has been established in the laboratory of I. P. Pavlov [1] that the greater the amount of food intake, the more gastric juice is secreted. Secretion duration increases approximately $1\frac{1}{2}$ times when the amount of food consumed is doubled. These facts have been proved [2, 3]. In the studies cited, the amount of food consumed did not cause the animal to become completely satiated; on the contrary, the animals greedily consumed all food placed before them.

It was also observed in the laboratory of I. P. Pavlov that the consistency of food has a definite influence on gastric secretion [4].

Gastric secretion in dogs with a Pavlov stomach has recently been studied under conditions of meat fed in small amounts many times until complete satiation was obtained [5]. It was found that juice secretion was maximal 30-40 minutes after the first small feeding, and thereafter decreased.

Until recently, there was no one opinion on the role of the gastric mechanoreceptors in gastric secretion. Only thanks to carefully conducted studies [6] and [7] has the question of the mechanical factor as a stimulator of gastric secretion been conclusively and positively solved. Further studies [8] have shown that strong mechanical stimulation of the gastric walls sharply inhibits gastric secretion caused by simulated feeding.

There are also indications in the literature that strong stimulation of the stomach receptors causes both conditioned and unconditioned reflexes to be inhibited [9, 10, 11, 12, 13, 14].

In this article, we present experiments studying the secretory activity of the salivary and gastric glands caused by feeding the animal different amounts of food or by expansion of the gastric walls to different degrees.

EXPERIMENTAL METHODS

Dogs were used in the experiment: 3 with a stomach isolated according to Pavlov, 2 with a stomach isolated according to Klemensevich-Heidenhain and 3 with a permanent salivary gland fistula, stomach isolated according to Pavlov and Basov's gastric fistula.

The gastric juice was collected for periods of 4,5 and 10 hours, the free hydrochloric acid and the total acidity in the hourly batches were determined by the titration method, and the peptic activity in the total amount of juice and, in a series of experiments, the dry residue with its organic and inorganic components were determined by Mett's method.

We used a mixed food (bread and meat) or bread alone in varying amounts as the food stimulus. Stimultaneously with the feeding, or 1, 2, or 3 hours afterwards, 200, 250, 400 or 500 ml of water 37-38° in temperature were introduced into a rubber balloon previously installed in the stomach.

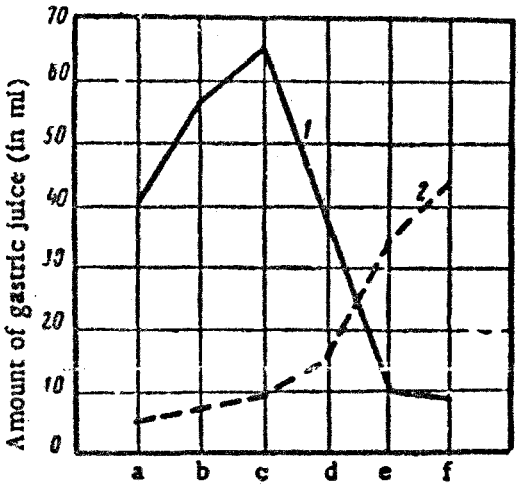
We used an 0.25% solution of hydrochloric acid and a meat-sugar powder as unconditioned stimuli to stimulate saliva secretion. The conditioned stimuli we used were a bell and a spray (sprinkling the oral cavity with distilled water).

The oral cavity was sprayed or the meat-sugar powder was offered every 15 minutes during the experiments, but the first sprinkling or the first offer of the meat-sugar powder was not made until 30 minutes after the animal had been fed.

EXPERIMENTAL RESULTS

The experiments showed that as the amount of food intake increased, the latent period of secretion gradually increased from 5 to 12 minutes and that the latent period of secretion increased 3-8 times, i.e., up to 44 minutes, with the fixed amounts of food. As the amount of food was increased, the amount of juice secreted increased accordingly, but later, with further increases in the amount of food, the amount of juice decreased. The more the amount of food, the less the amount of juice secreted. The free and total acidity of the gastric juice decreased accordingly (see Figure).

Therefore, a greater secretory effect was observed from a one-time feeding of a smaller amount of food than with a larger amount of food.



Change in gastric secretion (1) and latent period of juice secretion (2) with consumption of different amounts of food.
Amount of food: a) 100 g of bread and 50 g of meat; b) 200 g of bread and 100 g of meat; c) 200 g of bread and 200 g of meat; d) 400 g of bread and 200 g of meat; e) 700 g of bread and 200 g of meat; f) 700 g of bread and 300 g of meat.

To prove this fact, the dog was given once a comparatively large amount of food (200 g of meat and 400 g of bread), to which 40.7 ml of juice was secreted in 5 hours. If, however, the dog was given the same amount of food divided into four hourly feedings (50 g of meat and 100 g of bread per hour), more juice was secreted – 67.5 ml, and high tension of the gastric walls was maintained for the whole feeding period (Table 1).

When longer observations (10 hours) were conducted, it appeared that a greater quantity of juice was secreted during the last few hours to the larger amount of food, while, to a comparatively lesser amount of food, the amount of juice secreted was accordingly less.

The same rule was observed in the dogs with the Klementsevich-Heidenhain stomach.

Therefore, different amounts of food had different effects on the gastric glands. First of all, one could observe a uniform secretory effect, secondly, one could obtain a greater effect with a lesser amount of food and a lesser effect with a greater amount of food, and finally, one could obtain complete inhibition of secretion to a large amount of food at a fixed time interval. From the experiments conducted, we concluded that inhibition of gastric juice secretion occurs as a reflex to gastric mechanoreceptor stimulation.

In order to test our proposition, we examined the effect of mechanical stomach wall stimulation on gastric secretion by supplementing the feeding with the introduction of 250 ml water into the balloon installed in the stomach. Gastric secretion became intensified due to the use of comparatively weak stimulation at the same time as the food stimulus. Average data obtained from a dog with a Pavlov stomach is given in Table 2.

In the next experimental series, a comparatively stronger mechanical stimulation of the stomach walls (introduction of 400 ml of water into the balloon) was given simultaneously with the food (300 g of bread). Gastric secretion was considerably inhibited under these conditions; the latent period increased from 12 to 55 minutes, and the total amount of juice decreased. There was a strongly-expressed inhibition in these experiments at first, later replaced by an intensification of secretion. This phenomenon must be caused by the adaptation of the stomach walls to prolonged mechanical stimulation. In order to prevent this adaptation, water was introduced into the balloon and emptied out again every 10-15 mins. In this way, we achieved a more

pronounced, general inhibitory effect than was possible with one-time mechanical stimulation.

TABLE 1

Gastric Juice Secretion with One-Time and Frequent Feeding

Experimental Conditions	Latent period (in min)	Hours	Amount of juice (in ml)	Free HCl (in ml .1N NaOH)	Total acidity (in ml .1N NaOH)
One-time feeding (200 g of meat and 400 g of bread)	9	1	10.8	124	174
		2	9.1	107	155
		3	7.6	128	175
		4	5.5	130	181
		5	7.7	134	183
		Total	40.7	122	172
Four-time feeding (50 g of meat and 100 g of bread each time)	5	1	14.9	130	183
		2	14.9	130	185
		3	14.9	131	185
		4	11.1	129	184
		5	11.7	129	183
		Total	67.5	129	183

TABLE 2

Gastric Juice Secretion on Feeding With 300 g Bread

Experimental Conditions	Latent period (in ml)	Hours	Amount of juice (in ml)	Free HCl (in ml .1N NaOH)	Total acidity (in ml .1N NaOH)
300 g bread	11 5	1	9.3	79	121
		2	4.7	71	114
		3	4.55	54	99
		4	3.45	38	87
		5	2.9	33	87
		Total	24.9	65	111
300 g bread + filling of balloon with 250 ml water	11 0	1	6.8	78	125
		2	8.3	104	147
		3	7.65	106	152
		4	4.2	76	122
		5	4.6	60	100
		Total	31.55	82	131

Mechanical stimulation also inhibited gastric secretion in the dogs with the Klemensevich-Heidenhain stomach.

In order to confirm the fact that impulsation from the gastric mechanoreceptors is of definite importance to the development of inhibition, the mucosa of the greater stomach was sprayed with a 0.25% solution of

novocaine before the mechanical stimulation. We found that, while 19.7 ml of juice had been secreted after 5 hours (latent period of secretion 55 minutes) with the consumption of 300 g of bread and the introduction of 400 ml of water into the ballroon in the stomach, then, under the same conditions, after the gastric mucosa had been sprayed with the novocaine solution, 32.5 ml of juice was secreted (latent period of secretion 8 minutes).

Consequently, these experiments prove that reflex inhibition of gastric secretion occurs with strong stimulation of the gastric mechanoreceptors, as with the consumption of a large amount of food.

Examination of conditioned and unconditioned reflex saliva secretion under conditions of both large and small amounts of food consumption showed that both conditioned and unconditioned reflex saliva secretion is sharply inhibited when the dog has consumed a large amount of food (Table 3).

TABLE 3

Amount of Saliva in ml of Conditioned-Unconditioned and Conditioned Stimuli with the Consumption of Various Amounts of Bread

Amount of bread (in g)	Bell + acid	Bell+ acid	Bell + acid	Bell	Bell + acid	Bell	Bell + acid
Empty stomach	0.9	2.1	1.8	0.7	1.5	0.6	1.4
200	1.0	2.2	1.9	0.3	1.4	0.3	1.25
400	0.6	1.2	1.25	0.1	0.5	0.1	1.0
600	0.3	0.7	0.5	0	0.3	0	0.5

Note: The saliva was collected for 2 minutes

We observed the same pattern in salivasecretion to the meat-sugar powder as occurred to the irrigation of the oral cavity with a 0.25% solution of hydrochloric acid.

In some experiments, we also examined the effect of teasing on gastric secretion with either an empty stomach or with the balloon in the stomach filled with 500 ml of water. When the balloon was in the stomach, there was almost no gastric juice secreted.

Therefore, the data presented indicate that the more food consumed and the stronger the stimulation (chiefly of the mechanoreceptors) of the stomach walls, the weaker the conditioned and unconditioned reflex secretion of saliva and gastric juice, and the weaker the food reaction. When a very large amount of food is fed, the food reaction changes into a defense reaction — the animal turns away from the food, and saliva and gastric juice secretion is sharply inhibited.

All the facts given above must be considered due to the development of inhibition in the central nervous system caused by strong stimulation of the gastric mechanoreceptors.

SUMMARY

Experiments on dogs showed that single abundant feeding produces less secretion than if the same quantity of food is subdivided into numerous feedings. Inhibition of stomach secretion is reflexive and is connected with the stimulation of mechanoceptors of the stomach. Both conditioned and unconditioned secretions of salivary glands are inhibited.

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