# THE ELECTROPHYSIOLOGICAL STUDY OF RECEPTION FROM CERTAIN INTERNAL ORGANS IN MAN

## REPORT 2. ELECTROPHYSIOLOGICAL CHARACTERISTICS OF THE RECEPTORS OF THE STOMACH AND SMALL INTESTINE IN THE INTACT ANIMAL AND AFTER COMPLETE ISOLATION OF THESE ORGANS

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We showed in our previous communication [2] that the receptors of certain organs removed surgically from human patients for various diseases retain the power to react to adequate stimulation. By perfusing the isolated stomach, segment of bowel, or thyroid gland we studied the impulse activity in the afferent nerves during the introduction of stimuli into the vascular system of the organ or the application of stimuli to the mucous membrane. Some differences that were found between the reaction of the receptors of stomachs resected for peptic ulcer and for malignant disease could not be confidently regarded as having been present before removal of the organs, while they were in situ in the intact organism. The possibility remained that removal of the organ caused essential changes in the pattern of function of the receptors, and prevented an assessment of their state before removal.

The object of the present investigation was to compare the impulses arising in the receptor organs in situ with their reaction to the same stimuli after complete isolation of the organs from the rest of the body. It is obvious that such experiments can be performed only on animals.

### EXPERIMENTAL METHOD

Experiments were conducted on cats under hexobarbital anesthesia (dose 200 mg/kg). After laparotomy, the branch of the vagus nerve running along the lesser curvature of the animal's stomach was isolated in the region of the cardia. The peripheral end of this branch was placed on electrodes. Two ligatures were tied around the stomach near the pylorus and cardia, and adequate chemical stimuli were introduced into the stomach cavity through a rubber tube tied into the pyloric portion: solutions of glucose (5-10%), hydrochloric acid (1-3%), caffeine (1-2%), and 10% alcohol. After registration of the impulses arising in response to these stimuli, the mucous membrane was washed with Tyrode solution. The stomach was resected, together with the omentum and spleen, extracted from the abdomen, and kept in Tyrode solution in a refrigerator at 5.8°. Cooling of the stomach was a very important factor in the technique, for it considerably retarded and diminished autodigestion of the mucous membrane. The length of time that the organ was kept in the refrigerator corresponded to the length of time that organs taken from human patients at operation were kept in the same conditions – on the average from 15 min to 3-4 h. In some experiments the organs were kept in the cold for 24 h or more. The potentials were then recorded again, but this time during perfusion of the stomach through its vascular system with Tyrode solution at constant pressure and at 35-37°. Experiments on the small intestine were conducted in a similar manner. For recording the potentials from the receptors of the intestine, the peripheral segment of one of the mesenteric nerves, or a fine intestinal twig, was used.

### EXPERIMENTAL RESULTS

Altogether, 40 experiments were performed, in 9 of which it proved impossible to record the reactions to stimuli either when the organs were inside the body or after their removal. In 6 experiments impulses were recorded only from the receptors of the intact organs. Finally, in 3 experiments impulses were observed to appear only after removal of the organs. Naturally, not all these 18 experiments were suitable for analysis because of absence or instability of the activity of the receptors throughout the period of the experiment. In 22 cases the impulses arising in the receptors in response to the stimuli lasted throughout the experiment. In most of these cases a very violent receptor activity developed, especially from the mucous membrane of the stomach, consisting of long volleys of impulses

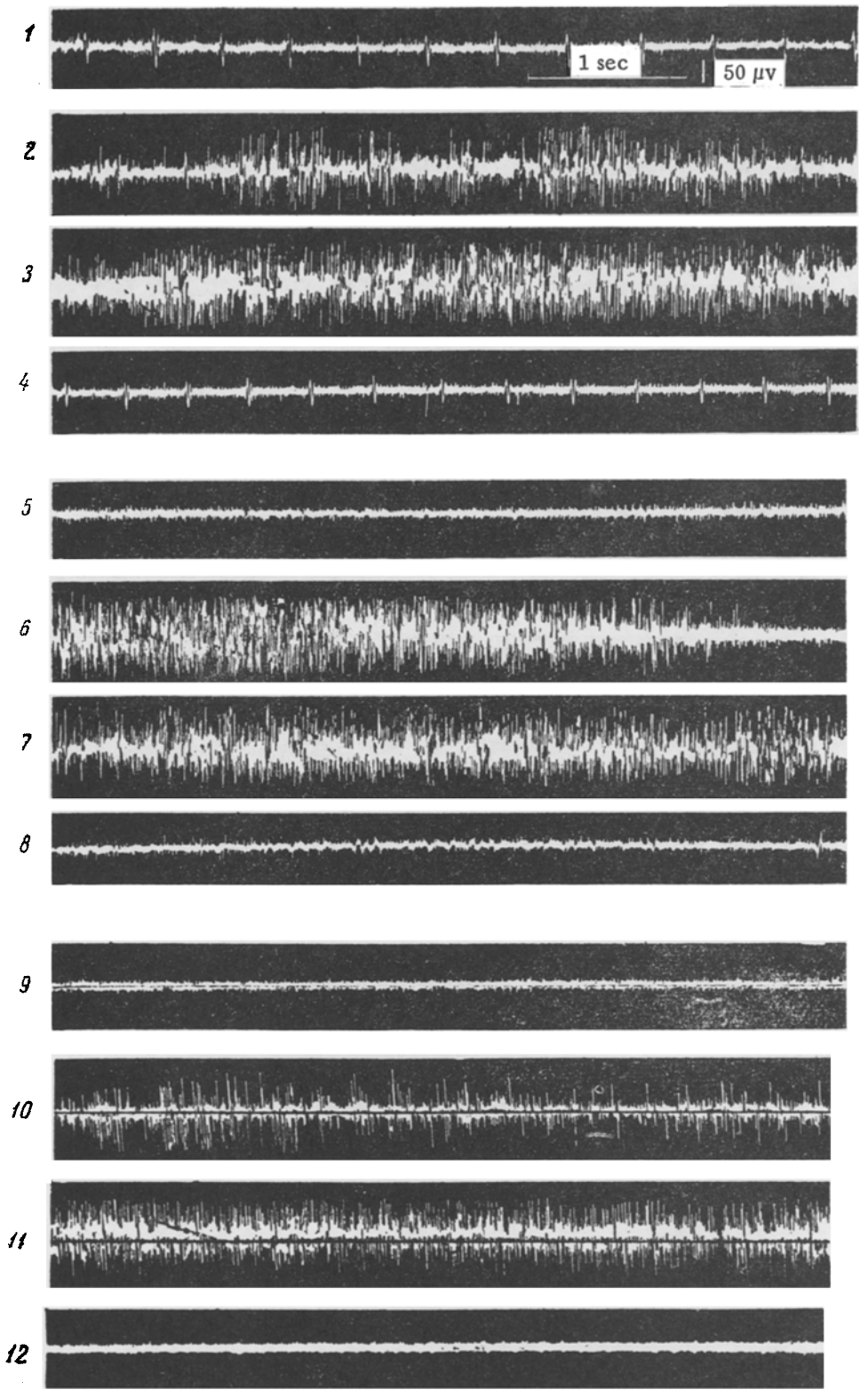


Fig. 1. Impulse activity of the afferent nerve of the cat's stomach before and after gastrectomy, and of the afferent nerve of the resected human stomach, during stimulation of the mucous membrane with caffeine solution. 1) Before removal of the cat's stomach, background; 2) 8 min after introduction of 1% caffeine solution into the stomach; 3) 10 min after; 4) after washing out the caffeine from the stomach; 5) 50 min after removal of the cat's stomach, background; 6) 14 min after introduction of 1% caffeine solution; 7) 17 min after; 8) after washing out the caffein from the stomach; 9) resected human stomach; background; 10) 1 min after application of caffeine swab to gastric mucosa; 11) 3 min after application of caffeine; 12) after removal of caffeine swab from mucous membrane.

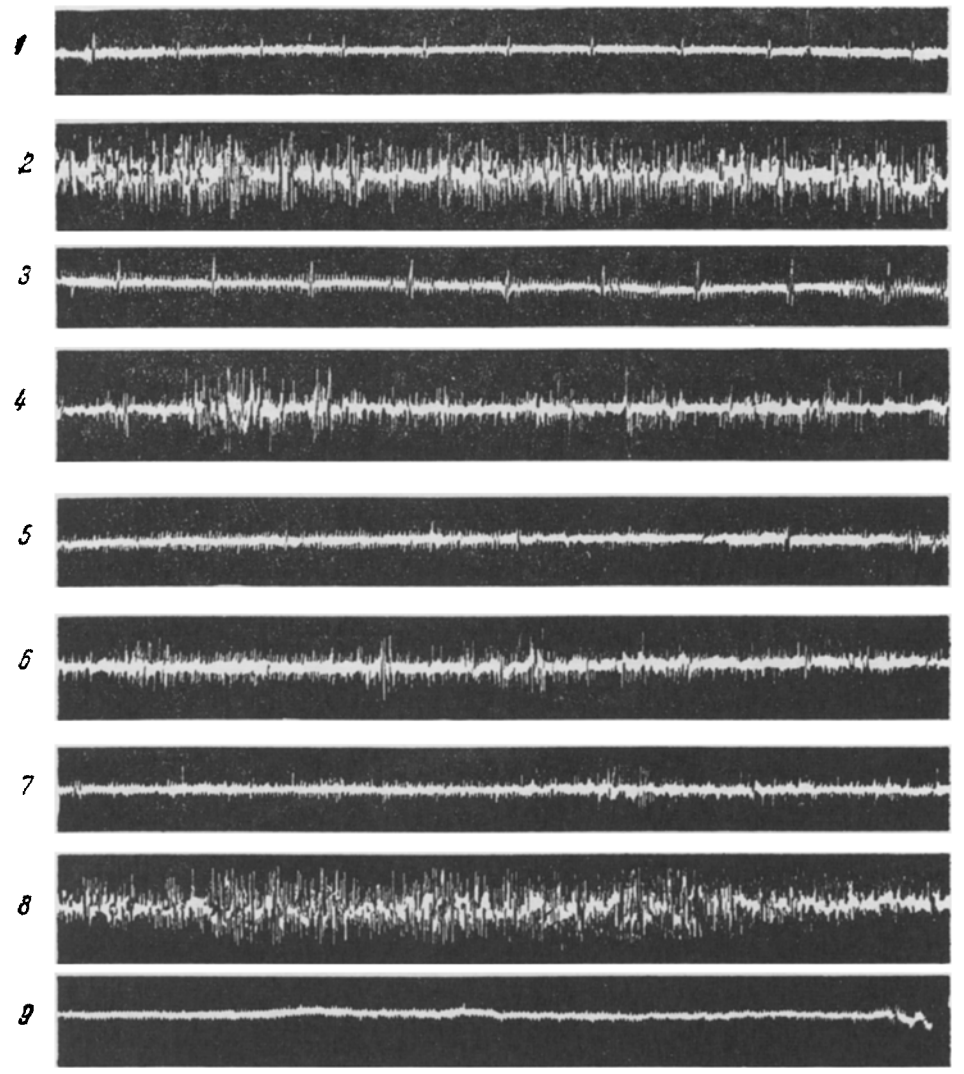


Fig. 2. Impulse activity of the afferent nerve of a cat's stomach before and after resection of the organ and during stimulation of the mucous membrane with solutions of hydrochloric acid and alcohol. 1) Before gastrectomy, background; 2) 6 min after introduction of 3% hydrochloric acid solution into the stomach; 3) after washing out the hydrochloric acid from the stomach; 4) 1 min after introducing 10° alcohol into the stomach; 5) 1 h 30 min after removal of the cat's stomach, background; 6) 13 min after introduction of 3% hydrochloric acid solution; 7) after washing the hydrochloric acid from the stomach; 8) 5 min after introducing 10° alcohol; 9) after washing out the alcohol from the stomach.

following each other at high frequency. Single impulses were observed much less frequently, which greatly hampered analysis of the data involving counting the number of impulses per second. The reaction of the receptors before and after isolation of the organ was therefore evaluated from the general pattern of the impulses. The results obtained by comparing in this way the impulses before and after removal of the stomach and intestine showed that in 12 experiments the general pattern of impulse activity remained almost unchanged; in 7 experiments there was a considerable increase in activity after isolation; and in 3 experiments the activity of the isolated organs was decreased. Hence, in 19 experiments in response to adequate chemical stimuli the character of the impulse activity of the receptors was either unchanged or actually increased after removal of the organs. Results of experiments illustrating this conclusion are shown in Figs. 1 and 2.

Besides these differences in the general pattern of the flow of impulses, we also examined another index of the state of the receptors, namely, the length of the latent period. Before isolation of the organs in most tests the time elapsing between application of the stimulus to the mucous membrane and the appearance of the stream of impulses was 2-6 min. After isolation of the organs, on the other hand, in most cases the latent period was doubled or even

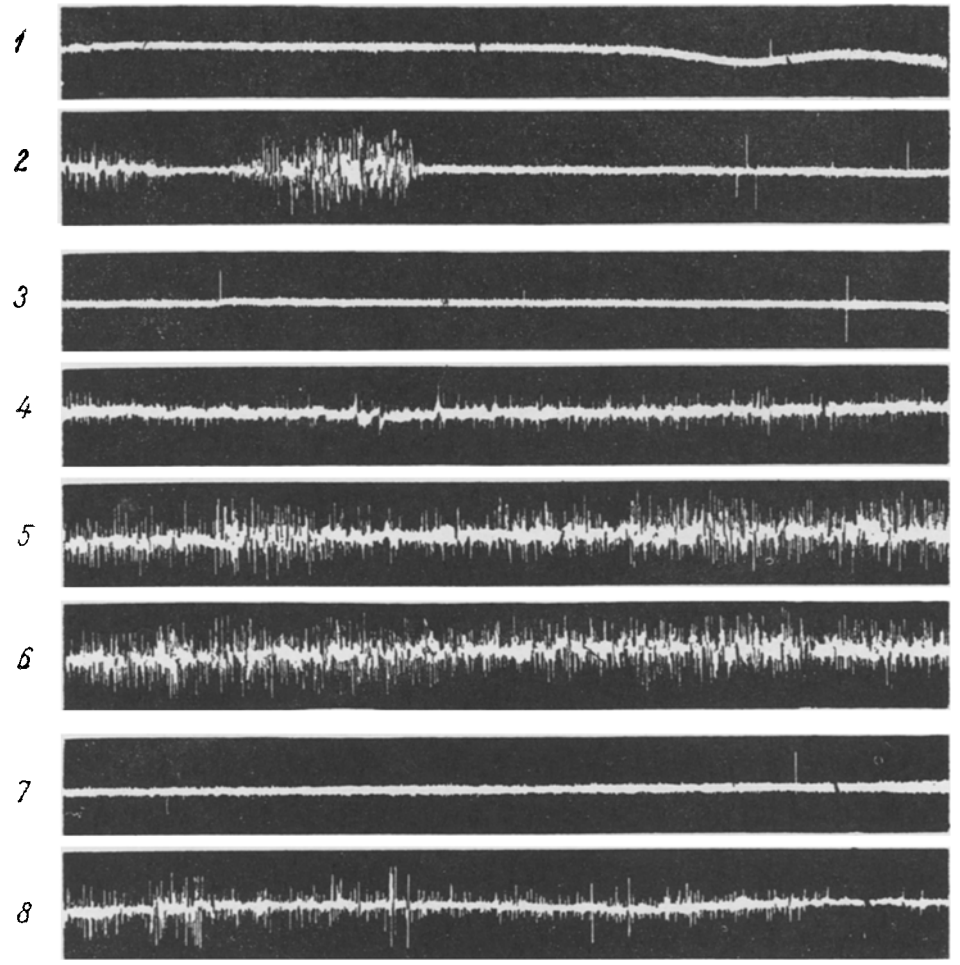


Fig. 3. Impulse activity of the afferent nerve of a cat's stomach before and 24 h after removal of the organ and during stimulation of the mucous membrane with caffeine solution. 1) Before gastrectomy, background; 2) 20 min after introducing 2% caffeine solution into the stomach; 3) 24 h after gastrectomy, background; 4) 16 min after introduction of 2% caffeine solution into the stomach; 5) 17 min after; 6) 19 min after; 7) 39 h after gastrectomy, background; 8) 10 min after introduction of 2% caffeine solution.

trebled in length, to an average value of 10-15 min. Only in three tests was the latent period shortened after removal of the organs, but in these cases the receptors displayed greater activity than when the stomach and intestine were in situ in the intact animal.

In 12 experiments the activity of the receptors after removal of the stomach and intestine was recorded after various time intervals for 24 h or more. Despite this comparatively long period of survival of the organs outside the body, the flow of impulses from the receptors in response to the action of the stimuli persisted on almost the same level as before removal of the organs from the body or immediately after their isolation. In these experiments, too, the general pattern of the flow of impulses was maintained throughout the period of observation of receptor activity.

When we studied the oscillograms obtained from the animals, we could not fail to observe the great similarity between many of them and the oscillograms recorded in experiments on human organs removed at operation. Considerable activity of the receptors of the gastric mucosa was observed in both. A particularly great increase in impulse activity took place in response to the application of caffeine, so widely used for investigating the gastric secretion.

Comparison of the character of reaction of the receptors of the stomach and small intestine from their impulse activity arising in response to the application of adequate chemical stimuli before and after removal of the organs from the body showed that the general pattern of the impulse activity underwent no significant change. This functional stability of the receptors after their removal from the body was not limited to the first few hours. Similar

results were obtained by O. P. Minut-Sorokhtina [1] during the study of the thermoreceptors of the veins, both in the intact animal and isolated in the form of a vein-nerve preparation. The principal properties of the thermoreceptors (rate of adaptation, reaction to temperature, etc.) were preserved in the conditions of the vein-nerve preparation.

While isolation of the stomach and small intestine from the rest of the body did not affect the general pattern of the flow of impulses, it led to lengthening of the latent period. This was due, in the first place, to a lowering of the excitability of the receptors of the resected organs, and in the second place to the more difficult access of the stimuli to the receptors, resulting from changes in the mucous membrane (edema, proteolytic phenomena, etc.).

The essential feature of our investigation was the application of adequate chemical stimuli, by means of which phenomena could be observed in the activity of the receptors which also arise in natural conditions in the intact organism. The changes in the flow of impulses during the action of these substances on the receptors of the organs in the intact animal and in the isolated organs were quite similar. This suggests that the flow of impulses recorded from the receptors of resected human organs corresponds in its general features to the impulses observed in these receptors in the intact human body in the presence of the same stimuli.

The differences in the character of the afferent impulse pattern in peptic ulcer and carcinoma of the stomach, which we have previously reported [2], are very likely due to peculiarities or disturbances of the function of the receptors of the gastric mucosa taking place in these diseases.


## SUMMARY

A task was set to ascertain the changes occurring in the impulse activity of the mucosa receptors in the stomach and intestine and after complete isolation of these organs. Experiments were staged on cats. A comparison was made between the character of impulsation from the receptors of gastric and intestinal mucosa with these organs intact and after their excision. Glucose, caffeine, and alcohol were used as receptor stimulants. The data obtained indicate that removal of the organs from the organism is not associated with considerable changes in the general picture of the impulse activity; only a prolongation of the latent period occurs. Experimental results suggest that the impulsation observed during stimulation of receptors of the organ removed (in man) during the operation, generally corresponds to that occurring in these receptors in the intact organism.


## LITERATURE CITED


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2. B. Z. Sirotin, Byull. éksper. biol. No. 9, 3 (1960).


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**All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.**

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