# REFLEX REGULATION OF THE "SPONTANEOUS" ACTIVITY OF THE CHEMORECEPTORS OF THE TONGUE

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Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 55, No. 8, pp. 7-11, August, 1963
Original article submitted July 13, 1962

The concept of "spontaneous" activity has provoked lively discussion among physiologists for many years. The enunciation and analysis of this problem pose a number of important technical problems. By "spontaneous" activity, some workers mean activity having no cause, in contradistinction to reflex activity, evoked by the influence of the external and internal environments. It follows, therefore, that the study of processes lying at the root of "spontaneous" activity is of great interest from the point of view of the theoretical analysis of the fundamental problems in modern neurophysiology on a materialistic basis.

"Spontaneous" activity is exhibited in the pacemaker rhythms of the heart in vertebrates, in some central neurons, notably the spinal center of the lymphatic hearts in amphibians [1, 2, 3], and also in many sensory neurons [7, 6]. Numerous investigations by P. G. Snyakin and his collaborators have shown that sensory neurons of various receptor systems constantly vary their activity when exposed to the direct effect of external environmental factors and also to the effect of these factors mediated by other sensory systems. The fact that the activity of neurons may undergo reflex changes means that great care must be used when speaking of "spontaneous" activity. Although the sensory neurons exhibit activity in the absence of a stimulus, this does not imply that this activity must be "spontaneous" in character.

Some physiologists, notably Bullock (1961), however, when describing "spontaneous" activity, localize its cause "inside the neuron and not in the mechanism of the surrounding medium."

There is no doubt that metabolic processes create the principal background features of the rhythmic activity of the neurons. Nevertheless, constant afferent influences from the same or different sensory systems modify this background rhythmic activity and adapt it to the rhythm of the various physiological processes taking place in the particular internal and external environmental conditions of the organism. Factors influencing metabolism lead to obvious changes in the "spontaneous" activity of nervous structures, as may be seen in the automatically working neurons of the center for the lymphatic hearts of amphibians (Esakov, 1959) and also in the "spontaneous" activity of the chemoreceptor apparatuses of the tongue. Without dwelling in detail on this point, which will be the subject of a special communication, we may note that the action of the physiologically active substance guanidine on the course of metabolism in the receptor apparatuses of the tongue causes a considerable increase in the intensity of the "spontaneous" activity, lasting for hours. Characteristically, too, this effect is paralleled by an increased reaction to adequate taste stimuli. Metabolic processes, the fundamental vital activity of nervous structures, thus create the background against which their physiological activity develops.

The object of the present investigation was to make an experimental study of the reflex control of the "spontaneous" activity of the receptors of the tongue.

## EXPERIMENTAL METHOD

Experiments were conducted on frogs. The "spontaneous" activity and the electrical reaction to an adequate stimulus (subsequently called "evoked" activity) were recorded in the lingual branch of the glossopharyngeal nerve. The "spontaneous" activity was recorded in the absence of application of adequate taste stimuli to the tongue, and the "evoked" activity was recorded 4 sec after application of a 3% NaCl solution or of tap water as a stimulus. The potentials were recorded on an Alvar electromyograph.

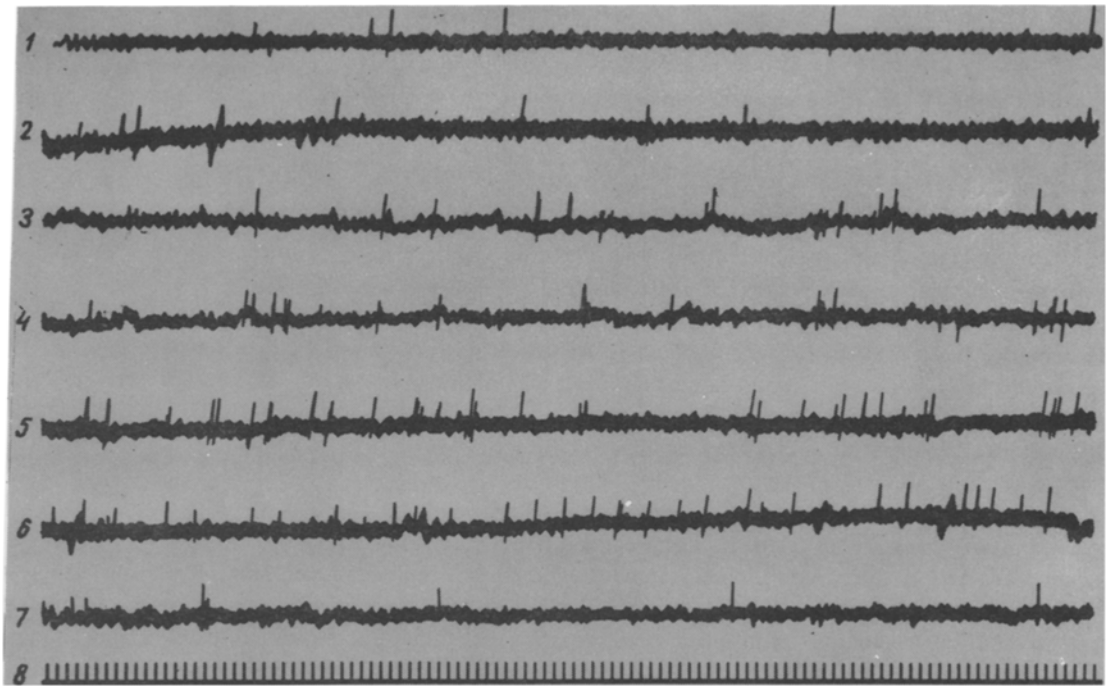


Fig. 1. Effect of mechanical inflation of the stomach on the "spontaneous" activity of the tongue receptors. 1 and 2) initial level; 3) 10 sec after inflation of the stomach; 4) the same, after 5 min; 5) 1 min after rhythmic (15 times) inflation of the stomach; 6) the same, after 10 min; 7) the same, 20 min after cessation of rhythmic inflation of the stomach; 8) time marker (50 periods/sec).

## EXPERIMENTAL RESULTS

Previous investigations (Esakov, 1961) demonstrated the reflex control of the "evoked" efferent activity of the taste receptors by influences from the interoceptors of the stomach. In this connection, it was important to discover whether changes take place in the "spontaneous" activity of these receptors as a result of influences affecting the digestive apparatus, and whether they arise parallel to the changes in the " evoked" activity.

The results of these experiments showed that stimulation of the mechanoreceptors of the stomach (stretching its walls by means of a rubber balloon) has an obvious action on the character of the "spontaneous" activity of the chemoreceptors. This effect takes the form of a considerable increase in the intensity of the "spontaneous" impulses (Fig. 1). The frequency of the impulses characterizing the "spontaneous" activity of the receptors of the tongue was more than doubled in response to inflation of the stomach. Rhythmic inflation of the stomach for 30-45 sec (15-20 times) led to changes in the "spontaneous" impulsation lasting for more than 10 min. Characteristically, the afferent activity underwent similar changes in response to stimulation by water and salt solution. It is clear from Fig. 2, in which the changes in the electrical ("spontaneous" and "evoked") activity in response to stretching the walls of the stomach are shown graphically, that the changes in these two types of activity of the receptors of the tongue develop parallel to each other.

We attempted to examine the character of the changes in the "spontaneous" activity when the flow of afferent impulses in response to adequate stimuli had undergone marked inhibition. An effect of this type was observed during the introduction of peptone into the stomach, and also during stimulation of the sympathetic chain. Experiments showed that both the introduction of peptone and stimulation of the sympathetic nervous system caused marked inhibition of the "spontaneous" activity of the receptors of the tongue. It is interesting that the effect of inhibition could be observed within 5-10 sec after the beginning of stimulation of the sympathetic chain, in the course of which the frequency of the impulses was halved (Fig. 3). At the same time, as mentioned above, stimulation of the sympathetic chain led to a significant inhibition of the "evoked" activity of the receptors. For instance, the frequency of the impulses in response to stimulation with salt fell by 20-25%, and in response to stimulation with water by more than 30%. This effect lasted for 15-20 min after a single application of stimulation to the sympathetic nervous system (Fig. 2, b).

Hence, both the "evoked" and the "spontaneous" activity of the receptors of the tongue are under the control of reflex influences derived from the interoceptors of the stomach, a discovery which confirms the correctness of the im-

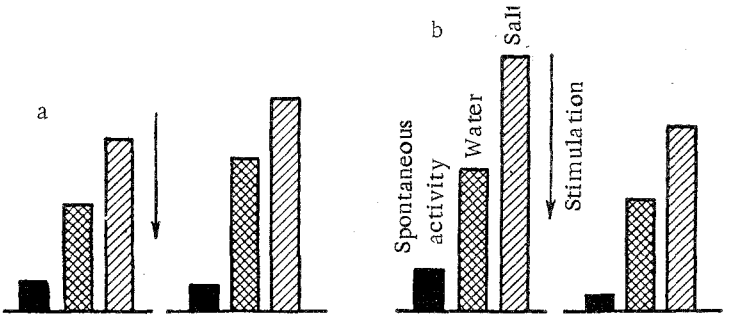


Fig. 2. Changes in the "spontaneous" and "evoked" activity of the receptors of the tongue before and after inflation of the stomach (a), and also before and after introduction of peptone into the stomach or stimulation of the sympathetic chain (b). The columns denote the frequency of impulses/ sec.

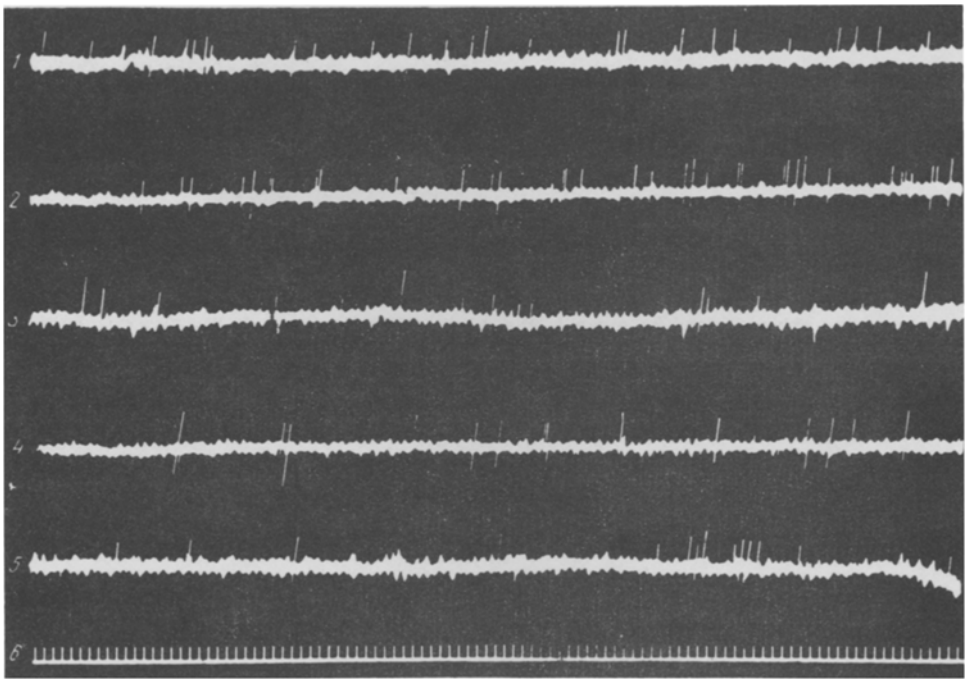


Fig. 3. Changes in "spontaneous" activity during stimulation of the sympathetic chain. 1 and 2) initial level; 3) 10 sec after application of stimulus to the sympathetic chain (downward deflections – artefacts of rhythmic stimulation); 4 and 5) 1 and 5 min respectively after stimulation; 6) time marker (50 periods per sec).

portant views of I. M. Sechenov and I. P. Pavlov concerning the importance of reflex influences in the control of physiological processes, including those described as "spontaneous." Reflex influences may lie at the basis of the working of systems exhibiting "spontaneous" activity. At the same time, they perform the task of connecting this activity with the conditions of the external and internal environment, ensuring its adaptation to the requirements of the organism as a result of changes in the conditions of life and functioning.

A similar conclusion has been reached by man workers studying "spontaneous" activity (Granit, 1957; Bullock, 1961; Rosenblit, 1961). There is no doubt that the term biological "noise" cannot be used to describe it, and Rosenblit defines it directly as a "state" during which the organism reacts selectively to sensory stimulation. The importance of

the "spontaneous" activity of the receptors evidently lies in the fact that it can indicate the preparedness of these apparatuses to perceive stimuli. In fact, the flow of "spontaneous" impulses increases parallel with the increase in the "evoked" activity, i.e., with the intensified reaction of the receptors to an adequate stimulus. As a rule, depression of the "spontaneous" activity develops in association with a lowering of the responses of the receptors to an adequate stimulus.


## SUMMARY

The spontaneous activity of the chemoreceptors of the frog's tongue was studied during stimulation of the interoceptors of the stomach and of the sympathetic chain. It was found to be under the control of the nervous system, adapting the receptors to give improved perception, and it indicates the preparedness of these apparatuses to receive stimuli. Spontaneous activity may be fundamentally a partial principle of the functioning of receptor elements. Further electrophysiological investigations of this problem are proceeding.


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