INTERACTION BETWEEN TASTE RECEPTORS

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During perception of an adequate stimulus interaction is observed between taste receptors. This apparently represents a contribution to the primary analysis of information at the peripheral receptor level.

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A single afferent fiber of the lingual nerve in the frog divides within the tongue into several (4-6) branches, which as a rule supply different papillae [2, 3, 5], so that there is considerable overlapping of the receptive zones.* By reason of this innervation pattern the conditions are created for interaction between receptors of the same or of different receptive zones.

Rapuzzi and Casella [7] showed recently that during electrical stimulation of one papilla, impulses are found in 29. This demonstrates that impulses may reach the papillae antidromically.

The object of the present investigation was to ascertain whether impulses can spread antidromically during adequate stimulation of the taste receptors. A positive answer to this question would make it possible to postulate the existence of interaction between taste receptors analogous to that found between the photoreceptors of invertebrates [4], the retina of vertebrates [6], and tactile receptors [1].

EXPERIMENTAL METHOD

Experiments were conducted on an isolated tongue preparation of the frog (Rana temporaria). To detect the antidromic spread of impulses, the electrical activity was recorded from the central end of a nerve branch divided close to the papillae supplied by it, during adequate stimulation of neighboring taste receptors. For this purpose a nerve branch supplying one or two papillae was dissected on the ventral aspect of the tongue under a binocular microscope; the branch was divided in its distal part and the central end place on recording electrodes. There were a pair of silver electrodes placed 3 mm apart. The potentials were recorded on an "Alvar" myocathograph.

*From the 1000 fibers of the two lingual nerves approximately 5000 branches are given off, supplying 200 papillae.

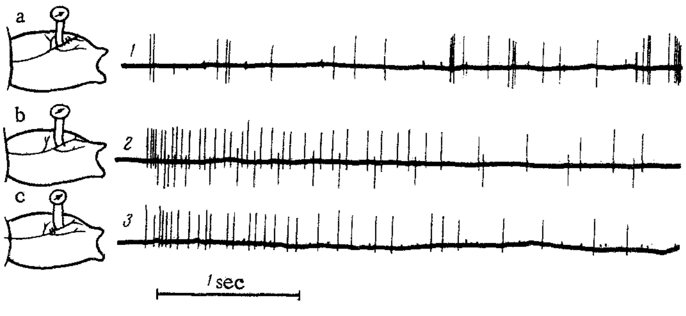

Fig. 1. Electrical activity of taste receptors during action of 5% (trace 1) and 3% (traces 2 and 3) NaCl solutions, recorded from intact branch (2) and also from central (1) and peripheral (3) ends of nerve branches. a, b, c) schemes used for recording electrical activity.

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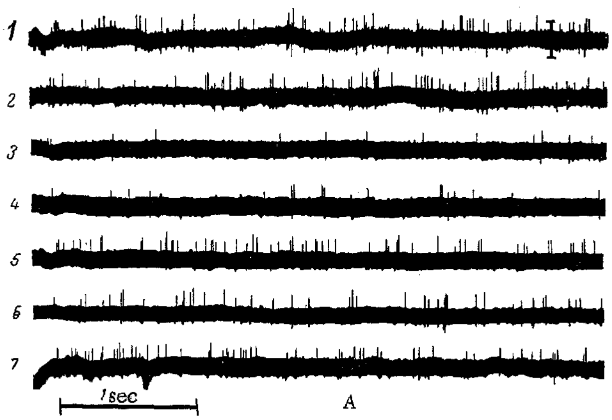

Fig. 2. Effect of antidromic stimulation of a neighboring nerve branch on electrical activity of taste receptors. 1, 2) Original responses to water; 3-7) responses after electrical stimulation (100 cps, pulse duration 1 msec, voltage 3 V, duration of stimulation 30 sec) of lingual nerve 2, 5, 12, 17 and 22 min later, respectively.

The taste stimuli used were solutions of salt in tap water. Electrical stimuli were generated by a type SIF-3 stimulator.

EXPERIMENTAL RESULTS

The experiments showed that when the tongue was irrigated with sodium chloride solution impulses (Fig. 1, 1) could be recorded from the nerve branch severed from the papillae supplied by it (Fig. 1a). This activity consisted of afferent impulses spreading antidromically from neighboring papillae.

If the electrical activity was recorded from an intact nerve branch (Fig. 1b) close by the papillae, impulses of opposite polarity (as regards deviation of the first phase of the impulses relative to the isoelectric line) were found. This reversal of polarity of the impulses was evidently connected with the direction of their movement along the nerve fiber (Fig. 1, 2). If the nerve branch was divided proximally to the electrodes (Fig. 1c) the impulses of one polarity, i.e., below the isoelectric line, disappeared whereas those above the line were recorded as before (Fig. 1, 3) Consequently, in the first case the impulses reached the electrodes from the proximal side, i.e., antidromically.

It was therefore interesting to discover the influence of these antidromic impulses on the functional activity of the receptors. For this purpose two neighboring branches were chosen in the tongue; afferent impulses were recorded from one and the other was stimulated by an electric current. Because of the considerable overlapping of the receptor zones during this procedure antidromic impulses could be sent into the test area.

The experiments showed that stimulation of this type led to a decrease in afferent activity (Fig. 2, 1, 2, 3; 55, 51, and 13 impulses respectively). This marked inhibitory effect continued until 5 min after each stimulation (Fig. 2, 4; 14 impulses). A return to the original level was observed after 10-12 min (Fig. 2, 5, 6, 7; 60, 42, and 60 impulses respectively).

Brief (2 sec) stimulation against a background of an afferent discharge of the taste receptors also led to inhibition, although it was less prolonged (1.0-1.6 sec).

The results of these experiments showed that during adequate stimulation of taste receptors electrical activity may spread not only orthodromically, but also antidromically to neighboring papillae. Figuratively speaking, in the course of perception of an adequate stimulus, the news is passed on from one taste receptor to the next. Impulses reaching the papillae and acting antidromically lead to inhibition of afferent activity. The duration and intensity of the effect depend on the duration of stimulation.

The antidromic influence spreading along the branches of the afferent fibers may evidently be a natural mechanism of interaction between taste receptors. As a result of such influences, activity of the receptors may be modified not only within the receptive zone innervated by that particular fiber, but also in a zone supplied by an afferent fiber not reached by antidromic stimulation, yet sharing a common zone of overlapping.

During the perception of an adequate stimulus, interaction is thus observed between taste receptors. This interaction is evidently a component of the analysis of information at the peripheral receptor level.

LITERATURE CITED

1. A. I. Esakov and G. M. Dmitrieva, Byull. Éksp. Biol., No. 3, 7 (1967).
2. L. M. Beidler, Progress in Biophysics and Biochemical Chemistry Pergamon Press Oxford, London-New York -Paris (1961), p. 109.
3. C. Casella and G. Rapuzzi, J. Physiol, Paris, 55, 219 (1963).

4. H. K. Hartline, Fed. Proc., 8, 69 (1949).
5. E. A. Gaupp and U. Echers', R. Wiedersheim's Anatomie des Froches, III Abst. Braunschweing, Germany, Viewg. (1904), p. 46.
6. S. W. Kuffler, J. Neurophysiol., 16, 37 (1953).
7. G. Rapuzzi and C. Casella, J. Neurophysiol., 28, 154 (1965).