ROLE OF LINGUAL NERVE FIBERS IN THE TRANSMISSION OF MECHANICAL SENSATION FROM THE TONGUE AND MOUTH IN CATS

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UDC 612.875

The role of fibers of the anterior, middle, and posterior branches of the lingual nerve in the conduction of mechanical sensory information from receptors of the tongue and mouth was established in cats. Considerable overlapping of areas of the dorsal and ventral surfaces of the tongue supplied by fibers of these nerves is demonstrated. Different types of mechanoreceptor responses from the tongue and mouth are described.

KEY WORDS: mechanoreceptors; mouth; branches of lingual nerve.

The mechanical component of the food is perceived by mechanically sensitive endings of fibers of the lingual nerve and chorda tympani [2]. Liquid and solid food acts differently on these endings, which are situated in the tongue and mucous membrane of the mouth, and they supplement integrated taste perception in animals and man. Besides transmitting information on the mechanical component of the food, the mechanoreceptors of the mucous membranes of the mouth and tongue also participate in the formation of coordinated acts of chewing, sucking, swallowing, and so on. Accordingly, the character of mechanoreception in the tongue and mouth of man [3] and animals [1, 2, 4, 6-9] has recently been actively investigated.

The object of this investigation was to study the role of lingual nerve fibers in the tactile sensitivity of the tongue and floor of the mouth.

EXPERIMENTAL METHOD

Experiments were carried out on adult cats anesthetized with pentobarbital (50 mg/kg). Unit activity was studied in the fibers of the lingual nerve in response to mechanical stimulation of the tongue and mucous membranes of the floor of the mouth. The anterior, middle, and posterior branches of the lingual nerve were isolated and the central end of the nerve itself was divided. To record the activity of the fibers, each branch of the nerve or some of its fibers were placed on bipolar electrodes. The tongue was stimulated mechanically by means of a glass rod or nylon thread (tip 0.2-1 mm in diameter), set in motion by an inductive gauge with a special square-pulse generator, so that the duration and frequency of the tactile stimuli could be altered. The apparatus also was fitted with a device for moving the stimulator in three planes through distances measured in tenths of a millimeter. The dorsal and ventral surfaces of the tongue were conventionally divided into 25-mm^2 squares. The topographic organization of the mechanoreceptor fields was determined by studying responses arising to stimulation in each branch of the lingual nerve during tactile stimulation of different parts of the tongue and mouth.

Laboratory of Physiology of Reception, P. K. Anokhin Institute of Normal Physiology. Department of Anatomy and Physiology of Man and Animals, V. I. Lenin Moscow Pedagogic Institute. (Presented by Academician V. N. Chernigovskii.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 80, No. 10, pp. 16-18, October, 1975. Original article submitted February 10, 1975.

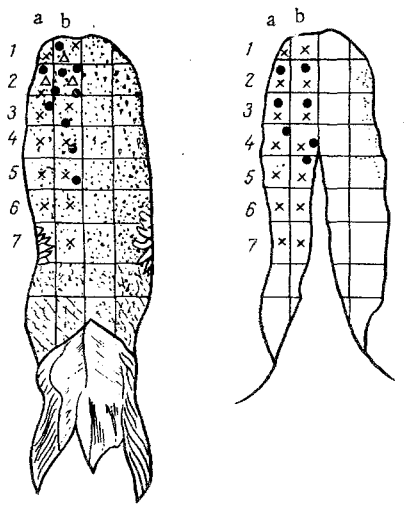

Fig. 1

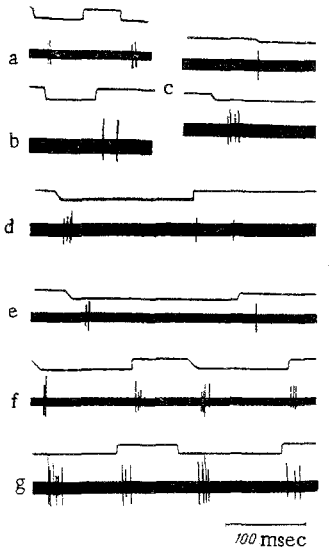

Fig. 2

Fig. 1. Mechanical-sensory innervation of dorsal (left) and ventral (right) surfaces of cat's tongue with fibers of anterior (triangles), middle (circles), and posterior (crosses) branches of the lingual nerve: a) squares of lateral, b) of medial regions of the tongue; 1-7) identification numbers of squares.

Fig. 2. Characteristics of phasic mechanoreceptor responses of the tongue: a) on responses; b) off responses; c) on responses to stimulation of lower (top record) and higher (bottom record) intensity; d) on and off responses; e, f, g) on and off responses with different latent periods. Time marker 100 msec.

EXPERIMENTAL RESULTS AND DISCUSSION

Fibers of the anterior branch of the lingual nerve participate in the transmission of mechanical sensory information only from a small area of the dorsal surface of the tongue, mainly on the medial side of its tip (Fig. 1, squares 1a, 1b, and 2b on the left side). Most fibers of this branch, on the other hand, transmit information from receptors of the floor of the mouth and inner surface of the gums, which are characterized by a high density of receptors. The dimensions of the receptor fields in these areas were less than 1 mm, whereas in other parts of the mouth they exceed 1 mm.

Fibers of the middle branch of the lingual nerve transmit mechanical sensory information from the anterior half of the dorsal surface of the tongue, mainly from its medial region (squares 1-3a, b and 4-5b), where, as at the tip of the tongue, the highest density of receptor units was observed.

Fibers of the posterior branch of the lingual nerve (Fig. 1) take part in the conduction of information from mechanoreceptors of the whole of the dorsal and also of the ventral surface of the tongue. The distribution of mechanically sensitive areas was characterized by greater uniformity and a lower density of receptor units than at the tip of the tongue. On the ventral surface the density of the units was usually smaller than on the dorsal.

At the tip and on the medial surface of the tongue, considerable overlapping of regions innervated by branches of the lingual nerve was observed.

With different intensities of point stimulation, responses of one or several receptor units, that could be classed as phasic or static in type, occurred. Responses of receptors of the phasic type were recorded to stimulation of different parts of the whole of the dorsal and ventral surfaces of the tongue and the floor of the mouth. Some phasic discharges, moreover, consisted of on and off responses, others of only on responses, and a third group of only off responses (Fig. 2). The number of spikes in the off response was nearly always smaller than in the on response. With an increase in stimulus intensity the number of spikes in the on response increased and spikes of different amplitudes, indicating involvement of several fibers conveying mechanical sensation, appeared in the on and off responses. Phasic receptors located in different parts of the tongue were characterized by different latent periods. The latent periods of the on

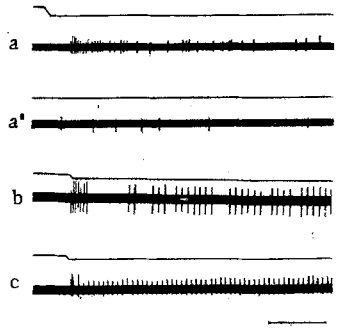

Fig. 3. Characteristics of phasic-static mechanoreceptor responses of the surface of the tongue and mouth: a) beginning; a') continuation of phasic-static discharge of tongue mechanoreceptors; b) another type of phasic-static discharge of tongue receptors; c) phasic-static response of receptors of inner surface of gums. Initial burst of spikes on all records denotes phasic responses; difference in latent periods of phasic and static responses can be seen in b. Time marker 100 msec.

responses of receptors in the medial part of the tip of the tongue were several times shorter than those of receptors on the lateral surface of the tongue. During repeated stimulation of the same area of the tongue, an increase in the latent period of the on responses sometimes was observed.

Besides phasic responses, responses of static receptors also were recorded to stimulation of the dorsal and ventral surfaces of the tongue (Fig. 3a, b) and the mucous membrane of the mouth (Fig. 3c). They also were characterized by different latent periods. At the same time, static receptors of the floor of the mouth and of the inner surface of the gums differed from the analogous receptors on the surface of the tongue by their lower threshold and the lower rate of adaptation. In most cases adaptation of the static receptors of the tongue took place after 1.5-4 sec, compared with 3-4 min for receptors of the inner surface of the gums.

On the basis of these results a map of the afferent innervation of both mechanoreceptor surfaces of the tongue by the anterior, middle, and posterior branches of the lingual nerve could be drawn. By contrast with previous investigations, in this case innervation not only of the dorsal [5] but also of the ventral surface of the tongue, the floor of the mouth, and the inner surface of the gums was studied. The results do not support the view that the ventral surface of the tongue has only a few mechanoreceptors [2].

The presence of mutually overlapping receptor fields and also of different types of receptor units (phasic and static), with different characteristics, on both surfaces of the tongue makes the adequate evaluation of the spatio-temporal pattern of action of the mechanical component of the food possible; this is a matter of great importance to the sensory analysis and initiation of responses connected with the mastication of food and its mixing with saliva.

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