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Latencies of Reflex Discharges in Some Oro-facial Reflexes of the Frog

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Summary

Unitary reflex discharges were recorded from the branches of the trigeminal nerve innervating the submental and masseter muscles following electrical stimulation of the lingual branch of the glossopharyngeal nerve, the maxillary branch of the trigeminal nerve and the mandibular branch of the facial nerve. Reflex discharges were effectively elicited by repetitive electrical stimulation of afferent nerves, but the number of reflex impulses as well as the latencies varied from discharge to discharge. This suggests that the pathway of these reflexes is polysynaptic.

Introduction

Our previous studies[1,2] revealed that the tap water applied to the frog tongue and palate elicits a nostril-closing movement caused by tonic contractions of the submental, submadibular, pterygoid and masseter muscles. Bilateral contraction of the former two muscles cause a forward movement of the prelingual tubercle of the lower jaw and those of the latter two muscles an upward movement of it, by which the medial rostral fossa at the anterior end of the upper jaw is pressed up and the nostril is closed[3].

It is well known that reflex jaw movements can easily be elicited by electrical stimulation of afferent nerves. In our previous study on the nostril-closing reflex of the frog[1], however, the reflex impulses recorded at the nerve branch of the trigeminal nerve innervating the submental muscle following electrical stimulation of the glossopharyngeal nerve (linguo-trigeminal reflex) exhibited no constant latency, that is, even if stimulus intensity was increased successively, the number and latency of the reflex impulses varied from stimulus to stimulus and from preparation to preparation.

Recently, we found that repetitive stimulation elicits reflex impulses effectively[4]. Thus, we intended to examine the reflex latencies more precisely by applying repetitive stimulation to afferent nerves and by recording unitary reflex impulses from thin nerve strands dissected from the main nerve.

Tactile stimulation applied to the palate and lip of the frog is known to elicit a jaw-closing reflex[5,6]. Thus, the latencies of this reflex was also measured by applying electrical stimulation to

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the maxillary branch of the trigeminal nerve.

Materials and methods

Male frogs, *Rana nigromaculata*, weighing 15—30 g were used. Under anaesthesia with ethyl ether, the brachial nerves were severed bilaterally and the caudal portion of the vertebral canal was destroyed with a needle to prevent movement of the animals after recovery from the anaesthesia; and then, 0.2—0.4 ml of 0.5 % MS222 was injected intraperiotonically. After the trigeminal, facial and glossopharyngeal nerves were dissected under anaesthesia, the animals were mounted on a wooden stage and were fixed with pins.

Electrical stimulation was applied to a lingual branch of the glossopharyngeal nerve or a submandibular branch of the facial nerve, and reflex neural discharges were recorded from a branch of the trigeminal nerve innervating the submental or masseter muscle with a bipolar metal wire electrode. The intensity and duration of electrical stimuli were 0.5—1 V and 0.3 ms, respectively. Reflex neural discharges were displayed on a catiod-ray oscilloscope and were photographed with cameras.

Experiments were carried out at room temperature (23—25℃) in a damp room.

Results

Since reflex discharges are known to be hardly elicited by single electrical stimulus in the nostril-closing reflex as described above, reflex discharges were elicited by applying trains of

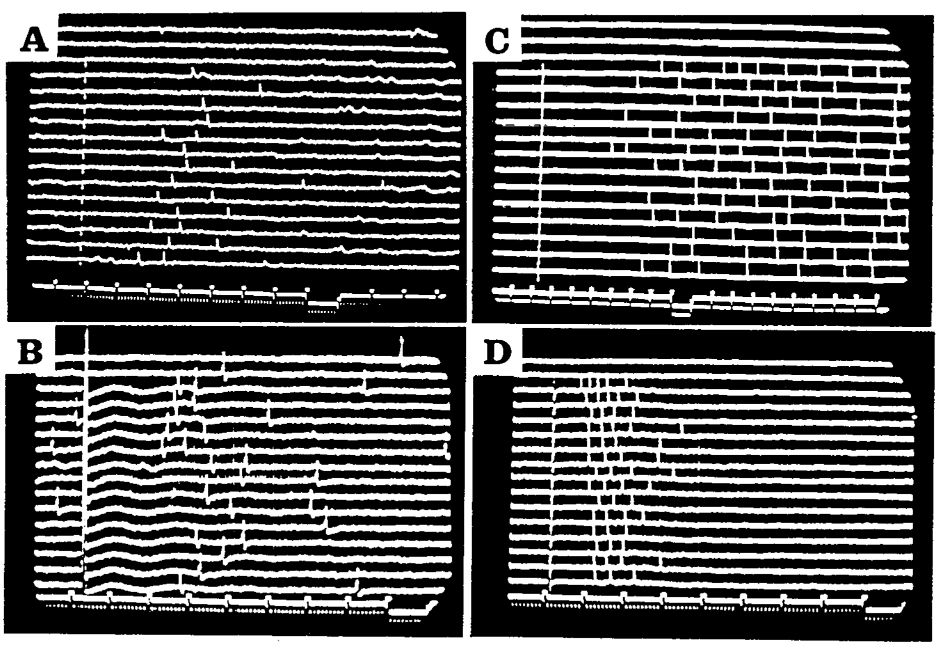

Fig. 1. Raster displays of reflex neural discharges following electrical stimulation of afferent nerves. A: a record in a small strand of the trigeminal nerve innervating the submental muscle; B and C: records in small strands of the trigeminal nerve innervating the masseter muscle; D: a record in a small strand of the hypoglossal nerve innervating the genioglossal and intrinsic tongue muscles. Vertical bars at the right corner in each photograph indicate 1mV. Time signals in each record indicate 1ms and 10ms.

electrical pulses to afferent nerves at 5 Hz. Fig. 1 shows examples of raster displays of reflex discharges obtained from a small strand of the trigeminal nerve innervating the submental muscles when the lingual branch of the ipsilateral glossopharyngeal nerve was stimulated (Fig. 1A, linguo-submental reflex), from a small strand of the trigeminal nerve innervating the masseter muscle when the maxillary branch of the ipsilateral trigeminal nerve was stimulated (Fig. 1B, maxillo-masseter reflex) and when the submaxillary branch of the ipsilateral facial nerve was stimulated (Fig. 1C, mandibulo-masseter reflex), respectively, and from a small strand of the hypoglossal nerve when the lingual branch of the ipsilateral glossopharyngeal nerve was stimulated (Fig. 1D, linguo-hypoglossal reflex). It can be seen that the latencies of reflex discharges in the former three (Fig. 1A—C) varied largely from trace to trace, while those in the last (Fig. 1D) did not. Moreover, the latencies in the linguo-hypoglossal reflex gradually prolonged from 8 ms to 11 ms, while the latencies of other three reflexes appeared to shorten gradually.

Fig. 2 shows the latency distribution of the former three reflexes. A was obtained from 136 reflex discharges in 13 preparations, B from 68 reflex discharges in 6 preparations and C from 144 discharges in 12 preparations. Their means and standard deviations were 38.4±15.4 ms in A, 59.6±43.5 ms in B and 57.2±23.3 ms in C, respectively.

The duration of reflex discharge also varied from preparation to preparation, but the long lasting reflex discharge, as shown in Fig. 2C, appeared to be elicited only in the maxillo-masseter reflex. This may be due to the fact that the masseter muscle, probably its part, may be innervated by tonic type of motoneurons.

Discussion

Kumai[7] studied the latency of linguo-hypoglossal reflex in the frog by applying electrical

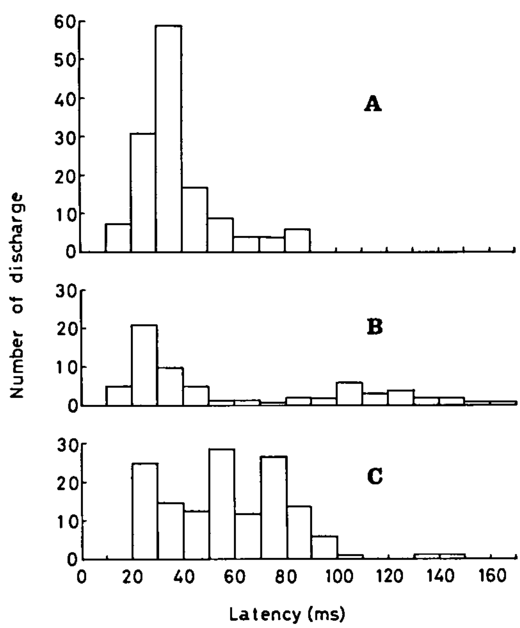

Fig. 2. Histograms showing latency distributions of reflex discharges following electrical stimulation of afferent nerves. A: glossopharyngeal-submental; B: trigeminal-masseter; C: facial-masseter.

stimulation to the glossopharyngeal nerve, showing the latency being short and in a narrow range. The mean latency and the standard deviation of the reflex discharge were 13.6 ms±0.5 ms when discharges were recorded in the branch of the hypoglossal nerve innervating the intrinsic tongue muscle following electrical stimulation of the medial branch of the glossopharyngeal nerve. On the contrary, the mean latencies and the standard deviations of linguo-submental, maxillo-masseter and mandibulo-masseter reflexes obtained in the present study were extremely large and in wide ranges. Since the reflex pathway of linguo-hypoglossal reflex is thought to be disynaptic[8], the pathways of the reflexes studied in the present study may be polysynaptic.

Weijs-Boot and van Willigen[9] have shown that electrical stimulation of intermolar region of the hard palate in rats elicits two jaw-closing reflexes, and two tongue reflexes, the latencies of which are 15—20 ms and 50—80 ms and 15—20 ms and 40—60 ms, respectively. Similar observations on the latency of oro-facial reflexes have been reported by other investigators[10,11]. The latency of linguo-hypoglossal reflex in the frog studied by Kumai[7] appears to comparable with the shorter latency of the reflex observed by Weijs-Boot and van Willigen and those of the reflexes shown in the present study appear to be comparable with the longer latency of the reflex observed by them. No precise study on the pathway of the reflex with long latency has been carried out, but the fact that the trigeminal motoneurons are innervated by reticular neurons in the brain stem[12] suggests that the pathways of the reflex studied in the present study may involve the reticular neurons.

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