ACCOMMODATION IN PERIPHERAL MOTOR NEURONS DUE TO PROPRIOCEPTOR IMPULSES

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The question of the effect of proprioceptor stimulation on central neurons is one which has long attracted attention. The aim of the present investigation is to throw light on the part played by the proprioceptor impulses in the accommodative process, by observing the rate of accommodation in peripheral motor nerve fibers.

METHOD

The experiments were performed on the frog Rana esculenta in autumn and winter. The brain was removed one hour before the experiment, and a preparation was made of the sciatic plexus and the muscles appropriate to the particular experiment. One of these muscles was connected to a myograph, to record the contractions.

For stimulation of the sciatic plexus we used a slightly altered version of Solandt's circuit, giving either a square wave or an exponentially rising wave form; by means of a two-way switch, either of these wave forms at various strengths could be applied to the sciatic plexus. Nonpolarizing electrodes were used.

The accommodation of the motor nerve was determined graphically by recording side by side the contractions evoked by stimulation of the sciatic plexus with a square and with an exponential wave form, and this also served as an index of the rate of change of accommodation.

RESULTS AND DISCUSSION

From the beginning we were convinced that the proprioceptor impulses have an effect on the accommodative power of the motor nerve, through changes in the relations in the nerves at nerve centers. One gastrocnemius muscle was stretched with a load of 50-100 g; the sciatic plexus of the opposite side was stimulated by applying either square wave or exponentially rising voltages, and the resulting muscle contractions were recorded; in this way both increases and decreases in the accommodative power of the motor neuron were observed. A two phase change in the accommodative power of the nerve also occurred.

In the following experiments the attempt was made to find in what way the accommodative power of the motor nerve changes in relation to the conditions of dominance between the centers, as effected by the proprioceptor impulses.

We therefore recorded normal values of the contractions of the calf muscles, by applying single square or exponential wave stimuli (capacity from 0.3 to 0.7 μF) to the sciatic plexus using the circuit of Solandt. After this an adequate stimulus to the proprioceptors of the calf muscles of the opposite side was given, by applying a load of 50 g, or by periodic stimulation of the muscles, using the Dubois-Reymond inductorium with a coil separation 11-9.5 cms, and a Bernstein interruptor.

Our experiments showed that adequate stimulation of the proprioceptors of the calf muscle, acting through changes in subordination in the centers, brings about a regular slowing of the accommodation of the motor neurons of the opposite side, and that the ratio of exponential stimulus tension to square wave stimulus tension.

These changes may be shown graphically (Fig. 1,b). We must suppose that the centers corresponding to the stretched triceps surae muscles are in a state of increased activity, in accordance with the principle of reciprocal innervation. The corresponding centers of the opposite side are inhibited, and this is shown by a slowing of the accommodation of the peripheral neuron.

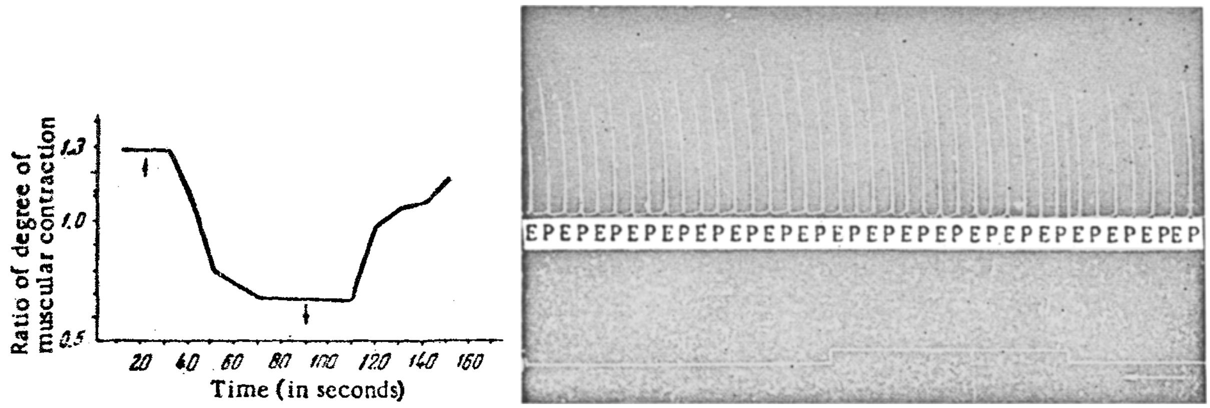

Fig. 1. Contraction of the triceps surae in the frog: a) Myogram of the triceps surae with stimulus applied to sciatic plexus. P – square wave, E – exponentially rising wave form. Traces (from above downwards): myogram, mark indicating load of 50 g applied to the triceps surae of the opposite side; myogram reads from right to left. Square wave voltage = 22, exponential wave form = 27 divisions of the voltmeter scale. Interval between stimuli 10 seconds; b) Diagram showing changes in accommodation; ↑ – application, ↓ – release of 50 g load applied to contralateral triceps surae.

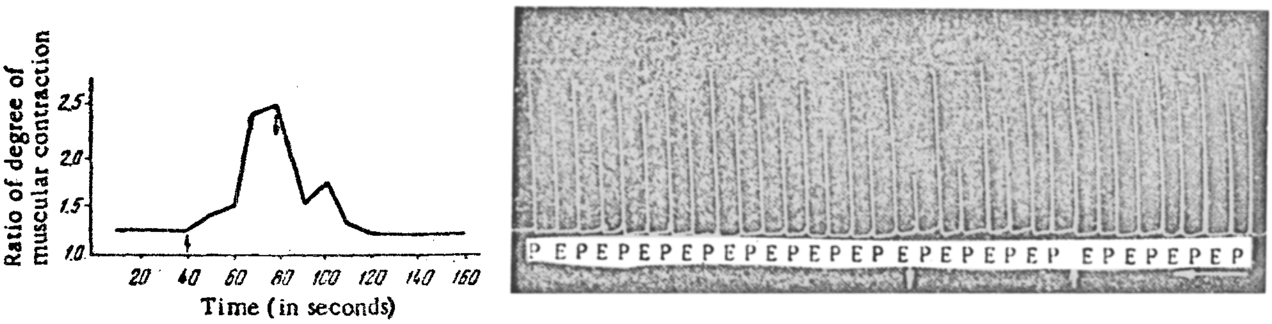

Fig. 2. Contractions in the m. semitendinosus of the frog. a) Myogram of the m. semitendinosus with stimulation of the sciatic plexus: P – square wave, E – exponential rise of voltage. Traces (from above downwards): myogram, mark showing application of 50 g load to contralateral triceps surae; ↑ – application, ↓ – release of load; myogram reads from right to left; voltage of square wave – 11, of exponential wave – 22 divisions of the voltmeter scale. Interval between stimuli = 10 seconds; b) Diagram showing changes in accommodation: ↑ – application, ↓ – release of 50 g load applied to triceps surae.

This conclusion is supported by the work of Kiselev, Uflyand, and Motsny who observed that during central inhibition induced by thalamic stimulation, in addition to other changes, there was a slowing of the accommodation of the motor nerve.

From P. E. Motsny's work we conclude that the slowing of accommodation in our experiment was due to a reduced lability of the muscle centers, brought about by proprioceptor influences from the muscle of the opposite side.

D. G. Kvasov and N. A. Shoshin describe similar changes in lability of the centers due to stretching the triceps surae.

In the second set of experiments we succeeded in following the accommodative changes in the motor neuron, due to changes in the subordinate relations in the centers brought about by stimulation of the contralateral antagonist.

The semitendinosus muscle was stimulated with single square wave and exponential voltages, and the calf muscle of the opposite side was stretched with a load of 50 g.

The results were always the same: the accommodation of the motor neuron increased, as can be seen from Fig. 2, a. The results are shown graphically in Fig. 2, b.

Our results agree with those described by Kvasov and N. A. Shoshin, who observed an increase in strength of the reflexes, not only of the stretched muscle, but also of its antagonist the semitendinosus, when a small tension of long duration was applied to the triceps surae.

We must suppose that the increased rate of accommodation in the motor neuron, as described in this experiment, is due to an increase in the activity, and consequent slowing of the accommodative process of the centers representing the semitendinosus.

When the m. semitendinosus of the opposite side was stretched, and the contractions of the triceps surae in response to stimulation of the sciatic plexus with the two wave forms were recorded, no clear change in the accommodation of the motor neuron was revealed.

In conclusion we may say that subordinate relationships are directly affected by proprioceptor impulses.

The accommodation of the peripheral motor nerve depends on the subordinate relationships of the centers; it is slowed by stimulation of the proprioceptors of the contralateral synergists, and accelerated by stimulation of the contralateral antagonist.

SUMMARY

Experiments with Rana esculenta have shown that the ability of peripheral motor neurons to accommodate is due to changes in the subordinate relations in the centers: accommodation is slowed if the proprioceptor of the contralateral synergist is stimulated but is accelerated when the contralateral antagonist is stimulated.

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