was 95.0 to 100.0 mg. per 100 cc. blood. After about one hour of status the values rose to 139.0 to 190 mg. per 100 cc. and after three hours of status the values were 150 to 240 mg. per 100 cc.

In 21 cases having moderate to very severe isolated seizures the blood sugar rose from the average of 92.5 mg. per 100 cc. blood before seizures to 168.0 mg. per 100 cc. during convulsions. In 7 cases the elevation of blood sugar was above 185 mg. per 100 cc. during the height of the convulsions.

In no instance was hypoglycemia found either before or during the convulsions.

8218 P

Synaptic Transmission in the Stellate Ganglion.*

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We have investigated certain aspects of the mechanism of synaptic transmission in a sympathetic ganglion by recording the action potentials in the inferior cardiac nerve of the cat while stimulating the preganglionic fibers to the stellate. This preparation has proved admirable for such a study because the long postganglionic nerve makes possible a careful investigation of the properties of the fibers whose response is used as a measure of the activity of the ganglion.

The form of the action potential in the non-medullated fibers of the inferior cardiac nerve has been determined by recording the impulses in the nerve during direct excitation. It differs from that of medullated nerve in 2 respects which are important to this investigation. Because the conduction velocity is much less (0.4 to 1.1 meters per second) there is a marked spread of the spike potential due to temporal dispersion of impulses in the several fibers. This temporal dispersion and the large positive and negative after potentials which are found in these non-medullated nerves may combine to give the potential wave a complicated form of several crests and troughs. In this we confirm Bishop.[1] Because of these considerations it is necessary to be cautious in the use of the post-

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[1] Bishop, G. H., *J. Cell. and Comp. Physiol.*, 1934, 5, 151.

ganglionic response as an index of repetitive firing from the ganglion or in the use of the ganglion potentials described by Eccles[2, 3] as a key to ganglionic processes.

The question as to whether each preganglionic volley sets up a single postganglionic volley or whether an independent rhythm is developed in the synapses of the ganglion has long been debated.[4, 5, 6] We have reopened the problem with the following experiments. The preganglionic nerves have been stimulated with single and repeated shocks and the potentials in the postganglionic nerves recorded. Provided the frequency of stimulation does not exceed about 40 per second we find that each volley of impulses in the preganglionic fibers sets up only a single volley of impulses in the postganglionic nerve.

But the ganglion introduces a certain amount of temporal dispersion into the volleys either because of differences in synaptic latency, or because of repetitive firing within the volley by the individual units, or because of both these factors. This follows from the observation that the spike potential in the postganglionic nerve is always more dispersed temporally when the impulses are transmitted through the ganglion than when merely conducted through an equal length of postganglionic nerve. The duration of this discharge from the ganglion is frequently as long as 50 milliseconds and may be longer as a result of previous stimulation. On the other hand, there is no evidence of after discharge in the form of successive, fairly definitely synchronized volleys set up by a single preganglionic volley.

We have frequently observed that the postganglionic response becomes progressively larger during the course of repetitive submaximal stimulation of the preganglionic nerve. This is due to the excitation of more and more postganglionic fibers by the same number of preganglionic fibers and is presumably related to the process of facilitation in the ganglion described by Eccles.[3] We have noticed this phenomenon with stimulation frequencies of about 5 per second, and the increase in response continued for over 10 seconds.

The work of Feldberg and Gaddum,[7] Feldberg and Vartianen[8] and others indicates that the postganglionic fibers are stimulated by

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2 Eccles, J. C., *J. Physiol.*, 1933, **80**, 25 P.

3 Eccles, J. C., *J. Physiol.*, 1934, **81**, 8 P.

4 Querido, A., *Am. J. Physiol.*, 1924, **70**, 29.

5 Bishop, G. H., and Heinbecker, P., *Am. J. Physiol.*, 1932, **100**, 519.

6 Knoefel, P., and Davis, H., *Am. J. Physiol.*, 1933, **104**, 81.

7 Feldberg, W., and Gaddum, J. H., *J. Physiol.*, 1934, **81**, 305.

8 Feldberg, W., and Vartianen, A., *J. Physiol.*, 1934, **83**, 103.

acetylcholine liberated at the preganglionic endings. In support of that hypothesis they find that perfusion of the superior cervical ganglion with Locke's fluid containing eserine, which protects acetylcholine against cholinesterase, increases the contraction of the nictitating membrane elicited by a submaximal preganglionic stimulus. In order to test this theory of synaptic transmission by a different method we have injected eserine intravenously in amounts such that the concentration in the blood circulating through the ganglion was from 1:1,000,000 to 1:10,000. Throughout the experiments the preganglionic nerves were stimulated at a low frequency and the action potentials in the postganglionic fibers were recorded. We never observed any effect with the low concentrations of eserine and only a block of synaptic transmission with high concentrations.

It is to be emphasized, however, that our experiments need not be considered as opposed to those of Feldberg and Vartianen. They perfused the ganglion with Locke's fluid containing eserine while in our work the ganglion was circulated with blood. Our negative results may be due to the fact that with blood circulating through the ganglion so much eserine is needed that the ganglion is inactivated before the concentration of eserine is sufficient to protect the acetylcholine.

Bathing the ganglion with acetylcholine causes a marked discharge of postganglionic impulses.

8219 P

Response of a Sympathetic Ganglion to High Frequency Stimulation.*

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If a preganglionic mammalian nerve is stimulated at a low frequency, each volley of impulses initiates a fairly well synchronized discharge in the postganglionic nerve.[1] When the rate of stimulation is increased to 30 or 40 per second there is a progressive de-

* Aided by a grant from the Committee on Grants-in-Aid of the National Research Council.

[1] Bronk, D. W., Tower, S. S., and Solandt, D. Y., PROC. SOC. EXP. BIOL. AND MED., 1935, **32**, 1659.