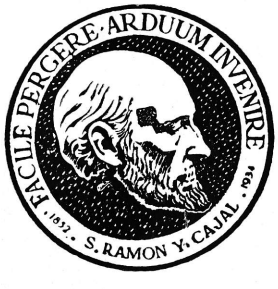
CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS

Trabajos del Instituto Cajal de investigaciones biológicas

TOMO XLVII

(LII DE LA «REVISTA TRIMESTRAL MICROGRAFICA»
FUNDADA POR S. RAMÓN Y CAJAL)



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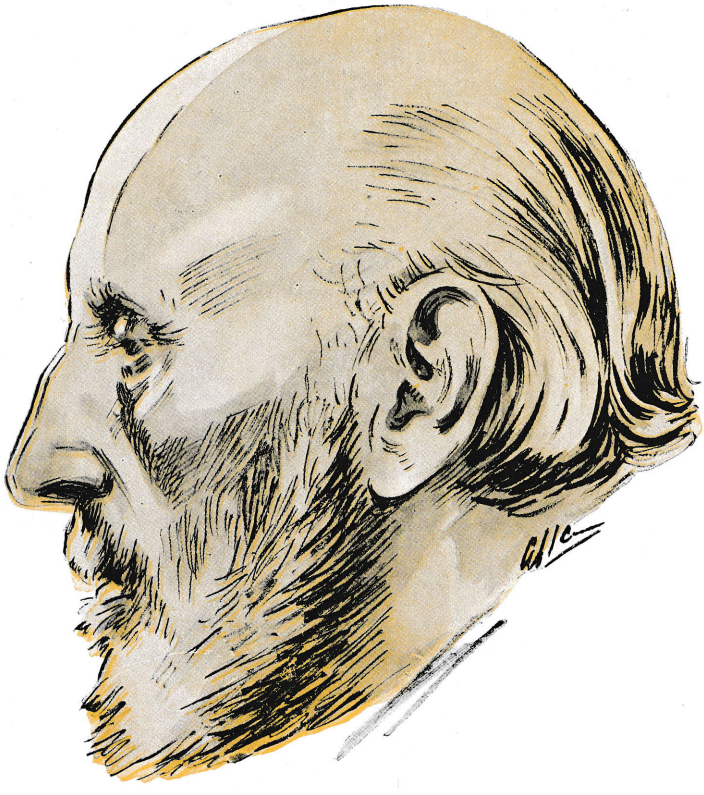

PRIMER CENTENARIO D

SANTIAGO RAMÓN Y CAJAL

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II

INDICE DEL TOMO XLVII

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Brain control of muscle spindles by gamma efferents

RAGNAR GRANIT

Recent work by Dr. BIRGER R. KAADA and myself (since published in *Acta physiol. Scand.*, 1952, *27*, 130-160) has established that the muscle spindles can be activated from various regions in the brain without concomitant activation of the ordinary motor fibres to muscle: It had been shown by LEKSELL (*Acta physiol. Scand.*, 1945, *10*, Suppl. 31) in our laboratory that selective stimulation of the small efferent fibres to muscle does not set up muscular contraction but stimulates the muscle spindles to discharge. These fibres, which on account of their conduction rate, he called gamma fibres to distinguish them from the ordinary motor or alpha fibres, are thus motor for the intrafusal musculature of the spindle organ. His results have since been confirmed and greatly developed by HUNT and KUFFLER working in Baltimore, U. S. A. (see e. g. S. W. KUFFLER and C. C. HUNT, *Res. Publ. Assn. Nerv. Ment. Disease*, 1952, *30*, 24-47).

In our work isolated spindle afferents were studied in decerebrated cats or cats anaesthetized with Dial. Muscle tension was myographically controlled with a sensitive strain gauge. Electrodes orientated with the Horsley-Clarke stereotaxic instrument were used to stimulate inside structures whilst cortical and cerebellar surfaces were stimulated with the rounded tip of a silver wire. In some cases thin efferent fibres were also isolated in the ventral root or in the nerve to gastrocnemius in order to measure the gamma frequency directly. Usually, however, it was studied by its effect on isolated muscle spindles.

A highly efficient facilitatory mechanism for the muscle spindles was found in the brain stem and diencephalic reticular system. This system, when stimulated for some seconds, set up a slowly increasing acceleration of the spindle discharge which continued for up to half a minute or more after cessation of stimulation. Less regularly simi-

lar effects were obtained from the motor cortex and the anterior lobe of the cerebellum. From the pyramidal tract the discharge could be accelerated quickly but the effect diminished during stimulation and ceased upon its cessation. Acceleration was also obtained from the habenula and the medial portion of the head of the caudate nucleus.

Deceleration of spindle activity down to complete inhibition was obtained from the bulbo-reticular inhibitory system and from the anterior lobe of the cerebellum in decerebrate as well as in Dial-chloralose animals. The former site proved to be particularly potent, easily suppressing a high discharge rate set up by a sudden load. Less pronounced effects were obtained from the motor cortex, orbital gyrus and amygdala.

The general conclusion of this work is that the efferent gamma system is tonically activated from central regions and in its turn controls the tonic activity of muscle spindle afferents. Thus the postural reflex is the last link in a system consisting of the gamma efferents and the muscle spindle afferents both of which provide permanent or tonic stimulation of the ventral horn cells.