CHAPTER XIX

PHYSIOLOGIC INFERENCES BASED ON A NEW STRUCTURAL CONCEPT OF THE SPINAL CORD

Reception of stimuli by sensory axon terminals.—Conjectures about the functioning of each termination type.—March of the excitation through the ganglion.—Hypothesis on the functions of the ganglion cell body.—Arrival of the impulse to the dorsal root and spinal cord.—Interpretation of the march of the excitation in terminal and collateral branches of radicular fibers.—[Direct propagation of impulses to motor cells.] Reflex movements: unilateral simple reflexes; unilateral diffuse reflexes; circumscribed and diffuse crossed reflexes; widely distributed reflexes; coordinated reflexes; cerebral reflexes.—Hypothesis on the mechanism transforming conscious reactions into reflex acts.—Diagram of central sensory pathways.—Voluntary movements and inhibition of reflexes.—Theories explaining the mechanism of action of the cerebrum on motor nuclei.—Diagram of the two descending motor pathways: cerebrospinal and cerebro-ponto-cerebello-spinal.

We have just seen from the structural study of the spinal cord, that this organ represents only the site of concurrence and articulation of four classes of neurons. 1st. The primary or sensory neuron exemplified by the spinal ganglion cell. 2nd. The secondary and tertiary sensory neurons, i.e. the uncrossed and crossed funicular cells of the gray matter. 3rd. The primary motor neuron or ventral radicular cell. And 4th, the secondary motor neurons, represented by both, pyramidal cells of the motor area of the cerebral cortex which form the pyramidal pathway, and [cells of the intrinsic cerebellar nuclei] which continue as the descending cerebellar fibers of Marchi.

If we thought about the probable march of impulses in the spinal cord, following the law of dynamic polarization, we would soon notice that all of this complicated series of neurons is divided into two currents or streams of constant direction, converging on a single point: the motoneuron. These two streams are: the sensory or peripheral, originated in the skin, mucous membranes, muscles, tendons, etc., which trifurcates on arriving at the cord through dorsal roots. Thus, it may reach motor cells either by reflexo-motor collaterals (short or direct pathways), or by a longer route represented by funicular neurons (medium pathways), or by a very long route which includes a complicated chain. This chain is represented by the serial articulation of primary sensory neurons, central sensory neurons (medial lemniscus originated in nuclei gracilis and cuneatus), and pyramidal cells of the cerebral cortex with their descending axons forming the pyramidal pathway.
The other stream is the voluntary motor path originated in the motor area of the cerebral cortex, where central sensory fibers terminate, that reaches motoneurons of the spinal cord by two roads. The direct or short pathway is represented by the corticospinal system of the cord, formed by axons of the cerebral pyramidal cells. The indirect descending cerebro-ponto-cerebello-spinal pathway is formed by pontine collaterals of the pyramidal pathway, pontine neurons, the axons of which form the middle cerebellar peduncle, Purkinje cells, [and intrinsic cerebellar nuclei cells], the axons of which form the descending cerebellospinal pathway of Marchi.

These two principal streams are not totally independent. The sensory pathway continues with the motor pathway at the level of the cerebral cortex, which is the highest point of the excitomotor arc, and where most possibly the sensory perception occurs, and the motor impulse originates. Let us now analyze in some more detail the march of these two currents.

1st. Sensory Current.—Reception of the neural stimulus by peripheral terminations.—Each sense organ, when considered physiologically and reduced to its simplest expression, can be regarded as a bundle of conductors arranged so that they collect different modalities, as well as intensities or amplitudes of a type of energy (light waves, sound waves, etc.). Therefore, we can surmise a priori that, also in the skin, it must exist a complex neural apparatus, organized to collect both different intensities and various qualities of a stimulus. And in fact, physiologic experiments, particularly those of Blich and Goldscheider, proved that the skin is sensitive to different modes of energy, such as heat, for which it has two varieties of nerve fibers corresponding to two tonalities: high tonality for sensations of hot, low tonality for sensations of cold. But these experiments appear to indicate, in addition, that the cutaneous tegument contains special fibers destined to collect painful stimuli, and other for tactile impressions. All of which suggests the idea that three senses are actually represented in the mentioned organ, corresponding to the three fundamental qualities of energy: heat or oscillatory movement of atoms; mechanical periodic shocks, which could be compared to the noise of the acoustic sensation; and certain energy of unknown physical characteristics that is only recognized so far in its subjective aspect, the painful sensation.

The first question that comes to mind on attempting to unravel the mechanism of the excitation in peripheral terminals is to define the sensory apparatuses corresponding to each energy modality. Which are the thermal, tactile and painful terminations? At first sight, it seems that the comparison of distributions of these endings with those of the points of pressure, hot, cold and pain determined by physiologists, should give us the clue of the problem. But these comparative studies have not been made as yet with the precision necessary to arrive at a complete solution. However, some of the corpuscles of the dermis and epidermis, such as the organs of Merkel, Meissner, Krause,