The Nobel Prize in Physiology or Medicine 1932
Sir Charles Sherrington, Edgar Adrian

Award Ceremony Speech

Presentation Speech by Professor G. Liljestrand, member of the Staff of Professors of the Royal Caroline Institute, on December 10, 1932

Your Majesty, Your Royal Highnesses, Ladies and Gentlemen.

Within the domain of physiology and medicine probably few spheres will be calculated to attract to themselves attention to the same extent as the nervous system, that distributor of rapid messages between the various parts of the body and, beyond that, the material foundation of mental life. An oft-used picture likens the nervous system to a telephone or telegraph system in the body, where the nerves are the cables, while the brain and spinal cord may be regarded as immense stations with numberless coupling possibilities. To obtain a clearer insight into this complicated machinery, its construction, and its own proper features, has been associated with great difficulties. Comprehensive investigations, especially by the two scientists Golgi and Cajal - both of them in their time rewarded by the Nobel Prize - have shown, however, that it is mainly built up of a very large number of characteristic elements or units, which have been given the name «neurones». Each of these consists of a cell, where certain parts are transformed for their special tasks into long processes or runners. Some of these - sometimes a metre or more in length - form part of just the lines which are united in the nerve cables, while others run within the spinal cord and the brain. The afferent or sensory neurones take messages from the surface of the body or internal organs to the stations, the efferent or motor neurones convey orders from these to the muscles and glands. In the stations special neurones can be coupled in between these two kinds.

Of fundamental importance for our knowledge of the workings of the nervous system was the discovery that an external influence, a so-called stimulus, can, without the cooperation of the will, call forth a definite response, such as the contraction of certain muscles. A well-known example is presented by the involuntary blinking at a loud and unexpected noise. The external influence is, so to speak, thrown back or reflected, from which the phenomenon received the name «reflex». For every one of our movements, even under the influence of the will, for numerous processes in the interior of the body, and in all probability also for mental life itself in its various forms, the reflexes play a highly important role. As a rule they are provoked by cooperation between groups of afferent, internuncial, and efferent neurones.

Sir Charles Sherrington has made extraordinary contributions to our knowledge of the reflex phenomena. In exact experiments employing quantitative methods he has investigated numerous reflexes, and also single neurones, with the object of establishing general laws for the origin and cooperation of the reflexes in the organism.

While a muscle which has been at rest becomes quite relaxed immediately after death, this is not the case with the living organ in a healthy person, where the rest is only apparent. Thus, even during sleep, but still more under the influence of a considerable load, e.g. standing, the muscle exhibits a varying degree of persistent but weak tension. This is due to reflexes released, as Sherrington has shown, principally in such a way that every stretching of the muscle affects special formations situated in its interior - a sort of reception apparatus or sense organ - from which signals are sent to the spinal cord, after which a degree of tension suitable to the conditions is mobilized in the muscle. From this the latter acquires a certain plasticity, it gives the body and its constituent parts the necessary stability and is ever ready.

When a reflex movement is provoked, a number of muscles usually contract in varying degrees. But, furthermore, Sherrington has found that this activity is as a rule accompanied by relaxation or inhibition of muscles whose effect is in the opposite sense. In bending, for example, the tension in the extensors is decreased and vice versa. As, in addition, every separate muscle receives a large number of nerve fibres, it is a complicated problem which, even in that apparently simple case, has to be dealt with in the station. Simultaneously, or in rapid succession, thousands of messages are received and deciphered, and the consequent coupling-in carried out in such a way that the movement is precise and appropriate. In more compound movements, such as walking or running, the various reflexes sometimes mesh like the cogs in a precision instrument, an extraordinarily complicated interplay thereby becoming necessary. To Sherrington belongs principally the credit of having solved the problem of how this is accomplished.

It has appeared from his investigations that a discharge from a motor neurone to the muscular fibres occurs when a condition of sufficient stimulus or tension is developed in the neurone, as a result of the impulses which have flowed in from various quarters. But here, as so often, different kinds of influences can make themselves felt in conflicting senses, nay, even one and the same external influence can result in conflicting effects on different neurones or even, under varying conditions, on the same neurone. In this connection what is of the greatest importance is the condition of the station itself, such as the degree of fatigue, or, in other cases, of specially increased susceptibility. The neurone has the capacity of to a certain extent gathering up and summing these different, simultaneous or rapidly succeeding impulses; the inhibiting and stimulating forces can then wholly or partly counterbalance each other, and the result will be decided by which of them obtains the upper hand for the time being. Both are equally necessary for the normal course of the reflexes and they must cooperate intimately. In many cases they obtain the mastery in turn, as in the case of rhythmic reflexes.

I must content myself with this short indication of Sherrington's considerable contributions. His discoveries have ushered in a new epoch in the physiology of the nervous system. On the firm foundation he has laid, many have already built further - among them should be mentioned particularly Magnus's and de Kleyn's brilliant work on the posture of the body, how it is assumed and maintained. But Sherrington's work has already partly passed through the ordeal of fire which lies in its application to pathological conditions; it has shown itself to be of great importance for the understanding of certain disturbances within the nervous system, and, certainly, matters here are still in their infancy.

While Sherrington has devoted his attention particularly to the reflexes as a whole, and very specially investigated how the coupling-in at the stations takes place under the influence of various factors, his fellow-countryman, Edgar Douglas Adrian, has attempted to illuminate the question of the nature of the processes connected with the lines to and from the stations and also within the receiving apparatuses, i.e. the sense organs. He has availed himself of the fact which has been well-known since the middle of last century, that activity in an organ is usually accompanied by electric changes, in that a region in action becomes negatively charged in relation to one that is at rest.

This was proved as regards the sense organs by our fellow-countryman Fritiof Holmgren in 1866. Such so-called «action currents» appear also in the nerves, where they flow with moderate speed; in the same way as one can listen to a conversation from a telephone wire one ought to be able to obtain a conception of the ingoing and outgoing messages or impulses by diverting the action currents from the nerves. Certainly it is a matter of excessively weak currents, but as the microscope once opened for investigators new fields within the world of form, modern technical progress has afforded unsuspected possibilities for studying the functions. For his purpose Adrian used radio amplifiers, by means of which he could increase the effects thousands of times and yet get them reproduced accurately. When he attempted in this way to divert the currents from a nerve under natural conditions, e.g. the signals which are sent when a muscle is stretched, he obtained irregular effects, difficult of interpretation. The explanation of this had already been given: the impulses in the different nerve fibres do not come simultaneously, they can therefore nullify or amplify each other. The situation may be compared with an attempt to construct the separate conversations by listening to the different wires in a telephone cable simultaneously. It was therefore necessary to try to obtain impulses corresponding to one single conversation or one sending station, and in this, by means of special artifices, Adrian and his collaborators were successful for both afferent and efferent neurones - thereby preparing the way for important discoveries. Adrian and his school were able to show that if the receiving apparatuses in the muscle were stimulated by means of various powerful loads, the size of the impulses was nevertheless unchanged. This was in agreement with the conclusion which had already been arrived at - inter alia through Adrian's own work: the single nerve fibre gives, as the expression is, all or none. The light which falls on the retina of the eye, the slight contact of the skin, or the factors which cause pain in a wound, all exercise their influence, as Adrian has shown, by giving rise to impulses of fundamentally the same kind in the nerve fibres by the mediation of the special sense organs. Of them all, it is also true that a more intensive external influence, such as a stronger flood of light, or a more powerful pressure, calls forth an ever more rapid stream of impulses up to a maximum value determined by the character of the nerve; in addition the stronger stimulus engages ever more single nerve fibres. But the orders issued to the muscles and nerves are also of this character. Thus the signals are the same everywhere, but the receiving stations change and the results with them. The sending stations, also, may be differently constituted; if the external influence which gives rise to the impulses remains unchanged, the rapidity of the impulses gradually diminishes, but the rate varies for different cases. The sense organs have thus a varying power of adapting themselves to their milieu and only respond to changes in it. These circumstances afford important points of contact as to the physiological tasks of the various sense organs and the connection between external influences and our sensations.

Adrian's investigations have given us a highly important insight into the question of the nerve principle and the adaptability of the sense organs. In reality they open new paths within important fields which have only to a slight extent been accessible for research hitherto.

As will appear from the above, Sherrington's and Adrian's discoveries concerning the function of the neurone deal mainly with different sides of the matter. Together, however, they provide a complete picture of the course of events, which implies a great step forward and gives research a new starting-point of the greatest importance in its perpetual struggle for clearer insight.

Sir Charles Sherrington and Professor Adrian. Twenty-six years ago the Nobel Prize for Physiology or Medicine was given to Golgi and Cajal who laid the foundation for the modern conception of the structure of the nervous system. It is with the function of that system that your work is concerned.

You, Sir Charles, in famous researches, in part already classic, in part still proceeding with outstanding success, have contributed more than anybody else to our knowledge of what you have termed the integrative action of the nervous system. Your numerous discoveries in this field have profoundly influenced our science and will certainly continue to do so in the future.

To you, Professor Adrian, is due the opening up of new lines of research of great importance and promise for neurophysiology. This has been amply demonstrated by your own discoveries concerning the nature of the nervous impulses and the physical basis of sensation.

The Caroline Institute has decided to award this year's Nobel Prize for Physiology or Medicine to you jointly for your discoveries regarding the function of the neurone.

On behalf of the Institute I offer you its hearty congratulations on your proud achievements, so worthy of the great English school of physiology. With these words I have the honour of asking you to accept the prize from the hands of His Majesty the King.

From *Nobel Lectures*, *Physiology or Medicine 1922-1941*, Elsevier Publishing Company, Amsterdam, 1965
