The Nobel Prize in Physiology or Medicine 1914

Presentation

The following account of Bárány's work was given by Professor G. Holmgren, Member of the Staff of Professors at the Caroline Institute*

Robert Bárány dedicated the most important part of his scientific research to a study of the inner ear, particularly to that part of it which is innervated by the nervus vestibularis and is, therefore, known as the vestibular apparatus.

In the early 19th century Flourens had already proved by experiment that by stimulating the semi-circular canals of the inner ear certain rhythmical eye movements (called nystagmus) could be caused and Purkinje showed that in human beings vertigo was induced by rotation. Ménière was the first to prove that diseases of the inner ear can produce giddiness. Later, a number of physiologists, especially Breuer and Ewald, studied the physiology of the inner ear and increased our knowledge of it in a high degree. Otologists also made daily observations in this field without, however, appreciating their significance and adapting them to the service of otology.

After Bárány, in May 1905, had communicated his observations on *caloric nystagmus* to the Austrian Otological Society, there followed during the next ten years a tremendous, almost revolutionary development of otology, in which Bárány's work was both the foundation and the central theme; many other research workers also contributed, in particular the younger generation of otologists in Vienna (Alexander, Neumann, Ruttin and others).

The starting-point of the work appeared, at first, to be quite simple. For a long time otologists had been aware that the syringing of a patient's ears often caused dizziness - some doctors had even observed nystagmus. But it was not known by what agency this came about or which organ released the phenomenon. Bárány made a systematic study of the question and found that syringing of the ear regularly produced nystagmus of a certain type. This nystagmus was connected with a feeling of giddiness. The explanation came to him quite by chance. A patient whose ears he was syringing said to him one day that he experienced a strong sensation of vertigo when the syringing water was too cold. Bárány then used very warm fluid in the syringe and the patient again complained of severe vertigo. Bárány noted the appearance of nystagmus here too, but its direction was

the exact opposite to the one previously observed. The explanation was now clear. The decisive factor was the temperature of the syringing fluid and it was soon also clear that the phenomenon, the so-called *caloric reaction*, proceeded from the semi-circular canals, in which the endolymph increases in specific gravity with cooling, showing a tendency to sink, whereas with warming the specific gravity decreases and the fluid shows a tendency to rise. The flux, or tendency to flux, which then appears in the endolymph of the semi-circular canals produces the reaction.

As a corollary of this simple explanation it then followed that a series of earlier hypotheses could be ruled out. The essential facts are simply whether the labyrinth is cooled or warmed and what the position of the head is when the process takes place. The caloric reaction for the first time provided otology with a method of investigation of the excitability of the vestibular apparatus which can be used in practically all cases. If the reaction is positive, then the canals are excitable, i.e. not totally destroyed, if it is negative then they are destroyed - with a few, easily checked exceptions. This very simply obtained reaction has become basic for our understanding of, and therefore for our therapeutic handling of, a number of labyrinth diseases - in particular those of an inflammatory nature. The mortality rate in a certain group of these, which used to be reckoned at 30-50% has now been reduced to a minimum - according to some statistics = ± 0, and this is mainly thanks to the caloric reaction and the labyrinth surgical methods which have been based upon it.

Bárány also studied systematically the other vestibular reactions. He provided an explanation for the vestibular phenomena occurring after rotation which was in sharp contrast to what had been thought before and established the clinical and physiological importance of the so-called rotatory reaction. By means of the so-called fistula test he made the «pneumatic hammer» of the physiologist Ewald available for clinical use and he gave the galvanic reaction the secondary place which it now occupies.

He also studied the remaining phenomena of the vestibular syndrome, both the subjective and the objective ones, and systematized them. Here he was chiefly concerned with developing the question of the so-called vestibular reaction movements. First of all he established that vestibular disturbances of equilibrium, which were already known, occur in a regular manner, in a certain relationship to the existing nystagmus, so that change of position, or tendency to change of position, always occurs in the same plane but in an opposite direction to the existing nystagmus. From this follows the interesting and clinically extraordinarily important fact that existing vestibular imbalance changes direction with an alteration in the head position. These imbalances, which may stem from the muscular apparatus of the trunk, correspond with other analogous phenomena in all the other muscles which are directed by the will. With an appropriate series of experiments it can be shown how each extremity, or part of an extremity, deviates from a certain position, or tends to deviate, in the same plane but in an opposite direction to the nystagmus caused, or already present. This previously quite unknown phenomenon has become, through Bárány's so-called pointing test, an integral part of the examination methods of ear and nerve specialists.

Attempts to explain the phenomena drew Bárány in a new and promising direction leading to important investigations into the function of the cerebellum. Bárány thinks that constant impulses are going out from the cortex of the cerebellum to all the muscles controlled by the will which are thus held in a constant, and under normal circumstances, uniform state of tension (tonus). This tonus is influenced by the stimulation of the vestibular apparatus in the regular manner already indicated. If one applies the simple test (Bárány's so-called pointing test) of raising the outstretched arm from a downward position upwards opposite a suitably situated, fixed object, e.g. a graduated disc (Boivie), it will be found that with repeated attempts every normal individual reaches approximately the same spot each time with either open or closed eyes. If the same test is repeated after stimulation of the vestibular apparatus, i.e. after syringing an ear with cold or warm water, the subject will point wrongly with closed eyes and always in the same way, that is to say, in the same plane in which the nystagmus occurs, but in an opposite direction. The reaction will be the same, *mutatis mutandis*, if the arm is moved in the horizontal plane or if the test is made with the leg, forearm, lower leg, trunk, head, etc. Bárány has illustrated this in an excellent manner. Let us imagine a horse walking and being led by two stretched reins. The horse can be led out of its direct path either by a stronger pull on one rein or by a loosening of the other. In Bárány's pointing test the cortex of the cerebrum represents the active force - the horse - while the cerebellar cortex supplies the tonus; one must assume that it has a centre for the tonus which is directed *against* the sagittal axis of the body, i.e. «inwards» and also a centre for the tonus *away* from this axis, i.e. «outwards». When the arm is directed into the horizontal plane one must assume that, as regards tonus, it is being influenced by one centre for tonus in an upward direction and one for tonus in a downward direction. Consequently one must assume for each joint in the body the presence of four of such tonus centres in the cerebellar cortex, one for each of four possible movement directions. By close study of cases of isolated damage to the cerebellar cortex and by suitable development and adaptation of the Trendelenburg method, by which the cortical centre can be temporarily paralysed by freezing, Bárány also succeeded in establishing the presence and position of some of these centres and thereby inaugurating a kind of topical cerebellar diagnostics of a very promising nature. Although by its very nature this study presents great difficulties, the solution of which requires considerable time, many of the points raised have already been confirmed from different sources, while others must be left open.

After the outbreak of war Bárány's efforts were partly directed into other channels which must be touched upon lightly here although they are not directly within the framework of the work for which the Nobel Prize has been awarded. As a doctor in Przemysl he soon became aware that the usual methods of treating infected cranial wounds gave very unsatisfactory results. In almost all cases where projectiles had penetrated into the brain taking with them infected particles of skin and clothing, infection occurred which sooner or later led to death. Bárány assumed that the so-called open methods of treating wounds generally current at the time were directly favorable to this infection and attempted in suitable cases, after careful cleansing of the cavity, to close the wound with a primary suture, thereby preventing continuing infection from outside. With this method of treatment, which, although Bárány was unaware of it, was also beginning to be used in Germany and, particularly, in France, he obtained immediately a considerable and

obvious improvement in his results and when Bárány came back in the middle of the war from a prisoner-of-war camp in Russia he applied himself exclusively to introducing the new method to the surgeons of his own country. At first he met with definite and tough resistance, but, when the experience of other countries became known and when Austrian surgeons had tried the method themselves, when also Bárány's great work on this theme was completed and published, opinion changed and he was able to add another great triumph to those previously achieved.

During the long period which he spent as a prisoner of war without any kind of literature, laboratory facilities or other scientific aids, Bárány was unable to proceed with this great work or with research into the vestibular mechanism. His speculative mind resorted then to the question of consciousness and its anatomical-physiological explanation to which he afterwards related a great part of his work, the first results of which have already been published.

As head of the Otological Clinic in Uppsala Bárány has already «established a school». Students from far and wide have made use of the modest, provisional aids which he was offered there and much important work has already been carried out there.

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* The Nobel Prize in Physiology or Medicine 1914 was announced on October 29, 1915.

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