that he should swallow anything was sufficient to bring them on; and he therefore entreated that no attempts to make him swallow medicine should be made, as they would be both useless and injurious. The paroxysms were induced by various external influences, such as the sight or sound of water, any sudden movement of persons in the room, the rustling of a dress, the creaking of boots, the opening or shutting of a door, a current of air, or rays of light. For instance, as the sun rose in the morning the rays of bright light suddenly passed into the room, through a skylight, and this was sufficient to induce a spasm. Again, he heard the noise of the *bhisti* (water carrier) pouring water from his *mushuck* (water bag) outside, and this brought on a violent paroxysm. On one occasion he complained of a desire to pass urine, out when the chamber utensil was brought to him he was unable to micturate, and a paroxysm was induced. He subsequently passed urine involuntarily. The paroxysms of suffocation also came on spontaneously. He could not bear anyone to approach the bed in which he was lying. It was with the greatest difficulty I managed to feel his pulse and administer medicines hypodermically. The fearful paroxysms of suffocation, accompanied, as they were, by the sudden springing up in bed, were sufficient to annerve the strongest man, and would, to the unprofessional mind, give the impression that the patient was a violent maniac. But there was no violence exhibited. The patient was rational till shortly before his death. He spoke sensibly about his affairs, recognized the fact that there was no prospect of his recovery, and met his fate with fortitude. There was no delirium or incoherence. He repeatedly assured me that there was no actual pain, merely the distressing symptoms connected with the disease.

He spoke about his case; he said that two and a half years ago he, amongst others, had been bitten by a pup which subsequently died mad. I afterwards ascertained that the period was one and a half, not two and a half years. The wounds were not cauterized at the time, as the pup was not supposed to be mad. For some time after he had a dread of hydrophobia, but latterly, for months, the idea had completely vanished from his mind. He now remembered that the present attack had commenced three days before with pain in the thumb and forefinger that had been bitten. He said to his wife at the time that he could not hold his pen. This pain passed up the arm and fixed itself in the right shoulder for a time, and there was numbness of the whole right upper limb; this he thought was merely rheumatism. These symptoms were followed by slight fever, with lassitude, weakness, and distaste for food and drink. But it was not till the early morning of the day on which he died that the awful reality flashed through his mind, when he found that he could not swallow fluids.

The paroxysms, already described, at first increased in frequency and violence, each leaving him more and more exhausted; but about noon they began to diminish in frequency and force, and he died of exhaustion at about 5 p.m.

I had the advantage of seeing several medical officers in consultation during the course of the day. They all recognized the hopeless state of the patient. It is only when placed face to face with a case of this dire disease that one recognizes the inability of any drug to stay its fearful course. During the day hypodermic injections of morphine in doses of $\frac{1}{4}$ to $\frac{1}{2}$ grain were administered every two hours or so, and to one dose was added $\frac{1}{4}$ grain of atropine. These had the effect of greatly calming the nervous symptoms and allaying the violence of the spasms.

This case involves several points of interest:

1. The unusual length of the period of incubation. From inquiries I made it was established that he was bitten at Agra in the end of March, 1884. This is clear from the statements of his connexions, and that of an officer of the 29th Native Infantry, to which regiment he then belonged. The period of incubation was therefore one and a half years; the ordinary period of incubation in this disease varies from three to six weeks, and authors distrust the accuracy of statements in cases when the disease is alleged to have occurred at lengthened periods after a bite from a rabid animal has been contracted, and think that the disease is confounded with tetanus and other nervous diseases which have some resemblance to hydrophobia.

2. That this was an undoubted case of hydrophobia, however, there can be no question. I have seen several cases of hydrophobia myself; and all the medical officers that saw this case had no hesitation in at once pronouncing it hydrophobia. Indeed, not one typical symptom of that fearful disease was absent.

3. It is sometimes argued that nervous symptoms resembling those of hydrophobia may be induced by fear after a person has been bitten by a rabid animal, and that these symptoms may actually prove fatal through the shock to the nervous system. No such argument can apply in this instance. The history of the case shows that all fear of hydrophobia supervening had passed away, and that the patient had for three days been suffering from the premonitory symptoms of the disease without any suspicion of its existence entering his mind. It is with a view to make this point clear that I have sketched the

history of the case in a somewhat irregular fashion, and not in accordance with the natural sequence of the symptoms.

4. The most important point, however, connected with the case is, fortunately, of a practical nature, and one to which I desire to call especial attention. The history tends undoubtedly to prove that the poison received from the bite of a rabid animal does not, as in the case of snake poisoning, rapidly invade the system, but remains localized at the seat of injury for an indeterminate period; and, maturing there by some peculiar process, suddenly, after the lapse of days, weeks, months, or years, invades the system. On no other theory can we explain the fact that the first symptom in the actual development of the disease was pain in the seat of the bite. The fact that the patient had no suspicion as to the nature of the pain or of the premonitory symptoms, that he did not recognize the fact that he was suffering from hydrophobia till the symptoms were fully developed, is of very great importance; otherwise it might be argued that the pain was the result of imagination.

The history of this case goes to prove that the poison remains localized for a period which varies in different individuals. If this theory be correct the practical lesson is that free removal or free destruction of the part bitten, by excision or caustics or both, should be had recourse to. For this purpose when a person has been bitten by a rabid animal the fleshy parts around the bite should be excised freely as soon as possible, care being taken that the excision should extend beyond the parts touched by the teeth of the animal. Should a surgeon not be at hand, lunar caustic, a live coal, or a hot iron should be freely applied to the parts so as to destroy the tissues around the bite. In all cases of bites from animals, even when no suspicion of rabies exists, cauterization should be had recourse to. Should these precautions not have been adopted at the time or soon after the bite, the cicatrix and surrounding tissues should be excised subsequently, should it be known or suspected that the animal had been suffering from hydrophobia. I believe there are sufficient reasons to suppose that had such excision been had recourse to in the case under review, even shortly before the active symptoms set in, the disease would never have developed itself. The lessons taught by this and similar cases should be brought home to the multitude. I believe if the measures proposed (which are not new) were more generally adopted, saving of life would result. When once the active symptoms of the disease are developed the result is necessarily fatal.

Groanian Lectures

ON

THE SIGNIFICANCE OF THE CEREBRAL CORTEX.

DELIVERED BEFORE THE ROYAL COLLEGE OF PHYSICIANS OF LONDON, JUNE, 1919.

BY

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LECTURES II AND III.

(Abstract.)

In the primitive vertebrate the olfactory areas in the cerebral hemisphere, and the visual and general sensory nuclei in the thalamus and the mid-brain, are linked by means of numerous tracts to the hypothalamus, which at first is a relatively large part of the brain. In the pursuit of food, as well as in the animal's other vital activities, this large hypothalamic apparatus is thrown into action as soon as the sense of smell excites a response. By means of numerous descending tracts the hypothalamus exerts a widespread influence upon a variety of visceral and vasomotor functions, some of which stir into activity the glands and other structures directly concerned with the processes of swallowing and digestion, as well as other mechanisms which enable the creature to devote the whole energy of its body to the immediate and vital purpose of the pursuit. And when the consummation of the reaction is attained, and the buccal mucous membrane is

itself stimulated, ascending tracts carry to the hypothalamus the effects of this excitation of the taste organs, and through it stir up even more potent effects in the digestive and other visceral systems.

It is something more than a mere coincidence that the pituitary body is developed from a combination of buccal epithelium and hypothalamus, and is an organ which excites (no doubt by very different means) profound effects in the visceral systems, in some respects analogous to that obtained by the neural bucco-hypothalamic connexion.

Thus the hypothalamus represents the mechanism whereby the instruments concerned with the phenomena of consciousness can influence the visceral functions of the body, and express those manifold emotional effects which play so obtrusive a part in many experiences that are strongly charged with affective tone.

In the first lecture emphasis was laid upon the anatomical facts (a) that the cerebral hemisphere was derived from and built upon what in the primitive vertebrate was simply the receptive instrument for smell impressions; and (b) that the olfactory tracts, unlike all the other sensory paths, lead directly to the cerebral cortex without the intermediation of the thalamus. The primitive hemisphere, therefore, must have been the instrument whereby the affective aspect of smell was appreciated—that is, it performed the functions with which the thalamus is concerned for the other senses.

Guided by the sense of smell, the behaviour of the primitive vertebrate is brought under the influence of other "distance-receptors," which secondarily acquire an affective significance or meaning by being brought into intimate relationship with the dominant sense. Specializations of structure and function then develop by the cultivation of these other senses, often at the expense of the sense of smell, and animals like the teleostean fishes are evolved which are guided mainly by vision. This determines a high development of the mid-brain and a retrogression of the cerebral hemisphere. Incidentally such creatures lose the possibility of further advancement in the direction of the higher vertebrates, not merely because they have become specialists, but also because the adaptability of the cerebral hemisphere upon which real progress depends has been sacrificed in the acquisition of visual efficiency.

After discussing other variations that occur in fishes, the momentous changes effected in the brain by the adoption of life upon land and the emergence of the Tetrapoda were next considered.

The new mode of life demanded not only the development of entirely new modes of locomotion, but also a transformation of the distance receptors of the hind-brain, as well as the organs of smell.

For the organ that was evolved to detect slight movements in the water became the organ of hearing, and the olfactory mucosa, which was specialized to respond to very delicate forms of chemical stimulation, now became much more highly sensitive and adapted to appreciate the more subtle effects of minute air-borne particles of odoriferous substances.

The heightened powers of smell, the new powers of hearing, and the necessity for acquiring new methods of locomotion, provided a powerful stimulus to the cerebral hemisphere; and there are reasons for supposing that the earliest Tetrapoda were provided with a brain with a well-developed cerebral cortex. But their surviving amphibian descendants only in part emancipated themselves from the aquatic mode of life, and were satisfied with slow-going clumsy movements of a simple character. As the result their cerebral cortex underwent a process of retrogression, and the amphibia dropped out of the race for vertebrate supremacy.

But one group of proto-amphibians was more progressive. They acquired the power of more rapid movement and of more varied response to the influence of their environment. The sensitivity of touch, smell, vision, and hearing became heightened and the influence of these senses so intimately integrated by revolutionary changes in the cerebral hemisphere as to make possible a much more complex and intelligent behaviour. The increasing significance of vision, hearing, and touch, found expression in the sudden growth of the thalamus and the development of larger tracts of fibres ascending from the thalamic nuclei into the lateral edge of the pallium, which then suddenly expanded and bulged into the ventricle. The great mass of low-grade

pallium, which may be called "hypopallium," thus formed represents the first relatively independent representation in the cortex of the senses of vision, hearing, and touch, at first chiefly of the trigeminal nerve. Then for the first time the cerebral cortex became an instrument whereby these senses played a combined part in controlling behaviour and added their quota to the discriminative side of the animal's consciousness. The reptile thus came to acquire the power of learning by experience from other senses than smell and of correlating the information acquired by touch, vision, and hearing, to perform acts of discrimination in which these several senses took a definite part.

But this hypopallium was an imperfect instrument; and when it became superseded by the development of the higher mechanism of the neopallium, it (the hypopallium) became converted into [the greater part of] the nucleus caudatus, the putamen and the claustrum.

RECONSTRUCTION IN MEDICAL EDUCATION.

BEING THE PRESIDENTIAL ADDRESS DELIVERED TO THE
METROPOLITAN COUNTIES BRANCH OF THE BRITISH
MEDICAL ASSOCIATION.

BY

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WHEN Peter, in *Joan and Peter*, was asked by his guardian to plan his own school, Peter considered and then said, "I'd like lessons about the insides of animals, and about the people in foreign countries—and how engines work—and all that sort of thing."

This was revolutionary, and, according to the recognized educational authorities, could not be permitted under any circumstances; hence Sydenham's visit to the appointed source of knowledge proved a dismal fiasco, and he was faced with the task of finding a sphere within which "reconstructed" education was really existent. He failed to find it, and by just such a degree Peter failed to secure what such an education would have provided. He was not much the worse for it, but he might have been so much the better had he had it.

The medical schools of Great Britain and Ireland have always had before them one principal object—the training of good general practitioners of medicine—and they have succeeded, for there is no other country in the world where such excellent men and women doctors can be found.

But medicine, surgery, and the allied subjects are always advancing, and the capacity of the human brain finds it difficult to keep pace with the advancement. For this, if for no other reason, reconstruction in medical education is called for.

Let me instance what I mean. When I was a student, not so very many years ago, all the medical out-patient work was done in a poor ill-equipped set of rooms, hidden away in a remote and rather dark corner of the hospital. Now there is a whole suite of rooms, well lit, well equipped, and used solely for its purpose. All the operative work on the surgical side was performed in a single operation theatre not used every day of the week. Now there are thirteen operation rooms of various sizes and for different departments. The entire accommodation for pathology was a poorly furnished room off the physiological department, enough perhaps, as only about half a dozen varieties of bacteria were known. Now the sections of pathology, general, histological, bacteriological, chemical, and research, are housed in a building which cost £30,000; and so it is with every other department.

In the face of these facts how is the student to be taught so that what he learns shall be adequate and sound? This is really the problem of reconstruction in medical education. The old was good, and the good that was in it must not be lost. The new is better, but its very vastness implies a danger. The preliminary and intermediate subjects, all of which are large sciences in themselves, have the possibility that they may be taught from an academic rather than from a practical point of view. Physics, chemistry, and biology—the foundations of a medical