

conviction. But when he attempts to demonstrate their validity, the facts often seem insufficient, and the deductions unconvincing.

The need of the moment is—not the enthusiasm of the disciple who builds the structure ever higher, not the indiscriminating attack of the *à priori* opponent—but the cold criticism of the impartial investigator, who will examine the foundations with every care, and estimate the justification with which each stone has been laid upon another.

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On the Functions of the Optic Thalamus and the Corpus Striatum.⁽¹⁾ By JAS. V. BLACHFORD, M.D., Medical Superintendent City and County Asylum, Bristol, and Clinical Lecturer on Insanity, University College, Bristol.

Suggestions have from time to time been made as to the probable functions of the basal ganglia, but so far none of them appear to have been very satisfactory.

It seems to be generally accepted that the optic thalami are not merely sensory centres for every or any special kind of sensation, but are large association ganglia, and it is the endeavour here to point out from anatomical, pathological, and

other reasons the kind of associations with which they are probably concerned, and the very important part they play in the life of all animals possessing them.

It may be objected that the conclusions arrived at are not in any way the result of experimental investigation, but when dealing with structures such as these, which in the higher animals are so deeply seated that considerable damage, or, at least, disturbance, must be caused to surrounding and very important nervous centres if they are operated upon; this method of inquiry seems to be not only useless, but often misleading, for by whatever method they may be extirpated, it is impossible to estimate the damage done to surrounding parts, and if the experiments consist of attempts at stimulation it is impossible to prevent the diffusion of the stimulant beyond the area under experiment, added to which in both cases we have to take into consideration the effect of the shock of the operation on the animal itself. In these circumstances, a better way of arriving at a correct conclusion as to the functions of such deeply seated and important nervous ganglia seems to be by reference to their development, their anatomical relations and the symptoms which are manifested when in disease of the central nervous system they appear to be chiefly affected, and by discussing how far this pathological condition interferes with that association of sensations which makes an intelligent appreciation of our surroundings possible.

First let us consider the developmental relations of the optic thalami. They are developed as thickenings of the postero-lateral aspects of the anterior cerebral vesicle. From the same vesicle we have the optic vesicle budding out giving rise to the optic tracts and retinae, and from its fore parts the buds which are destined to become the cerebral hemispheres.

We thus see that from the outset the parts which are about to develop into the optic thalami are very intimately associated with the cerebral hemispheres.

We next come to the consideration of their anatomical relations. To commence with, the optic tracts are to a great extent connected directly with them. The main fillet-fibres are said to end in the ventro-lateral or main sensory nucleus of Cajal; those of the central tract of the cerebral nerves,

and of the fifth, in the anterior semilunar nucleus, which is in close proximity to the main sensory nucleus. Axons from the corpus mamillare reach the anterior part of the thalamus through the bundle of Vicq d'Azyr, and so bring it into communication with the fornix and hippocampal region, and so probably with the osmatic centre. By the optic radiations of Gratiolet they are brought into direct communication with the cortical visual centre in the occipital lobe.

By their anterior peduncles they communicate with the fronto-parietal part of the cortex or sensori-motor area, and by their inferior peduncles with the temporal region, and so, no doubt, with the cortical centre of hearing. There are numerous other connections with various parts of the central nervous system, but for the present purpose it will be sufficient to enumerate these. In studying the connections of the thalamus, one curious and significant point arises, *viz.*, that, although it is intimately connected with the various parts of the cerebral cortex and with the corpus striatum, by both afferent and efferent fibres, those connecting it with the lower centres appear to be mainly, if not entirely afferent. In the section devoted to neurology in the last edition of *Quain's Anatomy* the following statement appears: "From the thalamic nuclei the afferent or sensory path is continued to most parts of the cerebral cortex by fibres which arise as axons of the thalamic cells. On the other hand, the thalamus receives fibres from cells of most parts of the cortex. How the nervous impulses, which descend along these fibres are continued to the lower centres is not certainly known."

As to the pathological symptoms the present discussion was suggested by a case which died in the Bristol Asylum some years ago and was the subject of a short paper. It was briefly as follows: "A man of middle age had been ailing for some three and a half months, the symptoms being very rapid loss of sight with oncoming dementia, the latter being out of all proportion to what one would expect from the loss of sight only, and the condition of dementia arrived at in a few weeks being far deeper than that occurring even in advanced general paralysis. At the same time, as far as could be ascertained (before this advanced condition was reached), there was no corresponding loss of sensation.

"On *post-mortem* examination no tumour or hæmorrhage could

be discovered, and there were no signs of general paralysis, but both the optic thalami and anterior corpora quadrigemina were mottled, and on section being made the cells were found to be degenerated." In this case there was a history of syphilis.

In the same paper two other cases were reported, each with a history of syphilis, with exactly similar symptoms, but in each there was a marked improvement upon the administration of pot. iod. in large doses, reaching as much as ʒj three times a day.

I think we are justified in assuming that these two were similar in nature to the one which was *post-mortem*, but that the treatment at any rate delayed the fatal result.

In looking up records of cases of lesion of the optic thalami (and these are few and far between), the chief symptom mentioned is invariably that of dementia.

Can we in any way explain the above symptoms, if, as it appears, we are dealing with a lesion of a basal ganglion and not one of the cortex?

Let us for a moment consider the nature of a simple perception: take that of a rough surface; such a surface to one who had vision only, but not the tactile sense, would mean nothing except that it differed in appearance from a smooth surface. Add the sense of touch, then, and whenever the surface is seen and felt at the same time, two distinct stimuli arrive at the central nervous system by different paths,—one by the optic tract, the other by the fillet. After a sufficient number of similar experiences, whenever one sensation occurs it gives rise to a faint sensation or idea of the other and *vice-versâ*. How is this brought about? There must be a common link somewhere, otherwise a faint sensation of the one would not follow a vivid sensation of the other.

We have seen before that the part which is centrally situated and most intimately connected with the cortical centres for these sensations is the optic thalamus. We have also seen that the most profound dementia occurs in lesions of that body.

Seeing that the two most relational senses are those of sight and touch, and that consequently anything which would interfere with their association would be most likely to bring about the symptom we are discussing, I think we may reasonably

infer that the association of the sensations of sight and touch occurs in the optic thalamus.

Take next the sense of hearing: if, whenever a rough surface is seen or touched, or both, the word "rough" is mentioned, then on this sound being again heard, although there is no surface to examine, the faint sensation of a rough surface, both in its appearance and feel, will occur to the individual, and will constitute the idea of roughness.

The optic thalamus has been shown to be in intimate connection with the cortical centre for hearing, so that in all probability it is the association medium between these three sensations.

What is the probable explanation of this. We must suppose that fibres from the optic tracts arborise round cells in the optic thalamus and anterior corpora quadrigemina bodies; from these, axons pass to the occipital cortex and arborise round visual cells, giving rise to the sensation of sight. Thence other axons pass back to the optic thalamus to arborise round other cells there. In like manner axons arise from cells in the tactile cortex and pass to the optic thalamus, and there arborise round the same cells; hence, whenever an object is seen and at the same time examined by the sense of touch, a certain kind of stimulus reaches these cells from the visual cortex, and is immediately followed by a certain kind of stimulus from the tactile cortex or *vice-versá*, and when these changes have followed each other sufficiently frequently, upon the production of the one the other will invariably follow, though with less intensity.

The axons arising from the thalamic cells will convey the result of these changes to the corresponding cells in the cerebral cortex, where they will give rise to sensations constituting the perception of the object observed.

The same will apply to sounds which can in any way be associated with sight or touch.

If it be admitted that all our sensations are cortical—and this seems to be generally accepted—and that our perceptions are the result of the association of two or more sensations, then there must be some centre in which they are associated, and we have seen that from a developmental and anatomical point of view the optic thalamus appears to be most suitable. If we add to this the fact that in disease of this body we have

a very pronounced dementia, which might be easily accounted for by a loss of perceptive power, we have gone a great way towards localising these association functions in the optic thalamus. If this is so, the optic thalamus may be looked upon as the centre for that association of the primary sensations of sight, touch, and hearing, which, when registered on the cortex, gives rise to the perception of things around us.

Let us go a step further; these cortical cells, which represent the association cells in the optic thalamus, if stimulated from some other source, will give rise to similar sensations, as if the stimulus arrived from the optic thalamus itself; hence, when in trains of thought arising in other parts of the cortex they are affected, faint perceptions will arise in the mind, much like those which would have originated had the stimulus arrived from the optic thalamus, the only difference being that whereas a stimulus arising in the optic thalamus necessarily entails stimulation of the sensory cortex, from which the afferent fibres to the optic thalamus arise, and so a vivid impression as well; in this case the faint impression arises without any vivid impression, is therefore still more faint, and forms what may be termed an idea. This being so, the optic thalamus is indirectly responsible through its registered impressions in the cortex for our ideas of the primary attributes of things around us.

The senses of smell and taste have not been mentioned, as they are so unrelational, and so form very few associations, but in those cases in which associations are formed between these senses and those of sight or touch these probably take place in the optic thalamus, so that to summarise briefly the functions of the optic thalamus:

(1) It appears to be concerned directly in the sensation of sight, some of the cells, especially those in the pulvinar and lateral geniculate body, forming relay cells between the retinae and the cells in the visual cortex.

(2) It is the centre of association between sight and touch themselves, and between these senses and all others, including, perhaps, the muscular sense.

(3) Indirectly through its representative cells in the cortex, in which these associations are permanently registered, it makes possible those ideas of the qualities of things without which thought, as we know it, would be impossible.

Concerning the muscular sense, of which mention has been made, it is very difficult even to speculate, but in those associations in which it is concerned it seems possible that there is some other centre involved primarily, and that the optic thalamus plays a secondary part; and more than that, seeing how intimately it is associated with the internal capsule, with its pyramidal and geniculate fibres, it seems not unlikely that the other or primary centre for the association of muscle sensation is the corpus striatum. Should this prove to be so, then, as the optic thalamus is responsible to the cortex for supplying it with associated material from which our primary ideas of attributes arise, so the corpus striatum is responsible for supplying it with the associated material for the recognition of our space and numerous muscle-sense relations, and so, ultimately, for the material for all the higher and more abstract thoughts.

In the paragraph dealing with the probable anatomical explanation of the association of sight with the other senses in the optic thalamus, it will be noticed that the new fibres reaching the thalamic cells are mentioned as arising in the cortical visual cells, and not as being collaterals from the fibres in the optic tracts as they pass through or near the thalamus. Proof that the association is not due to collaterals is derived from the fact that in blindness caused by tumours in the occipital region, although the retinal and corresponding tractal fibres are not impaired, stimulation of the retina has not been mentioned as giving rise to any other perception, such as one of roughness, smoothness, etc., which one would expect to get if the association were brought about by collaterals which arose from healthy nerve-fibres before they reached the seat of injury.

Another fact in favour of the optic thalamus being a purely association centre connected with the various parts of the cortex was mentioned in the paragraph dealing with its anatomical relations, namely, that the path along which nervous impulses descend from it to the lower centres is not certainly known; for if its function be to associate the various cortical sensations these paths would be unnecessary, and, therefore, non-existent.

(¹) A paper read at the Spring Meeting of the South-Western Division held at Bailbrook House, Bath, on April 29th, 1910.

In the discussion which followed, Dr. AVELINE asked if the optic thalamus had

been found diseased in many other cases of dementia. Dr. BLACHFORD pointed out that as far as he could ascertain it had not been so, and that in those cases following acute insanities, epilepsy and general paralysis, there apparently never occurred the very profound dementia arrived at in the cases here mentioned, and it was this fact which made him suspect that the change giving rise to it must take place at the very centre, where the association of the sensations, more especially the more relational, occur.

Some Points concerning the Diagnosis and General Treatment of the Feeble-Minded. By W. R. DAWSON, M.D., F.R.C.P.I., Medical Superintendent, Farnham House, Finglas, Dublin; late Medical Investigator to the Royal Commission on the Feeble-Minded.

THE class of defectives with which I propose to deal briefly in certain of its aspects consists of those persons over school age who are capable of earning a living in favourable circumstances, but are incapable, from mental defect existing from birth or from an early age, (*a*) of competing on equal terms with their normal fellows, or (*b*) of managing themselves and their affairs with ordinary prudence—a definition which, though rather rough, may be accepted as of some value in practice. Such persons have been found by the Royal Commission on the Feeble-Minded to constitute about 40 *per cent.* of all aments in the United Kingdom; and it has been estimated (¹) that their numbers in England and Wales amount to between 50,000 and 60,000. In my investigation, in the City of Dublin I found 365, or 30 *per cent.* of all aments. Thus they deserve separate study from their numbers alone, apart from the fact that, owing to their relatively high intelligence, they at once are more dangerous socially, and repay help better, than any other class of aments.

As regards *detection*, these cases naturally range themselves in two classes, *viz.*, those who, as defective children, have been at special schools, and are therefore already recognised, and those who have had no such advantage, a large proportion of the latter (three-fourths in the Dublin investigation) being found in workhouses and prisons. The balance of numbers will incline more and more in favour of the former class with