Wollaston, William Hyde. - On semi-decussation of the optic nerves

In : Philosophical transactions of the Royal Society of London, 1824, février 1824, p. 222-231

X. *On Semi-decussation of the Optic Nerves.* By William Hyde Wollaston, *M. D. V. P. R. S.*

Read February 19, 1824.

Whether we consider the astonishing subtlety of that medium, which renders visible to us objects existing at the most immeasurable distances from us, or that delicately constituted organ which, by its general structure, collects the rays of light, and by a nice adaptation of its parts concentrates their force on the sentient fibres of the retina, expanded over its inner surface, we can feel no surprise that such great talents should have been devoted to investigate the curious properties of the one, or that the structure of the other should have been examined with so much assiduity.

The keenness of inquiry manifested by the cultivators of anatomy in observing the most minute parts that have escaped the notice of their predecessors, shows that any addition to the common stock of our information on this subject will be gratifying to a certain portion of the members of this Society, and probably not uninteresting to the Society at large.

It is not my object, in the present paper, to examine either the *first* effect of the cornea in rendering the rays of light convergent, or the power of the crystalline lens in *finally* bringing them to a focus on the retina. It is not my intention to investigate whether the adaptation of the eye to different distances is effected by alteration of the *form* of the lens from

its own muscular structure, or by alteration of its *place*, from the agency of other muscles. Nor do I mean to consider either the *involuntary* motions of the iris dependent on the quantity of light present, or that *voluntary* contraction of it by which we adapt the aperture of the pupil for distinct vision at different distances, limiting thereby, what in optics is termed the spherical aberration of the lens.

The subject of my inquiry relates solely to the course by which impressions from images perfectly formed are conveyed to the sensorium, and to that structure and distribution of the optic nerves on which the communication of these impressions depends.

Without pretending to detect by manual dexterity as an anatomist, the very delicate conformation of the nerves of vision, I have been led, by the casual observation of a few instances of diseased vision, to draw some inferences respecting the texture of that part which has been called the decussation of the optic nerves, upon which I feel myself warranted to speak with some confidence.

It is well known that in the human brain these nerves, after passing forwards to a short distance from their origin in the thalami nervorum opticorum, unite together, and are, to appearance, completely incorporated; and that from this point of union proceed two nerves, one to the right, the other to the left eye.

The term decussation was applied to this united portion, under the supposition that, though the fibres do intermix, they still continue onward in their original direction, and that those from the right side cross over wholly to supply

the left eye, while the right eye is supplied entirely from fibres arising from the left thalamus.

In this opinion, anatomists have felt themselves confirmed by the result of their examination of other animals, and especially that of several species of fish, in which it is distinctly seen that the nerves do actually cross each other as a pair of separate cords, lying in contact at their crossing, but without any intermixture of their fibres.

In these cases it is most indisputably true, that the eye upon the right side of the animal does receive its optic nerve from the left side of the brain, while that of the left eye comes from the right side; but it is not a just inference to suppose the same continuity preserved in other animals, where such complete separation of the entire nerves is not found.

On the contrary, I not only see reason, from a species of blindness which has happened to myself more than once, to conclude, that a different distribution of nerves takes place in us, but I think my opinion supported by this evident difference of structure in fishes.

It is now more than twenty years since I was first affected with the peculiar state of vision, to which I allude, in consequence of violent exercise I had taken for two or three hours before. I suddenly found that I could see but half the face of a man whom I met; and it was the same with respect to every object I looked at. In attempting to read the name JOHNSON, over a door, I saw only SON; the commencement of the name being wholly obliterated to my view. In this instance the loss of sight was toward my left, and was the same whether I looked with the right eye or the left. This

blindness was not so complete as to amount to absolute blackness, but was a shaded darkness without definite outline. The complaint was of short duration, and in about a quarter of an hour might be said to be wholly gone, having receded with a gradual motion from the center of vision obliquely upwards toward the left.

Since this defect arose from over fatigue, a cause common to many other nervous affections, I saw no reason to apprehend any return of it, and it passed away without need of remedy, without any farther explanation, and without my drawing any useful inference from it.

It is now about fifteen months since a similar affection occurred again to myself, without my being able to assign any cause whatever, or to connect it with any previous or subsequent indisposition. The blindness was first observed, as before, in looking at the face of a person I met, whose *left* eye was to my sight obliterated. My blindness was in this instance the reverse of the former, being to *my right* (instead of the left) of the spot to which my eyes were directed; so that I have no reason to suppose it in any manner connected with the former affection.

The new punctum cæcum was situated alike in both eyes, and at an angle of about three degrees from the center; for, when any object was viewed at the distance of about five yards, the point not seen was about ten inches distant from the point actually looked at.

On this occasion the affection, after having lasted with little alteration for about twenty minutes, was removed suddenly and entirely by the excitement of agreeable news respecting the safe arrival of a friend from a very hazardous enterprise.

In reflecting upon this subject, a certain arrangement of the optic nerves has suggested itself to me, which appears to afford a very probable interpretation of a set of facts, which are not consistent with the generally received hypothesis of the decussation of the optic nerves.

Since the corresponding points of the two eyes sympathise in disease, their sympathy is evidently from structure, not from mere habit of feeling together, as might be inferred, if reference were had to the reception of ordinary impressions alone. Any two corresponding points must be supplied with a pair of filaments from the same nerve, and the seat of a disease in which similar parts of both eyes are affected, must be considered as situated at a distance from the eyes at some place in the course of the nerves where these filaments are still united, and probably in one or the other thalamus nervorum opticorum.

It is plain that the cord, which comes finally to either eye under the name of optic nerve, must be regarded as consisting of two portions, one half from the right thalamus, and the other from the left thalamus nervorum opticorum.

According to this supposition, decussation will take place only between the adjacent halves of the two nerves. That portion of nerve which proceeds from the right thalamus to the right side of the right eye, passes to its destination without interference; and in a similar manner the left thalamus will supply the left side of the left eye with one part of its fibres, while the remaining halves of both nerves in passing over to the eyes of the opposite sides must intersect each other, either with or without intermixture of their fibres.

Now, if we consider rightly the facts discovered by com-

parative anatomy in fishes, we shall find that the crossing of the entire nerves in them to the opposite eyes, is in perfect conformity to this view of the arrangement of the human optic nerves. The relative position of the eyes to each other in the sturgeon, is so exactly back to back, on opposite sides of the head, that they can hardly see the same object; they can have no points which generally receive the same impressions as in us; there are no corresponding points of vision requiring to be supplied with fibres from the same nerve. The eye which sees to the left has its retina solely upon its right side; and this is supplied with an optic nerve arising wholly from the right thalamus; while the left thalamus sends its fibres entirely to the left side of the right eye for the perception of objects situated on the right. In this animal, an injury to the left thalamus might be expected to occasion entire blindness of the right eye alone, and want of perception of objects placed on that side. In ourselves, a similar injury to the left thalamus would occasion blindness (as before) to all objects situated to our right, owing to insensibility of the left half of the retina of both eyes.

A disorder that has occurred within my own knowledge in the case of a friend, seems fully to confirm this reasoning, as far as a single instance can be depended upon. After he had suffered severe pain in his head for some days, about the left temple, and toward the back of the left eye, his vision became considerably impaired, attended with other symptoms indicating a slight compression on the brain.

It was not till after the lapse of three or four weeks that I saw him, and found that, in addition to other affections which need not here be enumerated, he laboured under a defect of

sight similar to those which had happened to myself, but more extensive, and it has unfortunately been far more permanent. In this case the blindness was at that time, and still is, entire, with reference to all objects situated to the right of his center of view. Fortunately, the field of his vision is sufficient for writing perfectly. He sees what he writes, and the pen with which he writes, but not the hand that moves the pen. This affection is, as far as can be observed, the same in both eyes, and consists in an insensibility of the retina on the left side of each eye. It seems most probable, that some effusion took place at the time of the original pain on that side of the head, and has left a permanent compression on the left thalamus. This partial blindness has now lasted so long without sensible amendment, as to make it very doubtful when my friend may recover the complete perception of objects on that side of him.

In reviewing the several phenomena that I have described, we find partial blindness occurring at the same time in both eyes. This sympathy from disease is readily explained, on the supposition that the parts which sympathise receive their nerves from the same source, while the opposite halves of the eyes, which are not at the same time similarly affected, are supplied from an opposite source; and the inference is immediate, that in common vision also the sympathy of corresponding points, which receive similar impressions from the same object, is dependent on the arrangement of nerves thus detected by disease.

We find moreover in the sturgeon, (and it is the same in some other fishes) whose eyes can scarcely see the same object at once, and have no corresponding points which ordi-

narily sympathise, that the two eyes do not receive any nervous fibres from the same source; but one eye receives its nerve wholly from one side, and the other from the other side of the brain.

From the structure of these fish we learn distinctly, that the perception of objects toward one side is dependent on nerves derived from the opposite side of the brain; and in the last case of diseased vision above related, we find apparent injury to one side of the brain, followed by blindness toward the opposite side of the point to which both eyes are directed.

A series of evidence in such apparent harmony throughout, seems clearly to establish that distribution of nerves I have endeavoured to describe, which may be called the semi-decussation of the optic nerves.

On single vision with two eyes.

So long as our consideration of the functions of a pair of eyes is confined to the performance of healthy eyes in common vision, when we remark that only one impression is made upon the mind, though two images are formed at the same moment on corresponding parts of our two eyes, we may rest satisfied in ascribing the apparent unity of the impression to habitual sympathy of the parts, without endeavouring to trace farther the origin of that sympathy, or the reason why, in infancy, the eyes ever assume one certain direction of correspondence in preference to squinting.

But, when we regard sympathy as arising from structure, and dependent on connection of nervous fibres, we therein see a distinct origin of that habit, and have presented to us a

manifest cause why infants first begin to give the corresponding direction to their eyes, and we clearly gain a step in the solution, if not a full explanation, of the long agitated question of single vision with two eyes.

It may perhaps to some persons appear surprising, that so many as three instances of a disorder which they presume to be rare, should have been witnessed by one individual; but I apprehend, on the contrary, this half-blindness to be far more common than is generally supposed; and I might with as much reason express surprise at its having so far escaped notice,* were I not aware how many facts commonly remain disregarded, merely for want of explanation. It is evident that I once, and for a long time, overlooked the inference that is to be drawn from this affection; and if the disorder had not happened to me a second time, I might never have reconsidered its cause.

Even since the preceding pages were written, I have met with two more cases of this disease. One of my friends has been habitually subject to it for sixteen or seventeen years, whenever his stomach is in any considerable degree deranged. In him the blindness has been invariably to his right of the

* RICHTER, in the third volume of his Elements of Surgery, has a chapter on half-blindness, and part of it relates to what he terms amaurosis dimidiata. From one instance there given, he seems to have seen some cases similar to those I have described; but he has not noticed the corresponding affection of the two eyes, or considered the sympathy between them.

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center of vision, and, from want of due consideration, had been considered as temporary insensibility of the right eye; but he is now satisfied that this is not really the case, but that both eyes have been similarly affected with half-blindness. This symptom of his indigestion usually lasts about a quarter of an hour or twenty minutes, and then subsides, without leaving any permanent imperfection of sight.

I have not seen the subject of the 5th case, but I am informed that he has had many returns of this affection, generally attended with head-ach, and always lasting about twenty minutes, with very little variation.

From the Press of
W. NICOL,
Cleveland-row, St, James's.