CEREBRAL AMBLYOPIA AND HEMIOPIA.¹

BY DAVID FERRIER, M.D., F.R.S.

SOME important differences of opinion still exist respecting the relations of the eyes to the cerebral hemispheres, and the facts of clinical medicine and pathology appear in some respects neither to agree altogether with any of the views founded on physiological experiment, nor to be quite in accordance with each other. My object in this communication is to remove some of these differences, and to endeavour to explain some of the apparent discrepancies among clinical facts. As regards the relations of the eyes to the cerebral hemispheres, and the localisation of a visual centre, the question may be briefly stated to stand at present thus :—

In monkeys and in other animals, I, followed by Munk, Luciani and Tamburini and others, have found experimentally that destructive lesions of certain parts of the cortex cerebri cause affections of vision, and of vision only, other forms of sensibility and motor powers remaining intact. In monkeys I localised² the visual centre in the angular gyrus; and I have stated that unilateral destruction of the angular gyrus causes total loss of vision in the opposite eye, of a temporary character, however; while bilateral destruction entails total loss of vision in both eyes—an effect which I inferred would be of a permanent character. I also stated that the greater portion of both occipital lobes might be removed without any discoverable impairment of vision.

Munk³ localises the visual centres in the occipital lobes.

¹ The substance of this Paper was read at the Meeting of the Brit. Med. Ass. at Cambridge, Aug. 1880.

² 'Functions of the Brain,' § 65.

³ 'Verhandl. der Physiolog. Gesellsch. zu Berlin,' April 12, 1878.

He states that a destructive lesion of one occipital lobe causes hemiopia of both eyes—the retinae being paralysed on the side of lesion, and therefore entailing blindness towards the side opposite the lesion. Bilateral lesions cause total blindness.

Luciani and Tamburini¹ agree with me, in opposition to Munk, in placing the visual centre in the angular gyrus; but they include also the occipital lobe, partly or wholly. They agree with Munk in stating that a unilateral lesion of the visual centre causes bilateral hemiopia, and not crossed amaurosis such as I have described. This is a very brief statement of the different views, but essentially it is all that needs be mentioned in the present relation. Goltz's facts,² apart from his views as to the localisation of function, also demonstrate affections of vision from cortical lesions.

Now if we turn from physiological to clinical and pathological observation, we not only have no clear evidence of impairment of vision from purely cortical lesion, but we have actually many cases on record, in which post-mortem examination has revealed destructive lesions in the angular gyrus, and in one or both occipital lobes, without any affection of vision having been observed during life.³

The clinical history and morbid anatomy of cortical lesions, therefore, if it does not oppose, at least does not give direct support to the localisation of a visual centre in the regions indicated. The evidence in favour of a cortical visual centre in man is mainly of a constructive character; that is to say, there are many clinical phenomena which are best explained by the hypothesis of such a centre, but they can scarcely be taken as at all clearly indicating its position.

Among the facts of this nature may be mentioned, the irritative symptoms, ocular spectra, coloured vision, &c., which occur in connection with "discharging lesions," situated towards the posterior aspect of the hemisphere; as in cases reported by Hughlings-Jackson and Gowers.⁴

¹ 'Sui Centri Psico-Sensori Corticali,' 1879.

² 'Pflüger's Archiv,' xx. 1.

³ See the author's 'Localisation of Cerebral Disease,' p. 110 *et seq.*

⁴ 'Lancet,' March 1879.

Secondly: the phenomena of "word-blindness" occurring in connection with lesion in the region of the angular gyrus, of the left hemisphere especially; as in a case related by Broadbent.¹

Thirdly; the temporary abolition of vision in one eye in connection with meningo-encephalitis of the opposite hemisphere, as in a case related by Abercrombie.² With this may be taken also the unilateral affections of vision described by Fürstner in general paralytics.³

The facts relating to injury and disease of the brain in the occipital region are discussed subsequently.

Other considerations might be advanced in support of the hypothesis of a definite visual centre in the cortex; but I do not propose to enter farther into this question, which I have already discussed elsewhere.⁴

But if the relation between visual defects and lesions purely cortical is not in all respects sufficiently well demonstrated, it is otherwise as regards the effects of lesions in the internal capsule, and in the medullary fibres in the neighbourhood of the optic thalamus, corpora geniculata, and occipital region.

In cerebral hemianæsthesia of organic origin, depending, as was first indicated by Türck, on lesion of the posterior segment of the internal capsule external to the optic thalamus, and since abundantly confirmed by numerous other reported cases, vision, as well as other forms of sensibility, is affected in a very distinct and special manner.

In the classical form of this affection vision is greatly impaired, if not temporarily entirely abolished, on the side opposite the lesion; the field of vision is greatly contracted; and there is achromatopsy, or impaired colour-perception.

Generally also, as was first pointed out by Landolt, there is some contraction of the field of vision on the same side as the lesion; but the visual impairment, i.e. the diminished acuity of vision and dyschromatopsy is essentially a crossed one. I might quote many accurately investigated instances of this

¹ 'Med. Chir. Trans.' 1872.

² 'Dis. Brain and Sp. Cord,' p. 121.

³ 'Archiv für Psychiatrie,' 1877 and 1879.

⁴ Op. cit.

affection now on record, but it will suffice if I refer to the perimeters of two well-marked cases recently under the care of Dr. Hughlings-Jackson and myself, and notes taken by Dr. Beevor.

CASE I.—T. H., aged 67, a house-painter. Never suffered from lead-colic or wrist-drop. No history of syphilis. Has had gout in the left foot three or four times.

The present illness came on suddenly seven months before admission into the National Hospital for Paralysed and Epileptic on March 30, 1880. He was engaged melting some lead, when he suddenly lost consciousness and fell down, without having had any premonitory symptoms. He regained consciousness in a few minutes, and found that he was paralysed on the right side of the body. His speech was indistinct, but he could understand what was said to him, and make himself understood in words. He says he lost both motor power and sensibility on the right side.

He first began to be able to move his fingers about a fortnight after the onset. In another fortnight he could move the elbow, and a little later he could move his arm at the shoulder.

He could not move the leg at all for two months. He first was able to flex the thigh, then the foot, then the leg, and lastly the toes.

Present Condition.—Patient is a strong, healthy-looking man. There is no cardiac disease, and the urine is free from albumen. Arcus senilis is well marked, and the arteries are somewhat rigid and tortuous.

Motility.—The right angle of the mouth acts a little less vigorously than the left, but the difference is not marked.

All the movements of the right hand and arm are possible, though feebler than on the left. The grasp of the right hand = 2 kilos., that of the left = 25 kil. There is, however, some stiffness of the phalangeal joints of the right hand, which impedes firm closure of the fist. There is a good deal of fibrillar tremor of the muscles of the right arm, especially the extensors, and there is well-marked oscillation—of the disseminated sclerosis type—when he endeavours to place his forefinger on a given mark.

The movements of the right leg are all capable of being carried out, though with much less vigour than the left.

Patellar tendon-reflex is exaggerated on the right side. There is no ankle clonus.

Sensibility.—Sensibility, both general and special, is impaired on the whole of the right side.

Face.—There is complete abolition of sense of impressions of

contact on the right side of the head and face. Painful impressions are felt only on the face and head in front of a line drawn vertically through the auditory meatus. Pressure over the exit of the branches of the fifth, causes severe pain. The ear may be pinched severely without causing any sensation.

Arm.—He cannot distinguish two points on the right hand. Tactile and painful impressions on the forearm are referred to the palm of the hand. Painful impressions, as such, are recognised and correctly localised on the fingers.

Leg.—Tactile impressions are not recognised anywhere on the leg or foot, but painful impressions are felt and fairly localised.

Muscular Sense.—Tested with balls alike in appearance, but of different weights, he can distinguish between heavier and lighter balls; but underestimates the absolute weight with the right hand, on the average making the same weight with the left hand double what he makes it with the right.

Smell is completely abolished in the right nostril. There is also almost complete anæsthesia in the mucous membrane of the right nostril.

Taste is abolished on the right half of the tongue. There is also tactile anæsthesia of this side, and of the mucous membrane of the right half of the mouth and palate.

Hearing is defective on the right side. With Gellé's aural tube, he hears a watch at 15 inches on the left side, and at 8½ inches on the right.

Vision.—Acuity of vision normal in left eye.

Vision is dim and indistinct in the right eye. Tested with Snellen's test types, he recognises E. No. CC. at 3 feet; C. (No. C.) at 2 feet, and LXX. at 1 foot. He requires to move his head in order to take in the whole of E, as he cannot see it all at once. Holmgren's coloured skeins he recognises and names fairly correctly.

The perimeter (see Plate I.) taken on April 24 shows that the field of vision is contracted on the right side to an almost central area—slightly towards the right—measuring from 10–15 degrees. The field of vision in the left eye measures 50 degrees from the centre towards the right, and 60 degrees to the extreme point of the left. (The want of exact symmetry depends on the prominence of the nose.)

On June 5, along with slight improvement in respect to the

I.

in <http://brain.oxfordjournals.org/> by guest on June 8, 2016

Musnier Brés, imp

C. Berjeau.

other defects, the perimeter showed that the field of vision in the right eye had extended to 60 degrees from the centre all round, and slightly farther upwards and to the left and downwards and to the right. In the left eye the area had extended to 70 degrees all round—the limit of the normal chart.

The ophthalmoscopic appearances of both eyes were in every respect normal.

CASE II.—Hannah O., aged 40, married. Has had eight children, five of whom are now alive. Four years ago, when in a state of anxiety about her daughter who was very ill, she went to bed quite well one night, but had an attack in the night in which she became insensible.

Was confined to bed for a week, and was more or less ill for six weeks, but not paralysed as to any of her limbs.

At the end of March, 1880, after a heavy day's work in the kitchen, she felt giddy in going upstairs. Shortly after she became insensible, and continued so for four days. When she came to herself, found she had lost feeling on the left side, and could not move the left arm or leg. This continued for a fortnight, at the end of which she began to move the fingers a little. The foot recovered later, but she was not able to walk without support for five or six weeks. During this time, she accidentally discovered one day, on closing her right eye, that she could not see with the left eye. Since her last attack she has continued feeble on the left side, particularly the leg, the condition of which she alone complained of when she came to the National Hospital for Paralysed and Epileptic on June 4, 1880.

Present State.—Patient is a fresh-looking woman. There is no cardiac disease, and the urine is free from albumen.

Motility.—The left side of the face acts very feebly as compared with the right.

The movements of the left arm and hand are feeble. Grasp of left hand = 5 kilos., that of the right = 25 kilos.

The left leg is very feeble, and the movements of the foot paralysed. In walking, she rubs the toe of her left boot on the ground.

Sensibility.—Muscular sense. Has a very imperfect appreciation of the position of her left arm when her eyes are shut. When she was asked to touch her nose with her left hand, she made an effort, and thought she had done it, though the arm, being firmly held was not moved. When tested with differently weighted balls, she

estimated 20 oz. in the left hand, as of exactly the same weight as 3 oz. in the right.

Cutaneous Sensibility.—She cannot feel a slight touch (such as is distinctly felt on right side) anywhere on left side. With stronger pressure, she feels and can localise fairly well, but she does not complain of pain on pinching or pricking deeply. Powerful stimuli are felt as mere contact. She cannot appreciate two points at the greatest distance possible, on the face, or hand, or foot.

Smell.—Smell is entirely abolished in the left nostril. The mucous membrane is also anæsthetic.

Taste.—Taste is completely abolished on the left half of the tongue. There is also abolition of tactile sensibility on the left half of the tongue, and on the left side of mouth and palate.

Hearing.—Is entirely abolished in the left ear. She cannot hear a watch or tuning-fork with this ear, either closely applied to the ear or conveyed through the skull. With the right ear she hears (through Gellé's tube), the tick of a watch at 60 cm.

Vision.—There is no ptosis. The refractive media and ocular tension normal, and the fundus and optic discs normal in both eyes. The conjunctiva of the left somewhat anæsthetic. The acuity of vision and colour-sense are normal in the right eye. Vision with the left eye is very dim. She requires to bring objects quite close up to her eye to appreciate them at all. Can only recognise Snellen CC. quite close to the eye. The colour-sense in the left eye is unusual. She can only recognise green. All other colours are described as only more or less 'glimmering.' Red in particular glimmers. This test was repeated several times afterwards, with precisely the same result. Usually, according to Charcot and Landolt, green is the next colour after violet which is most readily lost, while yellow and blue may continue to be recognised. Here, however, green only remained—a fact carefully verified by repeated and varied tests.

The extent of the visual field as indicated by the perimeter (Plate II.) taken on June 11, shows that in the left eye the visual field is contracted to an area of about 15 radius, situated somewhat above and to the left of the centre; while that of the right eye, also contracted, has a radius of 50, increasing to nearly 70 upwards and to the left. On July 30, while the

area in the left eye continued almost exactly as before, the right had become contracted to about 30.

A re-examination of this patient on Dec. 3, showed that the symptoms had become rather intensified than the reverse, the patient generally more feeble. The visual fields were seen to be even more contracted than on July 30. The acuity of vision and colour-sense were perfectly normal in the right, while the amblyopia had become still more marked in the left. The only colour recognisable was green, which, however, she now termed blue, instead of green as before.

The disposition of the optic tracts in the chiasma, and their relations to the eyes on the one hand, and their centres on the other, have been the subject of numerous investigations, anatomical, experimental and clinical, the results of which are more or less discordant.¹ On grounds of anatomical and microscopical investigation, Biesiadecki,² Mandelstamm,³ Michel,⁴ Schwalbe,⁵ support the theory of total decussation of the optic tracts.

Gudden,⁶ by tracing the degeneration of the tracts resulting from extirpation of the eyeball, and Nicati,⁷ by experimental division of the optic chiasma, support the theory of semi-decussation in all the higher animals; some of the lower, as well as fishes and birds, having complete decussation.

But clinical observation in man places the fact of semi-decussation of the optic tracts beyond all doubt. Many instances of hemiopia from lesions of one optic tract might be quoted. A case reported by Gowers⁸ shows this in a very satisfactory manner, and Baumgarten⁹ has demonstrated the degeneration of both optic tracts in consequence of destruction of one eye. Cases recorded by Hughlings-Jackson,¹⁰ Remy,¹¹ and J. L. Prevost,¹² show also that lesions in the region of the corpora geniculata produce a similar result.

The general disposition of the fibres of the optic tracts,

¹ See Bellouard, 'L'Hémianopsie,' Paris, 1880.

² 'Sitzber. d. Wien. Acad.,' Bd. xlii. 1860.

³ 'Archiv für Opth.,' Bd. xix. 1873.

⁴ *Ibid.*

⁵ Von Graefe and Saemisch's Handb. 1874. ⁶ 'Archiv für Opth.,' Bd. xx. 1874.

⁷ 'Archiv d. Physiologie,' 1878.

⁸ 'Centralb. f. die Med. Wissensch.' 1878.

⁹ *Ibid.*

¹⁰ 'Lond. Hosp. Rep.' vol. viii. 1875.

¹¹ Bull. Soc. Anat. 1875.

¹² Bull. Soc. Suisse, 1879.

apart from the relative position of the decussating and non-decussating fibres, may therefore be regarded as having been satisfactorily determined.

But when we pass from these to the cortical relations, we again meet with difficulties and discrepancies.

Charcot, founding mainly on the facts of cerebral hemianæsthesia, considers, as will be seen by reference to his scheme, that the decussation in the chiasma is again reversed,

L E, and R E, left and right eyes; c, chiasma; L G, and R G, left and right geniculate bodies; Q, corpora quadrigemina; L H, and R H, left and right centres of vision; *b* and *a*, nerve-fibres from left and right sides respectively of left eye; *b'* and *a'*, corresponding fibres from right eye.

probably in the corpora quadrigemina; so that by this the whole of the fibres of one eye are brought into relation with the opposite cerebral hemisphere. Hence the crossed amblyopia characteristic of cerebral hemianæsthesia.

How well this scheme suffices to account for the amblyopia of cerebral hemianæsthesia will be at once apparent, and the facts which I observed in monkeys after destruction of the angular gyrus on one side led me to consider this scheme as exclusively correct. But the recent researches of my colleague Prof. Gerald Yeo and myself—communicated to the Physiological Section of the Brit. Med. Association, 1880¹—as well as recent clinical observations, render necessary some modifi-

¹ See Abstract in 'BRAIN,' No. XI. p. 419.

cation of this, as well as other previously formulated views on the relations of the eyes to the cortical centres.

First, with respect to the negative or latent effects of lesions of the visual centres in man, viz. the angular gyri (with supramarginal lobules) and the occipital lobes.

We have found in monkeys that the only lesion which is capable of producing complete and permanent loss of vision—if even yet we are warranted in saying so much—is total destruction of the angular gyri and occipital lobes on both sides.

We have found that the effects of all other lesions are more or less transient, and that an animal can see with both eyes if only one angular gyrus remains; and still more remarkable that one occipital lobe is sufficient for this purpose. When we say that the animal sees, we do not merely mean that the eyes are sensitive to light, but that the animal can direct all its actions, and interpret, and act on, its visual sensations in an intelligent manner. We do not pretend to be able, from a study of even the most human of the lower animals, to exclude any affection of vision in its intellectual aspects; but we cannot find that the animal's modes of activity and habits are appreciably altered.

This extraordinary result will, if we may assume a complete physiological as well as anatomical homology between man and the monkey, serve to explain the absence of any permanent loss of vision in connection with lesions which do not destroy the whole area of the visual centres. I do not know of any such case in clinical records, and an event of this kind is not likely to occur under conditions in which it would be possible to arrive at really trustworthy conclusions, on account of the profound impairment of all the cerebral functions which would almost certainly be present.

The effects of unilateral destruction of the angular gyrus speedily disappear in the monkey. Hence in man, especially as the lesions of disease are more commonly only partial, or slowly progressive, the absence of symptoms in the sphere of vision occasions no great difficulty. Bilateral destruction of the occipital lobes (taking care not to trench on the parieto-occipital fissure and the posterior limb of the angular gyrus)

we have found, as I did formerly, to be without discoverable effect on vision. Hence the absence of visual defects in the cases of unilateral and bilateral occipital lesions which have been reported in man¹ is also in harmony with our experimental results.

Next as to the temporary effects of lesions of the visual centres in the monkey.

We have observed, in confirmation of my previously published results, a temporary total loss of vision in the opposite eye when the angular gyrus was completely destroyed. The total loss of vision, however, lasts at most only a few hours, after which period the modes of action of the animal undoubtedly indicate vision, to such an extent at least as to guide its movements and enable it to lay its hand on articles of food. That a condition of amblyopia may exist, however, is possible, though the determination of such a defect is in the monkey practically impossible. And the facts of hemianæsthesia show that there may be considerable amblyopia and contraction of the visual field without the patient being specially aware of it or complaining of defect of vision (see Case II.). If the lesion of the angular gyrus is not complete, the affection of vision of the opposite eye is less marked and more transient. These facts might be taken to indicate that central vision at least is possible, notwithstanding the removal of the opposite angular gyrus.

Recovery is not explicable by the activity of the other angular gyrus only, for we found that the removal of this also, after an interval of some weeks, produced only transient effect. It is different, however, when both angular gyri are destroyed simultaneously. Total blindness ensues; but on the third day there are indications of vision, though as long as three or four weeks afterwards there is still some visual defect, evidenced by the uncertainty and want of precision of aim when the animal tries to pick up articles of food lying on the floor. Extensive lesions, or even bodily removal of the greater portion of one or even both occipital lobes, cause no discoverable impairment of vision.

If, however, the angular gyrus and occipital lobe are

¹ 'Localisation of Cerebral Disease,' p. 116.

destroyed together on one side, vision is distinctly affected in both eyes. A condition of hemiopia ensues; vision being defective or abolished towards the side opposite the lesion, from paralysis of both retinæ on the corresponding side. Whether this hemiopia is symmetrical, or whether each retina is paralysed precisely on one half, or whether one eye is affected more than the other, is very difficult to determine accurately; but we should not pronounce definitively on this point. This condition of hemiopia is also only of temporary duration, though it lasts longer than the cross amaurosis from destruction of the angular gyrus. At the end of a week there is evidence of vision to both sides, and the animal soon recovers, to all appearance perfectly.

From these facts it would appear, therefore, that there is a twofold relation between the eyes and the cortical visual centres; the one mainly cross—the central portion of the retina probably bilaterally represented—by the angular gyrus; the other bilateral—the corresponding side of both retinæ being represented—by the occipital lobe, not alone, however, but in conjunction with the angular gyrus. Perfect vision is possible with the angular gyri when the occipital lobes have been removed almost up to the parieto-occipital fissure, directly after the operation. Perfect vision is also possible by the occipital lobes alone at a relatively short period after the extirpation of the angular gyri; and not only so, but even one angular gyrus, or one occipital lobe may suffice.

Many important questions as to the theory of vision and the comparative relations and development of the homologues of the angular gyri and occipital lobes in different animals are suggested by these results; but at present some of the clinical bearings only will be considered.

The cross amaurosis or amblyopia which we have found to result from lesion of the angular gyrus is entirely in harmony with the affection of vision which is usually seen in cerebral hemianæsthesia. It would therefore appear that the fibres which pass to the cortex in the posterior third of the internal capsule (posterior segment) are those which are specially in relation with the angular gyrus, and represent the opposite

eye as regards those functions which are affected in hemianæsthesia.

That a cross affection of the vision may occur from cerebral lesion seems therefore established both experimentally and on clinical grounds. Nothnagel also¹ regards this as a necessary corollary from the cases already on record. But in addition to—and by some considered incompatible with—this cross affection, the occurrence of hemiopia from cerebral lesion, especially in relation with lesions involving, if not confined to, the occipital lobe and its medullary connections, has been of late strongly urged on grounds of clinical and pathological observation² in combination with the physiological experiments of Munk. The cases, however, which have been so far recorded, are, taken by themselves, not sufficiently definite to establish an indisputable causal relationship between the hemiopia and the cerebral lesion as such, or to indicate with any degree of precision the locality of the centre in question. The lesions have either been multiple,³ or of the nature of tumour,⁴ or if of the nature of softening, the lesion has generally been so diffuse and extended so deeply into the medullary substance, that great caution requires to be exercised in founding conclusions on them. This is all the more necessary, inasmuch as lesion or pressure on the optic tract alone causes hemiopia, and this may be affected indirectly though the lesion is not directly situated on its course. The cases also already alluded to, reported by Hughlings-Jackson, Remy, and Prevost, show that lesions in the posterior aspect of the optic thalamus and corpora geniculata cause hemiopia. Hence the possibility of affections of these structures, directly or indirectly, must be excluded before we can consider the causal relationship between hemiopia, and the cortical or subcortical lesions is at all satisfactorily established.

Taken, however, with the facts of experiment above described, the clinical cases have a much greater value. The

¹ 'Topische Diagnostik des Gehekrankheiten,' p. 499.

² See Bellouard, *op. cit.*; and Nothnagel, *op. cit.*

³ Cases by Hjort, Förster, Hosch, Chaillon (cited by Bellouard, *op. cit.*), Huguenin (cited by Nothnagel)

⁴ Cases by Pooley, Hirschberg, Jastrowitz, Mohr (*op. cit.*).

following cases may be selected as the least complicated examples of hemiopia from cerebral lesions.

Wernicke's case¹ was one of right hemiopia, aphasia, and subsequent hemiplegia. There was a cortical lesion of the left hemisphere involving the angular gyrus, a considerable extent of the occipital lobe, and the upper portions of the sphenoid-temporal convolutions as far as the fissure of Sylvius. The lesion extended into the medullary fibres of the ascending parietal convolution, and deeply into the medullary substance of the occipital lobe, dividing the radiations of the optic tract. There was also a focus of softening in the left corpus striatum, but the optic thalami, corpora geniculata and quadrigemina, optic tracts and the rest of the hemisphere presented no abnormal appearance.

Baumgarten's case² of left hemiopia had among other slight lesions (one in the roof of the anterior horn of the left ventricle, another in the right optic thalamus), an extensive apoplectic cyst in the right occipital lobe. The rest of the brain was described as normal.

Curschmann's case³ was one of left hemiopia, occurring without other cerebral symptoms, in the course of fatal poisoning by sulphuric acid. After death there was found "a large softening in the right occipital lobe reaching to the surface, chiefly towards the posterior and inner aspect." The optic tracts and rest of the brain were described as normal.

This appears to be the least uncomplicated case as yet on record, so far as I have been able to discover.

If we may accept these cases as being purely subcortical, and exclude all implication, direct or indirect, of the corpora geniculata and optic tracts, we may interpret them according to what has preceded, as being destructive of the radiations of the optic tract, not merely to the occipital convolutions but also to the angular gyrus. The extent of damage, even though it may appear that the occipital lobe—and this term is used as a rule too vaguely—alone is the seat of lesion, can rarely be determined accurately from the lesions of disease only.

¹ 'Verhandl. d. Physiolog. Gesellsch. zu Berlin,' April 12, 1878.

² 'Centralbl. f. die Med. Wissensch.,' No. 21, 1878.

³ 'Centralbl. f. pr. Augenheilkunde,' June, 1879.

Some interesting cases are also on record of hemiopia resulting from traumatic injuries, more especially in the occipital region.

In one of these reported by Cohn,¹ in consequence of a fall on the head there was right hemiopia and some degree of aphasia for three months after the injury. Several months later, however, both the hemiopia and the aphasia had completely disappeared.

In others, again, the hemiopia has been apparently permanent. The most uncomplicated case of this kind perhaps is the one described by Keen and Thomson,² and also by Dr. Otis in vol. i. p. 206 of the 'Medical and Surgical History of the War of the Rebellion,' with a chromo-lithographic illustration of the seat and extent of the injury.

Patrick Hughes received a gunshot wound of the head at the battle of Antietam on September 17, 1862. The descriptions of the course of the bullet and extent of the injury given by different surgeons differ somewhat, but the description given by Keen and Thomson, with which the chromo-lithograph appears to agree, is as follows: "Wound of entrance in the middle line, $1\frac{1}{4}$ inch above external occipital protuberance—small depressed wound; wound of exit 2 by $2\frac{1}{2}$ inches, its centre being 2 inches to the left of the middle line, and 3 inches above the wound of entrance."

The man was paralysed in the right arm and leg for some time, and considerable fungus cerebri formed and was removed. He, however, recovered within a year, and was able to work. At the date of examination (Dec. 20, 1870), by Drs. Keen and Thomson, well-marked right hemiopia existed, without any pathological appearance in the fundus oculi.

This case is a valuable one, both on account of the nature of the injury and the care with which it has been investigated.

The seat of lesion and the direction of the projectile render it probable that the damage was confined to the posterior lobe of the left hemisphere, touching on, but not permanently destroying the centres for the arm and leg, situated somewhat in advance at the upper extremity of the fissure of Rolando.

¹ Cited by Bellouard, *op. cit.*

² 'Trans. of the Americ. Ophth. Soc.' July 1871, p. 122.

In many cases of injury to the head it is much less easy to exclude direct implication of the optic tract at the base, and this must always be regarded as a possible occurrence, even though the injury might appear to be purely cerebral.

Thus it is highly probable that pressure on the optic tract is the cause of the temporary hemiopia described by Gowers¹ in connection with apoplectic extravasations, existing along with conjugate deviation of the eyes. The hemiopia is towards the side opposite the lesion. We may suppose that there is, for the time being, pressure on the optic tract on the side of the effusion. This at least would seem to be the cause, unless it can be shown that other forms of sensibility, general and special, on the opposite side are also for the time abolished; facts which would indicate rather temporary annihilation of the functions of the whole hemisphere.

That a cerebral lesion in the occipito-angular region may cause hemiopia altogether apart from direct or indirect implication of the optic tract or corpora geniculata is, however, possible, is rendered clear by the experimental facts above recorded, and some of the clinical cases are best explained on this hypothesis.

A temporary functional disturbance of this region appears also most satisfactorily to account for the scintillant scotoma, so frequent in connection with migraine, the phenomena of which have been minutely described by Airy,² Liveing,³ Dianoux,⁴ and others.

Sometimes only one eye is affected, wholly or partially, at other times a fugacious homonymous hemiopia is observed.

In addition to the ocular symptoms, there are not unfrequently other paræsthesiæ and parakineses on the hemiopic side, with temporary disturbances of speech of the aphasic type. These phenomena, with the accompanying acute hemicrania, may all be accounted for by neurosis of the cerebral membranes, and temporary disturbance of the functions of the subjacent cortical centres.

If we consider it sufficiently well established by the above

¹ 'Brit. Med. Journal,' Nov. 24, 1877.

² Megrim, 'Sick Headache,' &c., 1873.

³ Proc. Roy. Soc. Feb. 1870.

⁴ 'Du Scotome Scintillant,' 1875.

facts and considerations that hemiopia may be caused either by lesion of the optic tract, or from cortical or subcortical lesions in the occipito-angular region, it becomes an important question whether we can distinguish during life between the one and the other.

On this point we are naturally considerably aided by the simultaneous occurrence of symptoms indicative of a cerebral origin, such as hemiplegia, hemianæsthesia, aphasia, &c., but these alone are not altogether sufficient, nor are they always present, nor would they exclude simultaneous implication of the optic tract by pressure or otherwise.

A perimetric investigation of the eyes in hemiopia, proved to be due to direct lesion of the optic tract¹ shows the visual field divided by an almost vertical line passing through the point of fixation. On the one side of this line vision is entirely abolished to the right or left, as the case may be, both centrally and peripherically. Each optic tract supplies precisely the corresponding half of both retinæ.

On the other hand, there are many cases of homonymous lateral hemiopia, in which, though the lateral defect has been of indefinite duration, central vision is retained in both eyes for some distance on all sides of the point of fixation.

This is a fact of great importance and signification, and one to which I would direct especial attention as likely to furnish a means of diagnosis between cerebral and peripheral hemiopia.

In cases where central vision is retained for some degrees on all sides of the point of fixation I should regard the cause of the hemiopia as cerebral. The facts above recorded show that the angular gyrus of each hemisphere has a bilateral relation with the centre of the retina, so that, notwithstanding the complete destruction of the visual centre in one hemisphere, central vision is possible with both eyes, through the sound angular gyrus. Hemiopia therefore may exist towards the side opposite the lesion, with retention of central vision in both eyes.

The facts both of experiment and of cerebral hemianæsthesia, indicate that the area of central vision is more exten-

¹ Gowers' case, *supra cit.*

sive on the eye opposite the sound side; but central vision, more or less, is still possible though the opposite centre has been destroyed.

A rigid perimetric investigation is therefore a matter of great importance in reference to this question, and a careful comparison of the relative extent of the area of central vision in each eye desirable.

In many of the cases of hemiopia supposed to be due to injury or disease of the occipito-angular region, the perimetric investigation has not been recorded in such a way as to settle this point.

But in the case of Patrick Hughes,¹ Drs. Keen and Thomson found that in the right eye—the hemiopic side—“at the point of fixation the vertical line which bisected the field seemed to deviate slightly towards the defective side.”² The figure they give shows a distinct area of central vision, interrupting the vertical line above and below the point of fixation.

Though they suggest excentric fixation and the possibility of the patient having followed the light inadvertently, yet the facts are more in accordance with the explanation I have suggested, viz. the functional activity of the sound angular gyrus.

Hirschberg regards it as the rule that in homonymous hemiopia the vertical line always diverges towards the defective side near the point of fixation, so as to have an area of central vision ranging from 3° to 5°. Where this is so, we may regard the hemiopia as of cerebral origin. And I am of opinion that careful examination will in all cases of cerebral hemiopia establish a greater clearness of central vision and over a larger area, in the eye on the side of lesion than in the opposite. An examination of some of the cases with the perimeters given by Schweigger,³ also bears this out. The point, however, is one which I must leave to ophthalmologists.

It is a question whether there is any difference between cerebral and peripheral hemiopia, in respect to the degree and time of occurrence of atrophic changes in the optic disc.

¹ Op. cit. p. 126.

² ‘Archiv f. Ophthalm.’ Bd. xsii. Abtheil. 3, 1875.

³ See page 470.

The statements as to the occurrence of atrophy in hemiopia are somewhat at variance. In many cases, even of long duration, ophthalmoscopic examination seems to have been negative. Gowers¹ has uniformly failed to discover it. Others again have described it, but while some have seen atrophic changes in both papillæ; others again, as Mauthner, state that in homonymous hemiopia atrophic changes are visible only in the disc on the hemiopic side. In a case of right hemiopia, however, of over ten years duration, which I have carefully examined in reference to this point, I have found atrophy of both discs, but certainly more pronounced on the right.

It is certain, however, that atrophy of the optic nerve does not occur so readily as atrophy in cases of lesion of peripheral nerves in general, a fact which may be due, as Gowers suggests, to the so-called trophic influence of the retina itself.

And this is supported by the fact that also in heteronymous, temporal or nasal, hemiopia, depending without doubt on peripheral lesion, the ophthalmoscopic examination is often, if not constantly, negative.

The question is one, however, which still requires investigation. That pale atrophy of the optic discs may occur from purely cerebral lesions altogether apart from lesion of the optic tracts, is a fact which the experiments of Dr. Yeo and myself—to be published in detail at a future date—clearly indicate.

The mere fact of the occurrence of optic atrophy would not therefore appear to constitute a means of diagnosing cerebral from peripheral hemiopia, but we might say that a rapidly occurring and decided atrophy of the optic discs would indicate peripheral rather than cerebral hemiopia, as direct lesions of the optic tract are more likely to be propagated to the retinal expansion of the optic nerve.

As to the duration of hemiopia depending on cerebral lesion, if we might argue without qualification from the monkey to man, we might expect that it should in time clear up and disappear. But the facts relating to cerebral amblyopia in connection with lesion of the posterior segment of the internal capsule seem to show that the duration of visual

¹ 'Brit. Med. Jour.' Nov. 1877.

defects in man is much greater than in the monkey. Persistent defect in the acuity of visual perception and discrimination can be demonstrated in man, long after any defect as to mere light and shade, on which we have mainly to rely, can be recognised in the monkey's behaviour and modes of activity. It is further quite possible that the recovery from hemiopia in this animal may not amount to fine visual discrimination, though the perception of light may be sufficiently restored for ordinary modes of activity. The higher specialisation of the visual sense and important intellectual relations of binocular vision in man would lead us to believe that recovery after total destruction of the visual centres in one hemisphere would rarely if ever be absolutely perfect. The question is whether recovery to some degree at least may occur. The prognosis in cerebral hemiopia is generally held to be unfavourable. The hemiopic defect existed in Keen and Thomson's case (p. 470) eight years after the infliction of the injury to the brain.

In a case recently under my observation, however, of which the following is a condensed abstract of the notes, the symptoms as to vision were such as indicate gradual recovery from an extensive damage of the visual centres, and perhaps may throw light on certain forms of scotomata sometimes met with, the pathology of which is still obscure.

CASE III.—J. S., *ætat.* 43, admitted into the National Hospital for Paralysis and Epilepsy on March 5th, 1880. Had an apoplectic seizure, with more or less unconsciousness for several days in Aug. 1879. On regaining consciousness, found that he was paralysed as to sensation and motion on the right side, with some degree of aphasia. He observed at this time that he could only see the left half of objects.

At the time of admission he was still suffering from considerable right hemiparesis and right hemianæsthesia, both as to tactile and muscular sensibility, hearing, and taste. Smell, however, was abolished in the left nostril instead of the right as usual.

The note of the examination of the eyes simply states that right hemiopia existed, but unfortunately no exact perimetric examination was made at this date.

The perimeter taken on 23rd March (Plate III.) shows a

VOL. III.

want of symmetry in the visual fields, the right being considerably smaller than the left. At the same time there is in both a symmetrical quadrant-shaped scotoma downwards and to the right. The areas of colour-vision were found to correspond to the normal. On May 21, after two months' treatment, considerable improvement had occurred both as to motion and sensation on the right side.

The perimeter at this date shows that the visual field has become enlarged correspondingly in both eyes, the want of symmetry being retained.

The scotoma downwards and to the right still continues.

The ophthalmic appearances were negative.

The other symptoms in this case and the want of symmetry in the visual fields all indicate a cerebral origin. If we suppose, though unfortunately it cannot be demonstrated, that there was true homonymous lateral hemiopia in this case—and the patient was very positive as not having been able to see to the right either upwards or downwards at first—this might be looked upon as a partial recovery from cerebral hemiopia, and defects of this kind may be regarded as the remnants of a hemiopia at first complete. I find that a similar case in which complete recovery ensued has been recorded by Lang.¹ But the explanation of this and similar cases which most readily occurs is that the cerebral lesion has been only partial, and that, as in aphasia, the recovery is not so much the compensatory activity of the centres in the other hemisphere as the restoration, more or less complete, of the centres which have been damaged.

I have not been able to find any cases on record of hemiopia undoubtedly of cerebral origin in which the centres have been proved to be completely destroyed in one hemisphere, followed by recovery, unless we can regard the cases of latent occipital lesions as such. On referring to the recently published lectures by Mauthner,² which I have seen just before sending these pages to press, I find that he regards the prognosis of true homonymous hemiopia as almost invariably unfavourable, and that if it has existed for a few weeks a

¹ 'Centralbl. f. pr. Augenheilkunde,' July 1880.

² 'Vorträge aus dem Gesamtgeb. der Augenheilkunde,' Heft. 6-8. 1881.

restitutio ad integrum is not to be looked for as at all probable (p. 371).

He however records a case of right hemiopia (p. 365) of thirteen years' duration at the time of the first examination, which four years subsequently, i.e. therefore seventeen years after its occurrence, had recovered so far that on the right half of the fields formerly quite dark, not merely was light perceived, but a considerable amount of visual perception had returned. Colour perception remained quite abolished, however.

It is doubtful whether this was a case of true cerebral hemiopia, however, as visual defect in both fields was said to have reached quite up to the fixation point.

But it is a point worthy of future investigation, even in long-standing and apparently incurable hemiopia of cerebral origin, whether indications may not be discoverable of gradual improvement by the compensatory action of the sound visual centres, and whether this may not be fostered and stimulated.

DESCRIPTION OF PLATES.

PLATE I.—Field of Vision, R(ight) and L(ef)t, of Thomas H. (Case I., p. 459.)

The continuous line indicates the extent of the field of vision on April 24.

The dotted " " " " June 5.

PLATE II.—Field of Vision, Right and Left, of Hannah O. (Case II., p. 461.)

The continuous line indicates the extent of the field of vision on June 11.

The dotted " " " " July 30.

PLATE III.—Field of Vision, Right and Left, of James S. (Case III., p. 475.)

The continuous line indicates the extent of the field of vision on March 23.

The dotted " " " " May 21.