

The Occipital Lobe and Mental Vision. — J. Soury, *Revue Philosophique*, January, February, December, 1895; February and March, 1896.

(A) FROM RETINA TO PRIMARY SUB-CORTICAL OPTIC CENTRES.

In these articles, M. Soury summarises the literature of "mental vision" from 1890—when he gave a critical account of its facts and doctrines in *Fonctions du Cerveau* (Paris, 2 ed., 1892). He discusses "(a) the cerebral centre of mental vision, (b) the intra-cerebral nervous apparatus relative to this function, consisting of primary optic centres (external geniculate bodies, pulvinar of optic thalamus, anterior quadrigeminal tubercles), and the projection and association bundles which unite the retinal fibres to the ganglia of origin for the optic nerve, and these ganglia to the cortex of the occipital lobe." The excitability of the cortex—recent histological methods (Weigert and Pal, Golgi, Ramón y Cajal, Ehrlich, Nissl)—the overthrow of the network theory of Gerlach and Golgi—the establishment of the theory of neurons, and propagation of nerve impulses by contiguity instead of continuity—as well as the comparative and virtually antagonistic development of basal ganglia and cortex of cerebral hemispheres along the scale of vertebrates—form the subject-matter of his critical digest. The following monographs are cited as the most important among the recent publications:—Munk's *Sehsphäre und Augenbewegungen* (Berlin, 1890); Monakow's *Experimentelle u. pathologisch-anatomische Untersuchungen über die optischen Centren u. Bahnen nebst Klinischen Beiträgen zur corticalen Hemianopsie u. Alexie* (Arch. f. Psych., xxiv., 1892); Henschen's *Klinische u. anatomische Beiträge zur Pathologie des Gehirns* (Upsala, 1890-1892); *On the visual path and centre* (BRAIN, 1893); *Sur les centres optiques cérébraux* (Rev. générale d'ophtalmologie de Dor & E. Meyer, 1894); Wilbrand's papers (*infra*); Sachs on the occipital lobe, *Das Hemisphärenmark des menschlichen Grosshirns. I. Das Hinterhauptlappen* (Leipzig, 1892); Violet's *Centres cerebraux de la vision et l'appareil nerveux visuel intra-cérébral* (Paris, 1893); and the anatomo-pathological studies of Dr. and Madame Déjerine. (Other references will be found in the bibliography at the end of this abstract).

Constitution of Optic Nerve.

The optic path as a whole runs from retina to cortex, but contains two parallel systems of conductors (a) centripetal, (b)

centrifugal in direction (R. y Cajal). The former arise in the axis-cylinder prolongations of the large cells of the retina, which form the optic nerve. They arborise freely with the protoplasmic expansions of the principal groups of nerve cells in the external geniculate bodies, and pulvinar of the optic thalamus. From the intercalary cells of these ganglia other axis-cylinder processes traverse the posterior end of the internal capsule, continue as the white sagittal substance, or optic radiations of Gratiolet, and end in the nervous felt-work of the fifth (and third) layer of the occipital cortex. There a new system of neurons (*neurones associatifs*) forms connection with the other cells of the cortex, more particularly with the giant solitary cells.

The centrifugal fibres start with the axis-cylinder processes of the pyramidal cells of the cortex, and arborise with the nerve cells of the superficial grey matter of the anterior quadrigeminal tubercles; the processes from these ganglia again terminate in the nervous felt-work of the retina (Monakow, 1892). The giant solitary cells of the occipital cortex are found to atrophy after section of the posterior segment of the internal capsule. Munk also affirms that centrifugal fibres are directed from the visual area to the centres of movement for the eye.

Reflex and Voluntary Movements of the Eye.

The experiments of Munk, Fritsch, Hitzig, Ferrier, Luciani, Tamburini, Bechterew, and Schäfer are summed up as follows:—(i.) The entire visual centre of one hemisphere is related with the homonymous halves of both retinae; (ii.) the superior zone of the visual centre of one hemisphere is related with the upper part of the homonymous halves of both retinae; the inferior zone with the lower part, the intermediate zone with the intermediate part. Schäfer also noted accompanying movements of the upper eyelid and pupillar modifications. Later on he showed that after removal of both frontal lobes anterior to the sylvian fissure, and section of the corpus callosum, electrical stimulation of the cortex still resulted in associated eye movements. The centre of these movements must, therefore, be sub-cortical, and probably lies in the grey matter of the quadrigeminal tubercles.

Danillo also noted conjugate deviation of the eyes, at the fifth month, in puppies and kittens, on exciting the occipital cortex (1888). Excitation of the white matter, after removal of the cortex, produces the same at the second month; equally so

if the cortex of the anterior motor region is removed, or isolated by vertical or horizontal sections. Excitation of the white matter of the motor zone produces no movement of the eyes. From this Danillo concluded that—(i.) The occipital lobes do not comprise centres analogous to those of the motor zone; (ii.) Ferrier's hypothesis (which accounts for the movements of the eye by subjective optic sensations, due to excitation of the occipital lobe) cannot be sustained; since stimulation of the white matter provokes the same movements, both after ablation of the grey matter, and at a period when the cortex is still inexcitable; (iii.) the phenomena observed after vertical and horizontal section of the brain, or extirpation of the motor zone, indicate that the centres of conjugate deviation lie deeper than either motor region of the cortex or occipital lobe. M. Soury suggests that the electrical stimulus in these cases may act upon preformed cerebral mechanisms, replacing the physiological nervous stimulus.

Munk established similar conclusions as to the independence of the eye movements caused by excitation of the occipital lobe; and since a horizontal incision, dividing the fibres of the corona radiata of the visual sphere, invariably blocked them, it is obvious that the oculo-motor functions of the occipital lobe are in relation with the basal ganglia *via* the optic radiations of Gratiolet. The occipital lobe can, therefore, no longer be regarded as purely sensory, seeing that its excitation provokes movements of the eye, upper eyelid, and iris. In contradistinction to the oculo-motor effects of visual sensation, due to excitation of the visual sphere, Munk determines other movements, which persist after ablation of both cortical centres of vision. He distinguishes (i.) *retinal reflexes*, or contraction of the pupil to light, even after removal of the cortex; (ii.) *visual reflexes*, e.g., winking, avoidance of obstacles; (iii.) *acquired visual reflexes*, e.g., flight from a whip, &c. Excitation of the occipital lobe induces reflexes of the second order. "We know," continues Munk, "that the corona radiata of the visual sphere contains, besides the fibres of the optic nerve, whose excitation, running centripetally to the visual area, determines vision, other fibres travelling in the same radiations, of which the excitation—starting with the visual sphere and passing centrifugally to the lower, sub-cortical regions of the brain—determines movement; and that the simple movements of the eye (as well as the movements of the eyelids, &c.), resulting from vision, are effected by this path; while other movements contingent upon sight need the inter-

polation of association-bundles and other cortical elements." These movements of the eye can, therefore, only be due to centrifugal impulses from occipital lobe to sub-cortical centres, *viâ* corona radiata (Sherrington, 39). Monakow places these centres in the anterior quadrigeminal tubercles. Knies further refers the movements of convergence and accommodation, which he characterises as "voluntary," to the occipital lobe; so that its cortex is both sensory and motor. And, in fact, convergence and accommodation are affected in all cortical troubles of vision, while the inferior ("involuntary") ocular reflexes may persist.

Clinical evidence shows that lesion of the anterior quadrigeminal tubercles is not essentially injurious to vision, but that it does involve disturbance of eye-movements and of pupillar innervation (Monakow). In the lower animals, even in certain mammals, these ganglia are of main importance to vision, as compared with the external geniculate bodies and pulvinar of the thalamus. The fibres which they contribute in man to the optic tract are relatively insignificant (Monakow, Bernheimer). The *pupillar luminous reflex*, however, appears to be governed by these bodies.

Argyll Robertson was the first to show (1869) that this reflex (direct contractility to light) can be abolished; while movements of accommodation and convergence are preserved. The fibres of the optic nerve transmit the luminous stimulus which governs movements of the pupils, to the point at which originate the branches from the oculo-motor nerve that innervate the sphincter of the iris. Wernicke finds that the reflex arc between retina and oculo-motor nerve, does not extend beyond the quadrigeminal tubercles, since (i.) when the path of the pupillar fibres is interrupted behind these ganglia, the reflex arc is left intact, and the pupils give nominal reaction to light; (ii.) when it is interrupted in front of them, the pupillar reflex fails to appear. Mendel's detailed experiments point to the *ganglion habenulæ* as the precise centre of the reflex. Iridectomy seems invariably to produce atrophy of this organ. He, accordingly, defines the path of the reflex as optic nerve and ganglia of habenula on same side, thence by posterior commissure to nucleus of Gudden, and so to fibres of oculo-motor trunk. It is to be noted that the loss of the pupillar reflex occurs in fifty to sixty per cent. cases of general paralysis, in which lesion of the ventricles, more especially of the third, is a common feature. The expression of the emotions shows the same anatomical and functional independence, accord-

ing as the facial movements are reflex or voluntary in origin. In the latter, the nervous impulses travel *via* internal capsule, and the foot of the cerebral peduncle; in the former, *via* optic thalamus and tegmentum of the peduncle. The loss of the emotional involuntary reflex of the facial nerve depends upon lesion of a sub-cortical ganglion (optic thalamus, or fibres of corona radiata); voluntary movements, such as mimicry of the emotions, are inhibited by lesions of the cortical centre of the same nerve.

Functions of Cerebral Cortex in the Scale of Vertebrates.

Passing on to the deductions made by Edinger (10), and by Goltz himself (15), from the effects of Goltz's operations on the cerebrum, M. Soury denies that any luminous sensation, or perception, can exist after the cortex has been totally extirpated. He refers the facts adduced to survival of sub-cortical centres, and to reflex actions usually associated with visual sensation, but intrinsically independent of it. Such are the pupillar reflex, and the *Blendungsreflex*, cited by Goltz.

Edinger's preparations plainly show the lacuna which exists between the dog's brain and that of man, or even the monkey. In the latter, minimal destruction of the Rolandic cortex determines paresis or paralysis—impotence of voluntary movement, and troubles of sensibility; in the dog (as in lower vertebrates) loss of the cortex does not imply loss of co-ordinated movements, nor of such as are voluntary or acquired, *i.e.*, represented in the cerebral cortex. Soury further pleads that Goltz's dogs are in a state analogous to the dementia of paralysis, and are, therefore, of no account in the *pros* and *cons* of cerebral localisation. In man, he concludes, (as opposed to lower vertebrates), total destructive lesion of the cortex of both occipital lobes produces absolute cecity: man cannot see with his lower, sub-cortical optic centres.

Trophic Centres of Optic Nerves.

The direct trophic influence of the retina upon the optic nerves is well-established. In cases of anophthalmia, the optic nerves, chiasma, and fillet, are wanting, the occipital convolutions on either side being atrophied. In subterranean animals, whose visual apparatus has degenerated, the tactile sense is peculiarly responsive to luminous excitation. Dubois (7) reduces the mechanism of vision, in the last resort, to a tactile manifesta-

tion. The syphon of pholas dactylus contracts to light, its photodermic functions resembling those of the retina.

Connection of Retina with Primary Optic Centres.

The histology of the retina and visual fibres are considered under this heading, but must here be omitted. The visual acuity of the *macula lutea* is said to depend upon the delicacy with which each cone (7,000 to 7,500) transmits its excitation to a bi-polar cell, this again to one protoplasmic arborisation of the ganglionic layer. The autonomy of the macular region persists throughout the optic nerve to the cortical centres; and the preservation of central vision in the majority of cases, where (as in hemianopsia) the entire visual cortex is destroyed on one side, indicates that each macula is connected with both hemispheres. The line which separates blind half from normal half of the field is not median; it passes five to ten degrees beyond the centre, leaving the macular region intact.

The importance of the sub-cortical centres must be remembered. They are the ganglia of origin for the optic nerve—the post-house where impressions conveyed by the retinal fibres are transmitted to other couriers. The transmission of visual impressions must be considerably modified by the distribution of the retinal fibres in the basal ganglia. An axis-cylinder process may interlace with one or with several dendrites of the nervous layer, which again reacts upon the cortical distribution.

In re centrifugal fibres, M. Soury adduces, as physiological evidence of their existence in the optic nerve, the discovery of Engelmann (11) of the movements of the cones and pigment of the retina under luminous and nervous influences. The cones of the eye retract in light. In a "dark" frog, direct illumination of one eye causes the other to contract. When the brain has been destroyed, light only affects the eye directly illuminated. This functional sympathy between the two retinæ can only be explained by synergic association of the cones through the optic nerves, acting centrifugally instead of centripetally. Hence Engelmann's hypothesis of two kinds of fibres in the optic nerve—(a) sensory, centripetal, conducting luminous and chromatic sensations; (b) centrifugal, motor, or "retino-motor." Indirect excitation of the optic nerve by strychnin produces the same action on the retina. Additional evidence is contributed by Nahmacher's experiments on amphibia (1893), Gotch and Horsley's on the spinal cord (1892.)

(B) FROM PRIMARY OPTIC CENTRES TO CORTEX OF OCCIPITAL LOBE. CALCARINE REGION AND CORTICAL RETINA.

M. Soury adopts the position of Henschen in regard to the cortical centre of vision. "Le lobe occipital est le centre cérébral de la vision mentale. De la rétine aux centres primaires optiques—corps genouillé externe, pulvinar de la couche optique, tubercules quadrijumeaux antérieurs—et des centres primaires optiques à l'écorce du lobe occipital, des faisceaux de projection relient les fibres rétinienne, —nerfs optiques, chiasma, tractus,—aux ganglions d'origine des irradiations optiques, dont les fibres se terminent par des arborisations libres sur la face interne du lobe occipital, dans le territoire de la scissure calcarine, véritable rétine corticale." The visual area is much more extended than the centres for perception of sensations of light and colour; and very different theories obtain as to the functions of those regions of the occipital and parietal lobe which it comprises. The anatomoclinical method (Monakow, Henschen, Déjerine, Sachs, Vialet, Redlich) throws more light on the functions of the nerve centres than the earlier anatomical or purely experimental researches. Thus it has been shown that in cases of blindness, involving widespread degenerations, the geniculate bodies alone are in direct relation with vision. The fibres of the optic nerve which pass into the pulvinar of the thalamus, the anterior quadrigeminal tubercles, the temporal and parietal lobes, are not visual (Henschen).

Degeneration of the pulvinar does not produce hemianopsia, when the geniculate body is intact. The anterior quadrigeminal tubercles may submit to grave lesion without disturbance of vision. The optic fibres in these ganglia must be accessory to the mechanism of vision; they do not conduct luminous and chromatic impressions from retina to cortex. The pulvinar and quadrigeminal tubercles are possibly reflex optic centres—in man they probably do not contain a single visual fibre. The geniculate bodies alone are in relation with vision, and lesion of these ganglia inevitably causes hemianopsia. Certain forms of sub-cortical hemianopsia may indeed be accompanied by pulvinar lesion, but the actual cause of cecity is lesion of the external geniculate body. Destruction of this ganglion determines an almost total disappearance of the bundle of Gratiolet, through which pass the visual fibres from the ganglion. So, too, in retrograde degeneration, the partial destruction of the occipital lobe may determine atrophy of the internal capsule, yet the fibres

involved are not visual. Lesions of the occipital lobe react upon the retro-lenticular region of the internal capsule—the fibres of which end in the central grey nuclei, while the capsular fibres proper pass on into the cerebral peduncle. (Déjerine.)

Clinical application of these conclusions is not slow to follow. Pick recognises that a lesion exactly limited to the optic thalamus produces no alteration in perception of colour and form, nor any deficit in the visual field. Lesion of the external geniculate body, or optic radiations, is required to provoke these troubles. The symptoms which originate from the thalamus are quite different, *e.g.*, motor troubles of expression—imitative, involuntary, automatic, &c. In man, the anterior quadrigeminal tubercles are equally deprived of the importance which Griesinger attributed to them in vision. Recent pathological observations prove that lesions of these ganglia may develop without essential alteration of vision; they involve motor troubles of the eye, and of pupillar innervation. The optic lobe in man is no more than a reflex centre. As we have seen, it is still (without speaking of the luminous pupillar reflex) of prime importance in the transmission of centrifugal impulses (*supra*, Wernicke, Monakow, R. y Cajal).

Nor has the inferior parietal lobule, or angular gyrus, any more direct relation with vision. Ferrier's localisation of the cortical centre of distinct vision in the angular gyrus of the opposite hemisphere—Charcot's explanation of the crossed unilateral amblyopia of hysterical hemianæsthesia, by a complementary decussation of the direct bundle of optic fibres, are, therefore, of no more value than the early observations of Goltz, Ferrier, and Munk, to the effect that unilateral lesion of the visual centre in dog and monkey determines complete cecity of the opposite eye, and not partial cecity of both retinæ—a conclusion based on the theory of complete decussation in these animals.

It was reserved for Henschen¹ to point out the true analytic method. "When the visual area is removed, the fibres which conduct the luminous impressions degenerate; secondary changes also occur in the fibres which unite the visual area with other portions of the cortex and with the central ganglia." In a case of hemianopsia, *e.g.*, it is illegitimate to charge with the visual disturbance all tracts that are found degenerated. Negative must be opposed to positive cases, and the principle of elimination, as laid down by Exner, Séguin, &c.,

¹ Henschen. "Sur les centres optiques cérébraux," p. 3, Extrait de la *Rev. génér. d'Ophthalmologie*, No. 8, 1894.

must ultimately result in the discovery of one constant, invariable lesion in cecity. Henschen,¹ by careful clinical comparison, arrived at the *cas type*, and determined the inevitable lesion to be localised in the cortex of the calcarine fissure. The other lesions observed have only produced blindness, inasmuch as they involved the visual fibres of the radiation of Gratiolet on its way to the calcarine cortex. The optic centre cannot, therefore, be localised on the external surface, or convexity, of the lobe—as determined by Munk and other physiologists: such lesions as they diagnosed must have involved the optic radiations. In Henschen's words, "hemianopsia results from a lesion only when it destroys the calcarine cortex, or the optic bundle which unites the geniculate body to this part of the occipital lobe. This bundle occupies the inferior part of the radiation of Gratiolet."

In Henschen's typical case, in which the patient was an intelligent subject, not suffering from dementia, the lesion was a softening produced by thrombosis, strictly confined to the cortex, lying deep in the calcarine fissure, and not involving more than one or two mm. in depth of the subjacent white substance. The case was not complicated by any lesion of the central ganglia. Microscopic investigation only revealed a secondary degeneration in the optic radiations, in consequence of the cortical softening.

The anatomical structure of the calcarine cortex (though differing from the rest of the occipital lobe, not merely in the thickness of the molecular layer, but also in its development of horizontal fibres, forming the band of Vicq d'Azyr), is not special to the fundus of the fissure. The same band extends for several mm. along the two lips of the calcarine fissure, the superior of which belongs to the cuneate, the inferior to the lingual lobe. It is to be expected that such identity of structure in either convolution should result in identity of function. And Hun adduces a case in which atrophy of the superior lip of the calcarine fissure produced hemianopsia of the inferior quadrant of the visual field on both sides. Wilbrand shows that the lower lip corresponds with the upper visual field. There would thus appear to be projection of the retina upon the cortex of the occipital lobe, as contended by Munk, and disputed by Monakow. Henschen accepts it, and proposes the name of "calcarine retina" for that part of the cortex of this fissure at which, according to him, there is projection of the elements of the peripheral retina, *via* the visual fibres of the optic nerves, chiasma, tracts, and optic radia-

¹ Cas de Henschen-Nordensen. "Klin. u. anat. Beiträge zur Pathologie des Gehirns," II., p. 387. Obs. XL.

tions. The macular bundle, though lateral in the papilla of the optic nerve, is certainly central in the chiasma and tract. Beyond the external geniculat  body, however, Monakow's anatomical objections appear to be well-grounded. Vialet proposes a physiological shortening of the path of the visual impulses, due to association, so that a ganglion cell of the retina might always be in relation with the same cell, or group of cells, of the cortex, owing to the incessant repetition of the transmitted impressions. The central and peripheral parts of the cortical retina would lie, according to Henschen, in the anterior and posterior parts of the cortex of the calcarine fissure. Sachs, again, has a case which does not correspond with this somewhat restricted cerebral localisation of the *macula lutea*. Henschen, like Wilbrand, admits that each half of either *macula lutea* is in connection with both cerebral hemispheres, while the macular fibres also undergo partial decussation in the chiasma, and are divided into direct and crossed bundles.

The preceding observations refer to the "cerebral retina," and not to the much larger region of the "visual area," which is the anatomical substrate of mental vision. While the region on which visual impressions are projected is very limited, that corresponding with visual representations is vast, and may very likely involve the convexity of the occipital lobe and the angular gyrus. Henschen concludes that the seat of perception and of representation occupy distinct positions on the occipital and parietal lobes. Vialet distinguishes "a visual centre of perception" and "a visual centre of memory," explaining their relation by association bundles. D jerine localises the "visual centre of words" in the angular gyrus.

Nothing is certain, however, beyond the fact that there is a cortical centre of visual perception, and that its lesion entails cortical hemianopsia. As to psychological cecity there are no proofs; it is a question of interpretation. At this point, Munk's dual schema of the cortical elements of perception and representation gains general acceptance, but simply as a *pis-aller*, because no other explanation is to hand, *e.g.*, in cases where the patient suffers from verbal cecity, loss of intelligence of written signs, along with unimpaired vision of the same signs. It is thus easy to pile up distinct centres of memory for all external objects. Vialet regards it as certain that some cerebral elements gather up new perceptions, while others warehouse the visual memories. M. Soury urges, on the contrary, a more sceptical attitude until further clinical evidence shall be forthcoming.

He sums up by defining the "optic path," or system of visual fibres properly so called, as constituted by two neurons—(1) an *anterior neuron*, formed by the great ganglion cells of the retinae and their prolongations, the elements of the bundles of the optic nerve, the chiasma and optic tract, the terminal axis-cylinder ramifications, arborising in the protoplasmic branches of the cells of the external geniculate body; (2) a *posterior neuron*, formed of the cells of the external geniculate body and their prolongations, which, as fibres of the inferior portion of the optic radiations, arborise in the middle of the different layers of nerve cells in the cortex of fundus and lips of the calcarine fissure.

The Occipital Lobe.

Space forbids us to enter fully upon M. Soury's review of the comparative morphology, arterial supply, embryology, and histology of the occipital lobe. This lobe is small in man as compared with the rest of the hemisphere; in monkeys it is highly developed. On the other hand, it is in man (unlike the monkey) as highly convoluted as the rest of the cerebrum; hence the superior size of its surface, no doubt in relation with the increased number of fibres from the optic radiations which spread over the calcarine region, and effect a high elaboration of central visual impressions. The external convex surface presents no connecting gyri between the occipital and the parietal and temporal lobes. So, too, the internal surface is continuous with the temporal lobe. The external parieto-occipital fissure is very small. In microcephalous cases (= pure arrest of development — idiocy) it is extensive; while the external connecting gyri become once more pronounced, and the occipital lobe is smooth, recalling that of inferior monkeys.

M. Soury does not admit the transverse occipital sulcus to be the homologue of the "*sulcus du singe*," as held by Ecker and Rudinger. In man this sulcus divides the occipital lobe into the superior and inferior regions. Where the "*sulcus du singe*" really exists, it seems, again, to imply arrest of development.

On the internal surface the calcarine fissure appears in the first months of intra-uterine life as two branches, which subsequently unite with the parieto-occipital fissure to enclose the cuneus. (In micro-cephalics the cuneate lobe is small and smooth, while the *pes hippocampi minor* is often wanting. In

Chinese brains, the cuneus appears to be very small). The calcarine fissure above, and the collateral fissure below, enclose the lingual lobe. Between the collateral sulcus and third temporal fissure lies the fusiform lobe. The cuneus, lingual lobe, and fusiform lobule are the three convolutions of which the lesions appear to account for hemianoptic symptoms, and which many clinical authorities regard as the cortical centre of vision.

These regions of the brain are supplied by the posterior cerebral artery; in particular by its two posterior branches, the posterior temporal and occipital arteries. The latter ramifies over the calcarine fissure, and, under the name of calcarine artery, is responsible for the nutrition of the most important regions of central vision. Monakow remarks that the obliteration of this artery is especially provocative of lesion, because it induces softening of the cuneus. The occipital artery may thus be termed artery of cerebral vision, or hemianoptic artery. The obliteration of any one of its branches, in particular of the calcarine artery, induces a lesion (anatomical and functional) of the cuneus and surrounding regions, especially of the lingual lobe. In arterial thrombosis, the seat of the softening is often less extensive in the cortex than the vascular region; because there is a possibility of collateral irrigation from neighbouring vessels, since the cortical arteries are not terminal, and anastomose freely (Mendel). In the white substance and basal ganglia, on the contrary, the arteries are terminal. Monakow insists on the gravity and complexity of troubles in the visual apparatus, arising from even a restricted area of softening of the white matter of the cuneus, since this involves the destruction of projection fibres passing from the primary optic centres of the convolutions of the convexity and lingual gyrus. It is more especially in regard to vascularisation in the central nervous system that the connections of its respective parts are of such importance; for the destruction of a nerve centre by anæmic softening or hæmorrhage, or the mere slowing-down and progressive extinction of its activity by arterial obliteration (local anæmia), reacts infallibly on the regions of the brain connected with this centre. The innumerable neurons which come from all points to terminate here, whether by their collaterals or by the arborisations of their axis-cylinders, as well as the dendrites or cellular bodies of the neurons of the affected centre, undergo, in consequence of the disturbance of their normal activity, alterations in nutrition, so profound as often

to reduce to silence considerable, and sometimes distant, regions of the cerebral cortex. M. Soury queries the use of the term functional lesion (in cases where the original lesion cannot be detected on examination of the cortex); all functional alteration may, in the last resort, be reduced to a disturbance of nutrition, taking nutrition to mean the most general cause of modification in the structure and texture of the anatomical elements. He contends that the key to an interpretation of the functions of the occipital lobe—i.e., to an understanding of mental vision—lies in the anatomy of its white matter, and connections with the neighbouring regions of the parietal and temporal lobes. The anatomical and functional relations of these lobes are of the utmost importance to the study of optic aphasia, verbal cecity, and alexia. In the anatomical descriptions that follow, Sachs (36) and Violet (43) are the principal authorities quoted.

In describing the *forceps corporis callosi*, Sachs postulates the existence of at least two nerve paths. If the cortical region of distinct vision in both eyes, corresponding with the macular region of the retina, is represented in the two occipital lobes, the two cortical points of distinct vision must be commissured by the fibres passing through the forceps. Again, the right occipital lobe must be associated directly with the left temporal lobe, in order that objects seen in the right half of the visual field may evoke the corresponding auditory verbal image localised in the left temporal lobe. This path (according to Freund) must be interrupted in optic aphasia.

In the histology of the occipital lobe, Soury adopts the 6 cortical layers of Ramón y Cajal (as against Meynert's 8). These are—(1) molecular layer; (2) layer of fusiform vertical cells; (3) layer of median myeline cells, or striated band of Vicq d'Azyr; (4) middle pyramidal layer; (5) giant pyramidal layer; (6) layer of polymorphous corpuscles.

A schema of the visual path to the occipital lobe (after Monakow) again presents the idea of retina, basal ganglia, and occipital cortex as optic centres for the departure and terminus of systems of optic fibres—"systems that are highly solidarified, since disturbances of nutrition, defective lesions, react from cortex upon primary optic centres, and from these centres upon the cortex." The schema accordingly includes two sensory and two motor neurons, with the cortical association cells of the external molecular layer.

In this layer (as elsewhere in the cortex) are the giant pyramidal cells, which receive the impact of nervous commotion,

and ultimately (by the process of muscular adjustment) adapt the organism to its environment—internal to external conditions. Nervous impulses pass to these cells from (1) cells of Golgi, with short axis-cylinders; (2) association cells between the several lobules of one hemisphere; (3) cells of the opposite hemisphere *via* callosal fibres; (4) sensory (visual) cells; (5) cells of different layers of the cortex, arborising in the molecular layer.

The same molecular layer gives origin to "the motor reactions, still occasionally termed *voluntary*." M. Soury points out that this word no more explains these reactions than does *consciousness* explain the vital processes of nerve-cells that have reached a certain intensity and duration. The nervous discharge, of internal or external origin (produced by the relative intensity of one group, or several groups, of associated mental images, or from the application to some region of the cerebral cortex of mechanical, chemical, or electrical stimuli), provokes, or arrests, muscular contractions of corresponding magnitude or intensity—actions or inhibitions, according to the nature of the centres excited. In sleep, or in chloroform narcosis, the motor reaction follows fatally the nerve-paths of least resistance, most worn, most frequently traversed; and the effect thus determined is inevitable. In narcosis the reaction is certainly unconscious; it is more or less conscious in dreams; in the waking state it is altogether conscious, though it varies with the nature of the act. But this epiphenomenon, consciousness, can no more modify the arrest, or production, of phenomena of central innervation, than the shadow of the traveller alters the rhythm or direction of his steps. The impulses transmitted from the sensory neurons to the dendrites of the great pyramidal cells of the molecular layer of the cortex, are the effective incitation of voluntary movement (R. y Cajal). In physiological excitation of the cortex, the stimulus may act directly on the dendrites of the pyramidal cells, or indirectly *via* nervous fibrils from the superficial layer of the cortex. In either case the artificial stimulus of physiological experiment acts on the highest nerve centres of the brain exactly like "the will."

HEMIANOPSIA.

The characteristic symptom of lesions of the cortical centre of vision is homonymous, bilateral hemianopsia. Lesions of the right occipital lobe abolish function in the right half of each retina; the left half of the field of vision is blotted out; and *vice versa*. The sense of light or of colour may be affected. Hemidyschromatopsia (loss of perception of some colours), or hemi-

achromatopsia (loss of all colours) may precede hemianopsia in the halves of the visual field affected. In ophthalmic migraine, where the transitory disturbances (hemianopsia, cortical cecity, aphasia, anæsthesia, paresis, &c.) appear to be determined by equally transitory states of anæmia in the occipital and temporal lobes, the loss of colour-sense may precede the loss of perception of light and space. The transitory scotoma of ophthalmic hemicrania is a central disturbance (hallucinatory) from the cortical centre of vision, although the patient "sees black," a peculiarity formerly supposed to distinguish sub-cortical from cortical hemianopsia (Mauthner, Dufour).

Lesion of the internal surface of the occipital lobe inevitably produces cecity in the corresponding half of both retinae, *i.e.*, in both eyes, never a crossed, monocular cecity of the opposite eye (Wilbrand, 1881). Ferrier is, therefore, disallowed (when he accounts for crossed amblyopia by saying that if the occipital lobe is in relation with the homonymous halves of both retinae, the angular gyrus is more particularly in relation with the yellow spot of the opposite eye), and is rendered responsible for all later errors with reference to the functions of the angular gyrus, crossed amblyopia, &c., of both French and English writers. Nor was Charcot more successful in explaining the crossed cecity of hysterical hemianæsthesia. He assumed a second decussation of the direct bundles of the optic fillet (that did not cross in the chiasma), so that the optic nerve would cross over completely before entering the brain, whereby the unilateral lesion of one hemisphere would produce cecity of the opposite eye. His other theory, that in common sensory anæsthesia, the special sensory anæsthesia which is its usual concomitant in hysteria and other neuroses, as well as in certain organic affections of the brain, derives from lesion of the posterior segment of the internal capsule, is also invalidated on anatomical grounds (Bechterew).

Charcot's clinical facts (as gathered up by Féré, 12) remain for explanation. They may be summarised as follows:—

(1) The intensity of the amblyopia is always proportional to the intensity of anæsthesia in the eye; it is less pronounced when the conjunctiva alone is insensible; more pronounced when the cornea is equally anæsthetic.

(2) If the hemianæsthesia merely affects the extremities and leaves the face intact, the visual disturbance may be absent; but if the face is affected and the extremities intact, there will be amblyopia.

(3) If in hysterical hemianæsthesia, the hemianæsthesia can be suppressed, the amblyopia disappears also.

The same facts apply to the crossed amblyopia consequent on organic lesions of the brain.

Bechterew notes the relation between general anæsthesia and weakness of sight on the same side, or common and special sensory anæsthesia, and extends it even to hypnosis. Frankl-Hochwart noted that in hysteria, unaccompanied by troubles of sensibility, the visual field was usually normal, together with visual acuteness and perception of colour (which, however, might be slightly diminished). It is especially in anæsthetic hysteria that the visual field is concentrically reduced, and the perception of light and colours lowered. There is an evident relation between functional troubles of the eye and disturbances of its sensibility. Knies, in his "*Troubles centraux unilatéraux de la vision dans l'hystérie*," described the troubles that accompany general hemianæsthesia, including the eye and its annexes (cornea, conjunctiva, &c.), as a diminution of central visual acuteness, nearly always implying concentric reduction of the visual field, and alteration of chromatic sensibility; the functions of the eye being normal, and the state of the pupils variable, with no known corresponding anatomical lesion. These troubles are subject to modification by psychical influences. The chief objection to a cerebral origin of such unilateral troubles is anatomical. Above the chiasma, no lesion of conductors or optic centres is known that can determine unilateral visual troubles. Hence the long acceptance of Charcot's posterior chiasma. Knies offers a new hypothesis: the proximate cause of these unilateral troubles of vision in hysteria is to be localised in the peripheral optic apparatus; the effective cause is central—*viz.*, a cerebral disturbance of vascular innervation.

All brain activity is accompanied by vaso-motor processes, which are vaso-constrictive in nature. The ablation of a cerebral hemisphere is followed *inter alia* by hemilateral paralysis of the cervical sympathetic. In hysteria the loss of the vaso-constrictive action, exercised normally by the centrifugal nerve impulses of the cortex, determines vaso-dilatation of certain peripheral regions. The calibre of the vessels enlarges, and since this occurs at the *foramen opticum*, the nerves undergo mechanical compression. This is translated into disturbance or transitory abolition of condition, and of the function of the sensory organ connected. Such compression of the myeline of a nerve may produce abolition of its conductivity without destroying the axis-cylinder. When the vascular dilatation ceases, the effect, *i.e.*, the functional trouble, disappears also. Hysteria would, therefore, according to Knies,

be "a disturbance of vaso-motor innervation, of cerebral origin." Many other hysterical symptoms can be explained from the same cause, as well as hypnosis, suggestion, sleep.

Bechterew concluded that amblyopia depends upon anæsthesia of the ocular capsule. Section of the sensory or ascending root of the trigeminal (which induces anæsthesia to touch and pain in half the face and head, with amblyopia of the anæsthetic side, and diminution of sensibility in other sense organs on the same side), proved that amblyopia can be induced by lesion of a sensory nerve, of which the roots are distributed to the face, and more especially to the ocular capsule. In other organs, too, diminution of function is related with anæsthesia of the surface. This is the explanation of amblyopia, and sensory anæsthesia in general, in cases of unilateral anæsthesia of the face and sense-organs of cerebral origin—at least, in cases of lesion of the cortex and posterior third of the internal capsule, provided the special conductors to the sense-organs (optic nerve, acoustic nerve, &c.), and their cortical and sub-cortical centres, are not affected.

The detrimental influence of facial anæsthesia on the sense-organs arises from troubles of nutrition. The nutrition of any organ is imperfect unless the sensory and motor nerves distributed to it, and especially the vaso-motor nerves, are in a normal state.

Any interference, central or peripheral, produces the same effect. Duval and Laborde proved that lesion of the ascending root of the trigeminal affects nutrition in the eye; Lannegrace shows that cerebral lesion produces a similar disturbance. All interference with nutrition in a peripheral sense-organ is translated into a corresponding functional alteration, *i.e.*, alteration of sensation; and Bechterew refers such disturbances of nutrition to inadequate arterial irrigation. Hence the capital importance of the state of the vaso-motor system to the interpretation of amblyopia, and of sensory anæsthesia in general, in sensory hemi-anæsthesia.

The acuteness of perception, far from diminishing, may be augmented, if the afflux of blood is considerable in the organs of the special senses, or in surfaces of the skin and mucosæ serving for the perception of tactile, painful, or other excitations. We know that contraction of the vessels from cold diminishes the perception of cutaneous excitation to the point of anæsthesia, while it rises to hyperæsthesia under the action of causes which dilate the vessels (heat, sinapism, &c.). Sensations of cold, absence of sweat, analgesia, defective hæmorrhage after profound pricks in

hysteria, are, like anæsthesia, explained by the diminution of the finest arterial vessels of the surface of the skin. The reality of this vascular spasm in hysterical hemianæsthesia is attested by the loss of heat on the insensitive side of the body, by the greater resistance offered to the electrical current, &c. In artificial anæsthesia, centrally provoked, the cutaneous regions rendered insensitive are lower in temperature than the surrounding regions.

Anæsthesia of the skin and mucosæ produces retinal anæsthesia, amblyopia of the eye on the corresponding side, by depressing the nutrition of the anatomical elements which receive external stimuli of luminous or chromatic sensations, and this solely in virtue of vaso-motor troubles, caused by inadequate irrigation of the peripheral organ of vision. Bechterew's theory¹ (which is extended to other sense organs) explains the crossed amblyopia of symptomatic hemianæsthesia in certain neuroses, or organic affections of the brain, without implicating the optic conductors, primary optic centres, or calcarine region of the occipital lobe. Disturbance of vaso-motor innervation, anæmia of the peripheral organ of vision (in consequence of cutaneous anæsthesia extending to this organ, as to other sense organs), is the cause of sensory anæsthesia, and it is superfluous to invoke either Charcot's "*carrefour sensitif*," or the equally erroneous hypothesis of a complementary decussation of the direct bundles of the optic fillets, behind or within the quadrigeminal tubercles.

Central hemianopsia is never monocular. Monocular hemianopsia, temporal or nasal, may result from lesion due to compression of the internal or external sides of the visual fibres of the optic nerve, previous to their partial decussation in the chiasma. This lesion involves the pupillar fibres, and the pupil of the corresponding eye reacts feebly or not at all to direct illumination, while it reacts synergically to illumination of the other non-affected eye, since the reflex paths are intact on the side of the uninjured nerve, as well as the centrifugal path from the reflex centres to the iris of the affected eye—this is the consensual reaction of both pupils. The pupillar fibres, which originate in the retinae, are distinct from the visual fibres in the optic nerve and chiasma, while they are not to be found in the occipital optic radiations. It is a moot point whether they pass into the optic tract. The pupillar reflex to light persists in

¹ Bechterew. "Ueb. die Wechsel-beziehung zwischen der gewöhnlichen u. sensoriellen Anästhesie (Functiionsabnahme der Sinnesorgane) auf Grund klinischer u. experimenteller Daten." *Neurol. Centralbl.*, 1894.

total, or cortical, cecity, *i.e.*, double or bilateral hemianopsia, due to lesions of both occipital lobes. Henschen finds pupillar fibres in the optic tract up to the level of the external geniculate body, which they do not enter; the hemiopic pupillar reaction is not therefore provoked by lesion of the external geniculate body. Bechterew, on the other hand, holds that the pupillar fibres diverge from the tractus as early as the chiasma, to enter the wall of the third ventricle.¹ The crossed cecity determined in birds by the destruction of one of the optic lobes, leaves intact the contractility to light of the pupil of the blind eye. Before entering the optic lobes with the visual fibres, the pupillar fibres, therefore, divide off from the tractus, and go directly to the region of the nuclei of the 3rd nerve. Bechterew found that both pupils reacted to light after section of the optic tract, in mammals. In man, he affirms the persistence of the pupillar luminous reflex in cases of cecity due to destruction of the quadrigeminal tubercles by compression from a tumour of the pineal gland. In general paralysis and tabes, the pupil may have lost the luminous reflex, while preserving the reflexes of accommodation and convergence, neither vision nor movements of the eye having undergone any alteration. The pupillar fibres have thus from a certain point a separate path from the visual fibres, from which they are throughout absolutely distinct. Darkschewitsch and Mendel, Edinger, Bechterew, Flechsig, Bogrow, have as many theories as to this path. Nothing seems certain except that two bundles of fibres pass from the optic tracts to the central grey matter of the third ventricle, and may be in relation with the nuclei of the ocular-motor nerve.

Wernicke's hemiopic pupillar reaction comes under the category of hemianopsia. Pick gives the reflex arc of the luminous pupillar reflex as composed of a *reflex centre* (no doubt localised in nuclei of ocular-motor nerve), and a *centripetal path* (optic nerve, chiasma, tract, quadrigeminal tubercles, and nuclei of the 3rd pair). If the pupillar fibres, which effect the luminous reflex of the pupil, are simultaneously attacked on the homonymous sides of both retinæ, by lesion of the visual fibres of the optic tract, and the two anæsthetic halves of the retinæ are illuminated (avoiding diffusion of light), the pupils will not contract; if the light falls on the sensitive halves of the retinæ, the pupillar reflex comes off. This is the hemiopic pupillar reaction.

¹ *Ib.* "Ueb. Pupillenverengernde Fasern." *Neurol. Centralbl.*, 1894, p. 802.

By compressing the chiasma at different points it is possible to produce *bi-temporal hemianopsia*—loss of function in the crossed optic bundle; *nasal hemianopsia*—lesion of the external or direct bundle; *superior and inferior hemianopsia*—compression above or below. Atrophy of the visual fibres by compression of the chiasma may also result from internal hydrocephalus.

Pierre Gratiolet, in 1854, discovered the central origin of the optic nerve. Meynert accepted his conclusions. Wernicke worked them out *in extenso*. Panizza, 1855, also pointed out that the bundles of fibres issuing from the posterior cerebral convolutions contributed to form the optic nerve, but he was less acute in his observations than Gratiolet; and Gudden, Luciani, Tamburini, all showed that the decussation of the optic nerves is only partial. Goltz admitted, in 1876, that each cerebral hemisphere was related with both eyes in the dog. He argued, however, that the visual disturbance consequent on operation was hemiamblyopia, or cerebral weakening of vision, and not hemianopsia. Munk was slow to admit bilateral disturbances of vision from lesions of the occipital lobe. He long held that the dog differed in this respect from the monkey, though eventually he established the relations of either hemisphere with both retinæ in birds as well as mammals. Vitzow, Gudden, Ganser, followed in the same lines. Monakow (31) really determined the nature and conditions of bilateral homonymous hemianopsia. He showed by experiment that ablation of a cortical centre (Munk's visual sphere) reacted on the development of fibres and primary nervous centres connected with it, by the functional inactivity which it involved. His facts support the anatomical conclusions already quoted. The extension he gives to the region of cerebral vision in which lesions produce hemianopsia, is a reaction against the doctrines of Séguin, Nothnagel, and Henschen. The delimitation of this region is still, however, far from certain; as also the relation of the different parts of the occipital lobe to the various retinal segments. Monakow emphasises the importance of the primary optic centres interposed upon the optic path, such as the external geniculate body (in which the majority of the visual fibres terminate and lose their individuality). This fact is too often overlooked in schemata, which are constructed as if the projection bundles radiating over the visual sphere were the direct prolongation of the optic fillets.

This has important bearings upon the doctrine of retinal projection (*supra*). The anatomical conclusion appears to be that not the retinal fibres, but the fibres of the external geni-

culate body, are projected upon the occipital lobe. Monakow disallows the direct localised projection of impressions from the *macula lutea* on the cortex, his theory being that the macular fibres are distributed to all parts of the external geniculate body, and thus transmit their impressions to every part of the cortical centre. This would account for the partial preservation of central, or macular, vision in most cases of cortical hemianopsia.

Monakow's theory of the reciprocal relations, functional and trophic, that obtain between primary optic centres and occipital cortex is based upon secondary ascending and descending degenerations. These differ, histologically, and in their general physiological effects, according as the visual lesion is central or peripheral. After enucleation of the eye-ball in the dog, the ascending degenerations are sclerosis of the optic nerve, almost complete degeneration of the optic tract, slight diminution of volume in the motor nerve to muscles of the eye (oculo-motor, pathetic, external oculo-motor), general reduction of number of nerve cells, especially in the nucleus of the common oculo-motor. In dogs, cats, and man, the anterior quadrigeminal tubercles are little degenerated, while the external geniculate bodies are considerably atrophied—showing that most of the retinal fibres are closely connected with this body.

The same ascending atrophy was noted by Tomaszewski in the case of a child who became blind and deaf at the age of two, in consequence of meningitis. The ocular bulb atrophied from inflammation, and when the child died at the age of eight, the optic nerves, chiasma, tract, quadrigeminal tubercles, occipital lobe, angular gyrus, &c., were all atrophied.

Retrograde Degeneration.

Along with Wallerian degeneration, which attacks the peripheral end of a nerve separated from its trophic centre, there exists a retrograde degeneration, a "cellulipetal" alteration of the central end, propagated from the point of section to the trophic centre, *i.e.*, mother-cell of the nerve; and even in certain cases passing this centre to invade secondarily the following neuron. Marinesco (27) has observed a degeneration, varying in degree, in the central end of the peripheral nerves of amputated limbs. This involves the myeline and axis-cylinder, and determines in places a complete atrophy of the nerves, with proliferation of the interstitial tissue. Anatomically there is no essential difference between this process and that of Wallerian

degeneration at the peripheral end: it appears later, and advances more slowly; it is more rapid in young children than in adults.

Why do the nerves of the stump, and even cells in the anterior cornu, degenerate after amputation, seeing they are still in relation with their trophic centres, the spinal ganglia? The trophic centres themselves must suffer from the lesions of their nervous processes; the protoplasmic and axis-cylinder prolongations of a nerve-cell, with their terminal arborisations and collateral branches, are as much part of the cell as the limbs are part of the body of an individual; unity of the cell and its axis-cylinder is complete—a neuron is an individual. Golgi, Forel, Monakow, v. Gehuchten agree that lesion to any part of the neuron must bring about, first, the rapid destruction of that part of the nerve; and then the slower, but inevitable, death of the central portion of the neuron. The inter-annular segments of the nerves ("adipose cells traversed by the axis-cylinder of the nerve cell," Durante) may constitute proper sources of nutrition, rendering the nerve, in some measure, independent of the parent cell. We do not, indeed, know whether the nerve derives its sustenance directly from the cell, or whether it borrows from local exchanges along its course, the nerve cell merely regulating the processes of assimilation. Undoubtedly, the nerve is subject to local influences from its environment, *e.g.*, effect of chemical agents in circulation. Renaut (Lyon) strongly urges the local reaction of a nerve independent of the ganglion cell. At the same time, the axis-cylinder must always be regarded as an integral part of the parent cell.

Marinesco refers the trophic functions of the nerve-cell, and their ability to nourish and preserve the structure of the neuron, to the continuity of peripheral excitations (thus reconciling functional inactivity and trophic influence in the neuron; Türk, Bouchard). The effects of interference of nutrition after amputation may extend to the cells of the anterior cornu, and thence to the motor nerves and the muscles supplied by them (*atrophie musculaire dégénérative*). Cerebral muscular atrophy may also be referred to interruption of functional excitation, and the hypothesis of a special cerebral trophic centre eliminated.

Retrograde degeneration is found along the sensory path of the optic nerve, as in the spinal nerves. Lesions of the occipital lobe, or external geniculate body, induce retrograde or cellulipetal degeneration in the neurons of the optic path, which may extend

as far as the tract and optic nerve, although each such neuron has its trophic centre in its own mother-cell. The external geniculate body and pulvinar degenerate after lesion of the visual area, *i.e.*, have no autonomous visual activity, or reflex activity—such as attaches to the optic lobes of birds; and Monakow believes that each segment of the thalamus is in exact functional and trophic relation with its own section of the cortex. The characteristics of cellulipetal degeneration are a more or less pronounced atrophy of the myeline, followed by its total disappearance, which leaves the axis-cylinders bare, till they, too, perish. Turning to clinical evidence, Moeli has shown that in adults, affections of the occipital lobe determine descending lesions that may be followed into the nerve cells of the retina. He cites two cases of foetal degeneration (porencephalia, internal hydrocephalia), due to lesion of the occipital lobe; the degeneration extended beyond the chiasma to the optic nerves. So, too, in another case: atheromatous softening of both occipital lobes in a man of 44, induced retrograde atrophy of the visual fibres and sub-cortical ganglia down to the optic nerve. Wilbrand, Henschen, and others found similar evidence for secondary descending degeneration. Nor does this stop at the optic nerve. The trophic disturbance of the basal ganglia affects the terminal arborisations of the opticus, and the descending alteration proceeds to the ganglion cells of the deep layers of the retina, and thence even to the rods and cones—the cellular prolongations in all cases being first to disappear.

M. Soury concludes from all these facts relating to the cortical localisation of bilateral, homonymous hemianopsia, that Ferrier is mistaken, and Munk correct, in their respective views concerning the cerebral centre of vision. Munk attributes the transitory hemianopsia, consequent on the extirpation of the angular gyrus, to the inflammatory reaction of the occipital lobe, and more especially to the compression (not destructive lesion) of the optic radiations of Gratiolet and Wernicke, which pass under the angular gyrus and inferior parietal lobe on their way to the cortex from the external geniculate bodies. It is thus that all lesions of the angular gyrus, &c., usually reach the projection bundle of the visual fibres. Should this be destroyed, and the message thus interrupted from the last sub-cortical station to the occipital cortex, nothing can avert absolute cortical, hemianopic blindness in the two halves of the retina implicated. Séguin (38), Forel, Nothnagel concur in locating the seat of vision, the optic field of perception, in the cuneus and first occipital gyrus. Unilateral lesion of these parts

produces hemianopsia, bilateral lesion produces total blindness.

HEMIOPIC HOMONYMOUS HALLUCINATIONS.

Tamburini defines hallucinations as a kind of epilepsy of the sensory centres. Visual hallucinations in the obliterated half of the field of vision may often be observed in hemianopsia of cortical origin. This is an extra phenomenon, super-added on the destructive lesion that produces partial cecity in both eyes, and due to an irritative lesion of the occipital cortex. Irritative processes resulting in hallucinations are frequently the precursor of destructive occipital lesions. Such visual hallucinations may even serve to determine the precise point of the cerebral cortex that is the seat of the lesion, *i.e.*, the hallucinatory alterations in the field of vision may be projected back upon the corresponding region of the "cortical retina." Soury does not accept the restriction of this irritative lesion to the calcarine surface of the occipital lobe (Lamy, *cf.*). He holds that the associations adequate to realise complex hallucinations must extend over much wider regions, probably over the convexity of the occipital lobe. He queries the possibility of unilateral hallucinations, and holds that just as a unilateral destructive lesion of the occipital lobe determines a homonymous bilateral hemianopsia, which produces partial cecity in both corresponding halves of the visual field, so a unilateral irritative lesion of the same region must determine a bilateral homonymous hallucination, which partially affects the visual fields of both eyes. Clinical evidence is quoted from Peterson, Colman, Hun, and Pick.

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- (1) *Beitrag zum Studium der Medulla Oblongata, &c.* VON RAMÓN Y CAJAL. Translated by JOH. BRESLER, Leipzig, 1896.
- (2) *Untersuchungen über die topographischen Beziehungen zwischen Retina, Opticus und gekreuztem Tractus Opticus beim Kaninchen.* PICK & HERRENHEISER, Halle, 1895.

(1) This is a *brochure* of about 140 pages, giving in a readable form the work of R. y Cajal upon the minute anatomy of the medulla oblongata, the pons Varolii, cerebellum, and origin of the cranial nerves. There is little to note that is not by now well known to most workers upon the anatomy and physiology of this region—facts which are gradually finding their way into the text-books, and which have already done much to explain many of the curious phenomena brought out by disease. The book is well illustrated, and there is an ample bibliography at the end.

(2) This is the record of an experimental research, performed with a view to trace the several bundles of fibres which constitute the optic nerve, optic chiasma and optic tract. A wound was made in the retina by means of a galvano-caustic needle, the operator being guided by the aid of the ophthalmoscope. After a limited time the animals were killed, and the nerves examined by the Marchi method. The following is a summary of the results: The fibres maintain the same relative position throughout the optic nerve and tract. In the chiasma, the decussation takes place in a regular order, the innermost bundles of the nerve crossing first, and occupying an outer position in the tract, the lower bundles of the nerve occupying the lower part of the tract, and the outer bundles occupying the inner part.

It is probable (although there was a technical difficulty in the operation) that the uppermost bundles occupy the upper part of the tract. The decussation of the fibres is only in a transverse direction, there being no alteration of the fibres in a vertical direction. The several segments of the nerve correspond in general to like segments of the retina.

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