OCULAR DISTURBANCES IN ENCEPHALITIS LETHARGICA.

P. J. WAARDENBURG, M.D.

ARNHEM, HOLLAND.

In reporting two cases seen by himself the author compares them with the cases that have already been published in Holland and reviews the accounts given of this disease in other countries. The general symptoms are considered and then the ocular conditions, motor, visual, and pupillary are each taken up in detail.

Among the many epidemics which during the last few years ravaged the old and the new world, many cases of *lethargic encephalitis* were published. (In Australia and Austria in 1917, in England and France in 1917-1918, in America in 1919). In Holland 15 cases were published in 1919 and 1920, to which I can add two new cases. Tho the diagnosis could not be made from the presence of any constant syndrome of clinical symptoms, to many investigators, the ocular symptoms have proven so helpful in fixing the diagnosis that they were estimated to be the most important; and especially because this disease is characterized not only by the frequency of the well known isolated or combined nervous paralysis, which we meet in other infectious and nervous diseases, but because supranuclear disturbances of the fibres or centres of associated movement, often preceding the other symptoms, were noted.

Nonne assigned an independent place to this illness, in contrast with three other diseases which gave differential diagnostic difficulties: (a) *nona* in which bulbar symptoms were absent; (b) premature paralysis agitans which proceeds more slowly and without inclination to sleep, (c) bulbar paralysis, in which changes of the ocular muscles and pupillary changes were absent. Moreover there are many other affections with which this encephalitis can be confused, but these can be safely dismissed here. Nonne called this illness epidemic bulbar myelitis and encephalitis of the *crura cerebri*. He gives account of the following details.

The affected persons, who either shortly before suffered from influenza, or not, or whose associates had suffered from it, or not, and who neither had had tuberculosis, lues, nervous diseases or psychoses, and who did not use alcohol or narcotics to excess rather quickly contracted encephalitis without many general symptoms. This encephalitis pro-

gresses more or less gravely, or shows an abortive form, and cannot be recognized to be an inflammation by examination of the cerebrospinal fluid. This has not proved true. There have been found in some cases, high pressure, leucocytosis, poikilocytosis, and the postile reaction of Nonne. In the blood can occur a slight leucocytosis.

Most cases heal entirely, but in a few cases there remain permanent disturbances of the cerebral nerves, and among them the most important is the reflex and absolute fixity of the pupil. Hence the Argyll-Robertson phenomenon can not be considered pathognomic for syphilis. There also often remain athetoid and choreic movements in the limbs, and physical and mental weakness. Death followed in the minority of cases. I found the following figures: in France there was mortality in 33% (Netter), in England 25%, in Austria 45% (bad condition of nutrition?), in America 10% of the clinical cases.

Nonne further draws our attention to the extrapyramidal disturbances of motion. The members of the body take a passive attitude, there is a general rigidity in the muscles, there is mimical stiffness, now and then there are tremors in different muscles and rhythmic contractions of the muscles of mouth and cheek. The reflexes are normal. The vesical function may be insufficient. There may be apathy or changes of disposition. Often there is no fever. Sleepiness is the cardinal symptom. About the paralysis of the cerebral nerves, I will speak in connection with the discussion of the cases published in Holland.

In 1920 Economo has described a new epidemic with toxic, tabetic and poliomyelitic symptoms. Pathologic-anatomic investigations have shown that the symptoms are due to nonpurulent poliomyelitis with hemorrhages and degenerative processes in the great basal ganglia, especially in the thalamus opti-

cus and the midbrain (corpora quadrigemina, aquaeductus sylvii, floor of the 4th ventricle); also now and then small cell infiltration of the leptomeninges and pial septa of the spinal cord, (von Economo, Stern, Oberndorfer, Nonne).

The virus is not known. Grampositive diplostreptococci were found by von Economo, von Wiesner and Stern, and a filterable virus by Loewe and Strauss, (very small cocci). Bacteriologic studies of the blood had no result. Various investigators, as Nonne and Netter, have drawn our attention to the fact that this encephalitis is characterized by the motor apparatus of the eyeball only being disturbed, externally as well as internally. Bollack states there is no impairment of visual acuity or fields, or of the sensibility of the cornea and conjunctiva. The last has not proven true. Nonne describes absence of the corneal reflex and hypesthetic skin and mucous membrane, also affections of the motor part of the fifth nerve. Three Dutch authors, van Wyke, Bosman and Hacke, also mention affections of the fifth nerve, in contrast with Bartels, who did not find them. It is my opinion that the first part of the utterance of Bollack too must be revised, and likewise Bartels' opinion that the negative findings of the pupil are of differential diagnostic importance.

I acquired this conviction because I observed a case with bilateral ring scotoma, which started at the blind spot and was doubtless not functional. In examining the literature, I found that this discovery is new. But it is incorrect to think that other investigators found the optic nerve always healthy. Von Economo and Bartels once found a slight retrobulbar neuritis, and once a beginning optic atrophy. The latter author describes a temporary paracentral scotoma—so this case shows resemblance to mine; and another time contraction of the visual field for green. Oberndorfer saw once in 8 cases a slight optic neuritis; and Hiram Woods and Shumway saw the same, each once in six cases (the patient of Shumway died afterward).

In consulting the Dutch literature it struck me, that just there so many ocular affections were mentioned; in adding my case to the observations of Henkelom, Cramer and Hacke, I find them 10 times

in 17 cases. It is true that the described symptoms: $V=1/60$, slight paleness, slight edematous swelling of the papilla, slight venous hyperemia of the background, are not of such importance that they may give rise to far-reaching conclusions; but undoubtedly they plead more for than against the meaning, that the optic nerve can also be affected in lethargic encephalitis. I think that the somnolence of the patients often prevented the investigators taking good visual fields.

My patient's history is the following:

CASE 1. D. W. M. age 23 years, consulted me April 26, 1920 with the following ocular symptoms: anisocoria, the left pupil (5 mm.) is wider than the right, (3 mm.) and shows neither a direct nor a consensual light reaction, nor a narrowing on converging. The right eye only shows a very slight direct and consensual pupillary reaction. The temporal part of the papilla is paler than that of the left eye. The accommodation is paralyzed on both sides and the patient cannot look downward. V. R. 4/18; L. 4/18, Hyperopia 1 D. and 1.25 D. Vision after correction R. 4/12; L. 4/8.

The man had been sick for some days, he had perspired abundantly, had had pains in arms and legs; he gave an impression of somnolence and had mimical stiffness. In the course of the first week it appears that the patient is sleepy and dull, tho he can be talked to. His voice is monotonous and low (bulbar paralysis). He is unable to wrinkle his forehead. He does not vomit and has no headache. He has a tremor of his head and hands, and rise of temperature that remained till his departure after 6 weeks, and fluctuated between 37.2 and 38. (in the evening generally between 37.6 and 38). This made the neurologist, Dr. Drossaers, and myself think of a disturbance of the center of heat regulation in the thalamus. Moreover a precise examination of the eyes showed a very slight ptosis and a very slight paresis of the recti externi, with a paresis of the convergence.

On April 29th the direct light reaction of the right eye was also very slight, but the following day was restored somewhat. After May 3d he could again wrinkle his forehead. On May 6th there

was again a consensual and direct light reaction in the left eye; whereas the reaction of convergence which was present on the right side remained indistinct on the left side. Gradually speech improved. He opened his mouth somewhat obliquely (paresis of the right pterygoid). Difficult movement of the oral and nasal muscles, chiefly on the left side. Lying on the floor the patient could raise his eyebrows, standing he could not do so.

The lumbar fluid contained 11 cells per mm. (Fuchs-Rosenthal method.) Later on Dr. Reinders Folmer found 8 per mm. The reactions of Nonne and Wassermann

weeks, as well on the perimetric arc as on Bjerrum's screen at different distances, and always found the typical ring scotomas on congruent places. The peripheral contraction diminished a little gradually; the ring scotomas remained. The patient went away with a slight improvement of the accommodation, the pupillary reactions and the downward movement of both eyes.

CASE 2. Y. G. R., aged 42, came January 26, 1920 with complaint of diplopia and the letters growing dim when reading (paresis of accommodation). His visual acuity of each eye with C+0.5, cy.=5/6. He had esophoria and

Fig. 1.—Fields of vision in Case 1 showing peripheral contraction, and ring scotoma thru the blind spot, in each eye.

were negative. The sediment contained no tubercle bacilli, and agar and ascites cultures did not germinate. In the first week the patient was too dull to allow his visual fields to be mapped out. After 2 weeks I found a concentric contraction of the periphery on both sides, (Fig. 1, Case 1.) on the left side of a wing shaped enlargement of the blind spot, and on the right side a ring scotoma, taking its origin from the blind spot, which also was enlarged in the horizontal direction. Everywhere it was between 10° and 20° away from the center, and had a breadth from 2° to 5° . After a few days I noticed that also the left eye showed a ring scotoma about the same shape. In order to exclude as well as possible the presence of a functional symptom, I determined these scotomas four times in the course of the following

the next day convergent squint. Moreover he was sleepy and dull, had mimical stiffness, slight ptosis on both sides, and unequal pupils, which showed no light reactions. The width of the right pupil was 3 mm. that of the left one 4 mm. On January 28th, he had a divergent squint with a paresis of the convergence, (Fig. 2, Case 2) and a slight insufficiency in moving his eyes downward. In attempting the latter he got vertical nystagmus.

He remained from February 3 until March 11 in clinical observation. Almost during the whole month of February, he showed a rise of temperature, fluctuating between 36.0° and 37.9° , rarely 38.0° , in the second half of February it fluctuated between 36.8° and 37.5° . In March the fluctuations had still narrower amplitude. In the first weeks the pulse changed be-

temporal

masa

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Fig. 2.—Fields of fixation in Case II showing paresis of convergence.

tween 110 and 95, diminished somewhat with the temperature but remained too frequent. Such was also the case with the respiration. From time to time the patient was short of breath and oppressed. He slept very much during the first 10 days, sometimes waking with a start by day. His mind was clear. No difficulty in urinating, no disturbances of the reflexes. Slight general hypertonia of the muscles. In the beginning he lay on his back for hours in an apparently passive attitude. Low monotonous voice, rigid smile, trembling mouth corners. On both sides a light facial paresis. When after 3 weeks the patient again tried to

tical tremulations were seen. The left pupil was still somewhat wider than the right one; the direct and consensual light reactions were feebly present, the reaction of convergence was absent. Moderate contraction of the left visual field. Normal blind spots.

December 14, 1920. The best proof of there being a persistent paresis of the convergence was that an advancement of the left rectus internus which I performed in July, 1920, to try to deliver the man from his spectacles of opaque glass and restore his binocular vision, at least for the distance, had only a temporary success. The left eye gradually deviated,

Fig. 3.—Fields of vision in Case II showing slight concentric contraction.

walk, he had to do this very carefully. At the end of January the convergence reaction of both pupils disappeared also, (absolute rigidity). The visual fields were moderately concentrically contracted. (Fig. 3, Case 2.)

The patient went home with a manifest divergent squint of inconstant amount. He worked again with a ground glass before one eye. The paresis of accommodation disappeared rather quickly. On June 25th, the patient was again sleepy. He had still a divergent squint, but temporarily could bring both eyes to the median line when fixing a near object. Soon after the left eye wandered outward. In looking downward, which he was able to do again, the divergence diminished. In looking upward it increased. The visual fields were normal, only shifted over each other in a horizontal direction. In looking upward ver-

so the situation in December was about the same as in June. The left internal rectus showed little nystagmus on looking extremely to the right. The pupillary reaction of convergence was entirely absent. Looking downward was accompanied with slight vertical movements. Fibrillar trembling in the right orbicularis. Accommodation normal. Pupils of equal size. (3 mm.) In February the situation was the same as Dec. 20.

COMMENT.

It is interesting to discuss these two observations in connection with the other Dutch cases published in the *Nederlandische Tydschrift voor Geeneskunde* in 1919, (Beck, v. Wyke, Liegebeek, v. Henkelom, Bosman and van der Tak) and in 1920 (Cramer, Hacke, Krusinga). Altogether 15 cases, of which 8 were described by Hacke. It is not easy to give a general review of the Dutch

cases. As the syndrome often is not very characteristic, many cases will not be recognized. It is also very probable that many cases were not published. Wolff says in a report that in 3 weeks he saw 4 cases; Cramer says that in 1918 and in 1919 he has also treated these cases, and that in 1920 he had heard of new ones. I know that in Arnhem the diagnosis has been made by others besides me. The following symptoms have been observed in Holland:

GENERAL SYMPTOMS. As a rule the illness began acutely with the well-known general symptoms. In 2 cases only the inclination to sleepiness or dullness was absent (van der Tak; case 2 of Hacke.) Sleeplessness twice preceded the lethargic state, and among the symptoms of irritation, we notice psychic disturbances as anxiety, depression, hallucination, delirium, aggressive attitude, etc. In 3 cases there was no fever. Acceleration of the pulse existed in half of the cases. Frequently the urine contained albumin, and sometimes uroblin. Irregularities in urinating, retention as well as incontinence, were described 8 times. Two persons suffered from excessive perspiration. Where the reaction of Wassermann was done, it was negative.

There were no meningeal symptoms. Stiffness of the neck was not found at all, and only Cramer observed Kernig's symptom in a slight degree. Dermographia has often been seen. In 7 cases a lumbar puncture was made. The fluid was clear and stood under normal pressure. The reaction of Nonne was slightly positive in the case of van Wyke, and in 4 cases of Hacke. A slight pleocytosis was found 3 times. Once (Henkelom) the blood showed a slight leucocytosis, and once (van Wyke) the bacillus of van Hoogenhuyze could be cultivated from it, as is the case of influenza. In general the illness proceeded favorably, healing slowly or quickly. Twice death followed (Beck, Cramer). A pathologic anatomic examination of Cramer's case showed no macroscopic changes. A connection with influenza could not clearly be determined. Only 2 patients (Beck, Henkelom) had suffered from it half a year before. In 3 other cases the illness started like influenza, a

few weeks earlier, and one woman's husband had had it.

SENSORY SYMPTOMS. Initial pains were found either in the back of the head (3 times) or in the abdomen and thigh (2 times, Hacke); others suffered from paresthesia (5 cases, one with strong itching) hypesthesia or hyperesthesia either in the region of the trigeminus or of the neck, trunk and limbs, one of a very constant nature (Kruisinga). Weakness or absence of the reflexes of the abdomen were found sporadically, sometimes the tendinous reflexes were more or less strong, and a positive reflex of Babinski has been temporarily present in the case of Leigenbeek, and an inclination to this was described in the first case of Hacke. Sometimes ataxic disturbances were mentioned as temporary phenomenon; Romberg's symptom was twice positive (Bosman, Kruisinga).

MOTOR SYMPTOMS. In the Dutch cases motor disturbances come to the front: (14 times in 17 cases). 5 times hyper-tonia is mentioned, while tremors and convulsions, choreic and fibrillary in lips, hands, feet, arms, legs, muscles of the trunk, very different in strength, are mentioned 12 times; 5 times the patient walked uncertainly and very carefully.

DISEASES OF CEREBRAL NERVES. We did not often meet with symptoms of bulbar paralysis. Once there was salivation (Cramer). Once the patient had great difficulty in swallowing (Bosman). Once the tongue could, only with difficulty, be presented, and twice the patient had a low monotonous voice. Auditory and vestibular disturbances are not described. Six times the facial nerve was affected, mostly in a slight degree; 6 times the patient had a mask-like face. Twice there were slight motor differences between different parts of the face. Twice a unilateral, once a bilateral paresis. As we saw above there occurred 5 times an affection of the trigeminus, twice the corneal reflex was absent, 3 times the motor part also was disturbed.

OCULAR SYMPTOMS have also been seen in Holland, altho not so as to dominate the condition. In 8 cases ptosis occurred, it was more or less fugacious. In my two cases the ptosis was of such a slight degree that it impressed me as be-

ing the result of a change of the tonus, a parallelism can be drawn between this and the mask-likeness of the face, neither of which was the result of a real paresis.

Diplopia has been stated 8 times, 4 times combined with ptosis. In the case of Bosman it lasted only one day. Paresis could not always be determined. Van Wyke's patient alternately had crossed and homonymous diplopia. Thrice a slight convergent squint was noted (Beck, Hacke, Kruisinga and my second case in the beginning.) Kruisinga's patient suffered from a paresis of the abducens on the left side. The patient of Liégebeek van Henkelom had a divergent squint with paralysis and paresis of the superior recti, and probably also of the trochlears (de Haas). Temporarily, only the outward movement of the eye was present; in Cramer's case the patient had great difficulty in keeping the eyes in an extreme position, and in the 5th case of Hacke rotatory nystagmus developed, when looking to the left or to the right.

In comparing my own cases with the others published in Holland it struck me that mine showed many interesting symptoms which made them resemble none of foreign publication. Paralysis of the accommodation and convergence and anisocoria are missed in all Dutch communications. Liégebeek van Henkelom alone says that the left pupil of his patient showed less reaction than the right. And Hacke tells us that the left pupil of his first patient reacted little to light and convergence.

The most important symptoms which I found in my cases are: ocular diseases, paresis of accommodation and convergence, long lasting anisocoria, temporary rigidity of the pupil and disturbances of the associated ocular movements. The latter is also reported by Liégebeek van Henkelom only (paresis in looking upward). Before ending this article I will make some remarks on these interesting phenomena.

VISUAL DISTURBANCES. In my cases the defects of vision are due to retrobulbar neuritis. Tho it is true that some cases of hemianopsia have been published, viz. Burrard and Greenfield, the regular form of the rings pleads against the improbable hypothesis that these rings should be interpreted as the acci-

dental combination of bilateral hemianopic defects of a peculiar shape. Intraocular diseases and reflex disturbances of blood circulation to the intermedial part of the choroid or the ciliary vessels can be excluded. Moreover ring scotomas have been discussed in multiple sclerosis. (Uhthoff, Wilbrand, Sängner); in hereditary neuritis, (Wilbrand, Sängner); in lues, (Igersheimer, Marx); in retrobulbar neuritis (von Graefe), and have been made very probable in affections of the optic nerve arising from various clinical causes (Gjessing, Morgan, MacWhinnie, Russ, Woods, Haus). In some of the latter cases functional disturbances could not quite be excluded. I will draw the attention to two facts: 1. That in these illnesses the ring scotomas were not always isolated, but often connected with central scotomas or enlargement of the blind spot. 2. That the ring scotomas often had inconstant and capricious shapes.

Besides the above mentioned diseases and in glaucoma, ring scotomas have also been found by von Szily and Löhlein in papilledema. There also they had irregular shapes and developed gradually.

I have had the opportunity to find ring scotomas in several cases of glaucoma. They are broadest on the side opposite to the blind spot. As a rule there are here two half rings which are displaced from each other at the raphe of the retina. I found a more regular form of the rings not only in the above mentioned case, but also in two other persons. The first time in a young man of 21 years who had optic neuritis, nonluetic. Rhinologic examination was negative. When his neuritis improved under a treatment of KI, Hg. and sweating, the inflammation of the papilla gradually changed into atrophy of the upper third to fourth segment of the papilla, indirect image, which continued in a narrow white annular rim round the papillas. In a second case, a girl of 15 years, I had the left ethmoidal sinus opened, notwithstanding the negative rhinologic findings, and the ring scotomas showed a tendency to disappear. I found half rings in the front of Bjerrum's scotoma besides in glaucoma, also once in optic neuritis, once in neuroretinitis aluminurica.

Tho we have the right to conclude from the existence of ring scotomas that there is a retrobulbar neuritis, this does not imply that in accepting this we can quite explain the ring scotoma. In the visual field they lie between the central and peripheral parts of the retina, but that is no reason why they should be due to ring shaped fibres in the optic nerve. The above mentioned case of the young man with the segmental atrophy of the papilla and the observations in glaucoma, where there remains a free space between the paracentral scotomas and the peripheral scotomas, is significant. It would lead me too far to go deeper into this matter, or into the, as yet undecided, question whether the fibres situated in the axis of the optic nerve go to the periphery of the retina (Leber, Bunge, Fuchs, Van der Hoeve), or to the central parts of it (Passow, Uhthoff, Wilbrand-Sänger, Igersheimer, Seidel).

PARESIS OF ACCOMMODATION. Lethargic encephalitis is distinguished by strong polymorphism. While Cords says that paresis of accommodation belongs to the less frequent symptoms, Bollack tells us that it is the chief characteristic, as he found it in 90% of the cases (18 in 20) 5 times it was complete, 13 times it was a paresis. He adds that it may last for months. Bartels quite agrees with this, he reckons it among the prodromal symptoms and found it in 72% of his cases (8 in 11) perhaps even in 100%. Paresis of accommodation may also be found in syphilis, botulism, and diphtheria. In botulism it may be accompanied by a total paralysis of the sphincter, which is absent in diphtheria. This is important with a view to the differential diagnosis.

In Holland we found paresis of accommodation only in my cases, (this is 11%, namely 2 in 17). This is remarkable, 15 patients being younger than 40 years, so presbyopia cannot be the cause of this paresis not being noticed.

PARESIS OF CONVERGENCE. My cases are the only ones in Holland, in which paresis of convergence was mentioned, so this makes 11% (2 in 17). In my first case there was a paresis, in my second case the paresis developed into paralysis. The pupillary reaction in convergence was absent on the left side of one patient, and on both sides of the other

patient. Bollack found it in 35% (7 in 20). Bartels has discussed paresis of convergence where the nervous impulse was unable to give a pupillary reaction. In his other cases the pupillary reaction was parallel to the degree of possibility of convergence. Cords presented 3 cases of paresis of convergence, in which twice the pupillary reaction was absent, tho the accommodation was normal. In one of these cases there was a temporary rigidity of convergence, while light reaction was present. When converging was again possible, the pupillary reaction also returned.

From my second case we learn that the fibre tracts for accommodation are separated from those for convergence, but that the latter are closely connected with those for the pupillary convergence reaction. The observations of Cords, Bartels and myself are interesting, because Bielschowsky tells us that normal convergence pupillary reactions exist in patients who are able to accommodate but cannot converge. My second observation is not in accord with this opinion of Bielschowsky. So there seems to result from the observations in lethargic encephalitis that a closer connection exists between the impulses for convergence and narrowing of the pupil than between the latter and the impulse for accommodation.

In my second case the paresis of the convergence had been preceded by an irritation of the convergence. Such an irritation of the convergence I also took for granted in a third patient (Fig. 4, Case 3). A man of 29 years suffered from the following symptoms: dullness, slight ptosis, mimical stiffness, and acute homonymous diplopia with convergent squint and normal looking fields.

ANISOCORIA. As the anisocoria which I found is one of the cardinal symptoms, it seems strange that it was not mentioned in the other Dutch publications. (Bollack found it in 70%, 14 in 20 cases.) The following possibilities exist. Either both pupils are wider than normal, or they are narrower than normal, and that in a different degree in both cases. One of the pupils is wider or one of the pupils is narrower than normal. It is remarkable that nowhere

in the literature are wide pupils mentioned. From this we must conclude that a complete paralysis of the sphincter did not occur.

Notwithstanding the dilatation of the pupil was only slight or quite absent, disturbances of the *pupillary reflexes* have been noticed, a few times also in the Dutch literature (see the above mentioned). The abnormal pupillary reactions seem to be of a transient and variable nature in contrast with the disturbances of accommodation. It was like this in my first case, and there exists no parallelism between them. A total rigidity of both pupils is very rare, but a total rigidity of one pupil also does not occur very often. There generally is a slow reaction, or a reaction with a slight amplitude. Bollack never found the symptom of Argyll-Robertson, which I observed during a few days in my second patient. The fact that my two patients also showed a total rigidity of the pupils is interesting too, especially in my second patient who had it in both eyes.

In order to explain the fact that the pupillary reflexes can be absent without the pupil being wide, Bartels accepts an irritation of the nuclei of the sphincter, because he noticed twice a contraction of the pupil during an attack of encephalitis, as sometimes occurs in meningitis. In this way he also explains the absence of dilatation in the dark. Tho this would explain the often short duration of the pupillary symptoms, too many difficulties are connected with it. In my opinion the pupil is, in most cases, not narrow enough to prevent further contraction; in cases of sympathetic paralysis the narrow pupil still reacts very well. Moreover it is difficult to accept a chronic spasm from the nuclei in those cases where the stiffness of the pupils remains for years. I do not agree with Cords when he says that an absolute rigidity of the pupils points to a damage of the nuclei of the sphincter, for this cannot explain that in his first case the width of the pupil was only $3\frac{1}{2}$ to $4\frac{1}{2}$ mm. On the other hand we are not compelled to accept a hypertonic or contracted sphincter, because it is not narrower than normal. Moreover in lethargic encephalitis we do not meet with a prolonged irritation of other nuclear

regions, i.e., spasm of accommodation, etc.

I think we can explain it in the following way: because the nuclei of the sphincter must be small, the hypothesis is not hazardous, that all supranuclear reflex paths which attain this nucleus from about the same direction, must lie very close together in some place. Now if we accept a partial or total destruction of these paths, whether or not accompanied by a slight irritation or paresis of the sphincter nucleus, then many facts can be explained in a plausible way, i.e., the long duration of the condition, the restoration in a different sequence, the different combinations of symptoms, etc. Thus a normal reaction of convergence can be combined with an isolated paralysis of accommodation, and the other combinations above mentioned. That there should be no reaction in the dark gives no difficulty, because it is more probable that the wideness of the pupil in the dark is owing to diminishing of tonus of the sphincter, rather than to active irritation of the dilatator. My second case in which the internal recti functioned well separately, but converging was impossible, points to a supranuclear disease, just as the other cases of plain paralysis of the convergence. Cords' hypothesis is that a recovering sphincter nucleus should first react on the stronger impulse of light, and then on the weaker impulse of convergence. But accommodation is not of great value in my opinion, because we do not know if this sequence is found in all cases.

PARESIS OF THE ASSOCIATED MOVEMENTS. We reckon among the associated movements of the eyes the movements of the bulbs in lateral, upward and downward directions. These, too, are often disturbed in encephalitis lethargica. This is combined with a total or partial contraction of the homonymous part of the field of fixation. It is noteworthy that in this disease the ocular paralysis in the vertical direction, which is very rare in general, predominates over the horizontal. Bollack found 4 times a disturbance of the upward direction, thrice of the downward direction, twice of both movements together, twice of the bilateral horizontal direction, once of a unilateral horizontal

Fig. 4.—Fields of fixation showing irritation of convergence in Case 111. (See p. 587.)

movement. Neither Bartels nor Cords ever saw a paralysis of the lateral motion. Cords gives no numbers, but he especially draws attention to the paralyzes of the downward motion, which according to Uhthoff and Bielschowsky are as a rule very extraordinary. Bartels saw a paralysis of the upward as well as of the downward motion, without a noticeable preponderance of the latter.

So both my cases with paralysis and paresis of the downward motion are an illustration of what others have found also. The existence of a supranuclear vertical paralysis of vertical motion seems to me more difficult to prove, however, than that of a supranuclear lateral paralysis. For the former may just as well be due to a bilateral nuclear or an infranuclear affection. In my cases the disturbances of the fixation showed an inclination to get well, they did not, however, last such a short time as Bartels describes. One of my patients showed a nystagmus in the vertical direction, especially in looking downward, but also somewhat in looking upward. Nystagmoid convulsions have been mentioned in many publications and reports. They may be understood as belonging to the "nystagme saccadée," as a result of the struggle between the consciously directing impulse of the will and the impulses that draw unconsciously toward a deviating direction. Similar symptoms are found in latent nystagmus. According to Bollack the nystagmoid movements which can be induced artificially by moving the head, or of the visual fields, occur in three ways: either simultaneously with a paresis, or during the restoration of a paresis, or even without paresis. In the latter case it is a sign of a disturbance of the associated movements as it is in disseminated sclerosis. Bollack found it 8 times in a horizontal, 6 times in a vertical and 2 times in both directions.

Whether symptoms of vestibular nystagmus occur in lethargic encephalitis is somewhat difficult to decide. Bartels, as well as Bollack, thinks this is the case. Bollack has examined 7 patients and has found 5 times a dis-

turbance of the caloric nystagmus, and once of rotatory nystagmus. From that he concludes that there is a disturbance of the vestibular nuclei, or of the connective fibres between them and the nuclei of the oculomotors, or the tonic centers of the conjugated movements.

LOCALIZATION OF NUCLEI AND FIBRES.

It was hoped that the study of lethargic encephalitis would help us in the localization of the tracts, fibres and nuclei. Yet we have not gotten much farther than the hypothesis. The paralysis of convergence which has been observed speaks for the existence of a center of convergence, which is placed by Bartels and Edinger in the median nucleus of the oculomotors which consists of great cells. Bernheimer held this to be the nucleus of accommodation. The most frequent combination of paralysis of the ocular muscles is ptosis and a disturbance of accommodation. This is why Bartels accepts that these nuclei must lie close together. Cords and Bartels also surmise the center of the levator and the supranuclear fibres or center of fixation to lie close together, by reason of combined paralysis of both. Until now a disturbance of the upward and of the downward fixation has only been accepted in the rare diseases of the corpora quadrigemina. Spiller (*Handb. d. Neurol.* 7, 2, p. 735) has found an affection of the corpora quadrigemina near the aqueduct in 19 out of 20 cases of vertical paralysis of downward fixation. An isolated disturbance of the downward fixation has not been discussed in these cases. The supposition that disturbances of the upward fixation should be due to a disease of the posterior corpora has not been justified by experiments on animals. The disturbances of the lateral fixation, which only Bollack has observed, must be ascribed to an affection of the fasciculus longitudinalis posterior.

It seems to me that these investigations have as yet not given many results, and even are unable to give them, firstly because of the diffuse extension of the processes, secondly because we possibly make a mistake by

localizing the frequent combinations of paralyses close together. We should not forget that besides the oculomotors, the facial, which lies at a great distance is often attacked. In order to explain all the other symptoms also we must accept foci to lie more dispersed rather than to be in continuous connection. Just as in diphtheria, botulism and other diseases, we must accept an eclectic action of the virus for definite cerebral parts. The nucleus of the trochlearis which lies close to that of the oculomotor often seems to be saved. The diagnosis of such a case being, however, very difficult, it may be sometimes overlooked. Often the nucleus of the abducens is affected without giving rise to disturbance of the lateral fixation. This justifies Marburg's opinion against that of Bing.

I cannot judge whether the frequent paralysis of the facial is a paralysis of the nucleus or whether it is owing to a damage of the superficial knee of the facial. It is very remarkable that the isolated paralysis of the muscles provided by the oculomotor were scarcely ever total (Bartels, Bollack), but either a paresis or a muscular asthenopia. In my opinion this is also the case in ptosis and in paralysis of the facialis. It might be asked whether among these there are also motor dis-

turbances of the same nature as the extrapyramidal ones. I do not agree with Bartels when he supposes only the nuclei to be attacked, and the cerebrospinal fluid only being the source of infection and this for the following reasons:

1. Cases are known of hemiplegia and hemianopsia.

2. Bollack found disturbances of the lateral fixation (fasciculus longitudinalis posterior).

3. It is not certain that there really exist supranuclear centers for the associated movements and the convergence.

4. The diseases of the optic nerve can be well explained only by defects of fibres.

5. Bilateral isolated paralyses or the ocular muscles occur without affections of the nucleus (Meyerhof's case of hemorrhagic encephalitis with bilateral paralysis of the abducens).

6. The long lasting disturbances of the pupillary reflexes without strong dilatation of the pupil plead more for affection of the reflex tracts than for a spasm in the nuclei.

7. The pathologic anatomic researches showed diffuse processes, generally perivascular, so that besides an infection via the cerebrospinal fluid, there also must be accepted an infection via the blood circulation.

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