CONTRIBUTION TO THE STUDY OF BITEMPORAL HEMIOPIA.

By H. M. TRAQUAIR,
Assistant Ophthalmic Surgeon, Royal Infirmary, Edinburgh.

That bitemporal hemiopia may develop in connection with a scotoma near the centre of the field has been known for many years, though until recently little attention has been directed towards this point, the great majority of reports merely stating the presence of the hemiopia, without giving details as to its nature.

In this form—scotomatous type—a blind area appears near the centre of the temporal field together with some peripheral contraction, usually commencing in the upper outer quadrant. By combined development of both defects the temporal field becomes lost. Early loss of direct vision is characteristic of the scotomatous type. In the other, or non-scotomatous type, peripheral contraction alone occurs, and direct vision may remain good for a long time.

It is desirable to distinguish these two types and to ascertain whether, and to what extent, each has a special clinical significance.

In order to demonstrate the presence of hemiopia and its nature, a series of test-objects of different sizes, both white and coloured, must be used, and the central part of the field—within the 30° circle—must be carefully examined by Bjerrum’s method.\(^1\)\(^2\) It is essential that the size of the test object should be stated, and this is most conveniently done by using its diameter in millimeters as the numerator of a fraction the denominator of which is the radius of the perimeter or distance of the patient from Bjerrum’s screen. In the present investigation the sizes varied from \(\frac{1}{200}\) to \(\frac{40}{200}\), blue, red, and green being used in addition to white.

As the loss of function varies in intensity in different parts of the defective area of the field, it is only in this way that an adequate analysis of the nature of the condition can be obtained as well as results which are capable of comparison.

**Case I.**—J. W., aged 31, came to the Eye Wards in the Royal Infirmary under the charge of Dr. Mackay in April 1912, complaining of bad sight. She has well-marked, though not extreme, acromegaly. Symptoms began to appear four years ago, loss of vision being the first noticed by the patient. The sella turcica is enlarged.

5th April 1912.—RV = \(\frac{6}{6}\); optic disc pale. LV = \(\frac{6}{12}\); disc normal.
The pupil reactions show some failure of light conduction on right side.

Fields of Vision (Fig. 1).—The fields for white, both \( \frac{5}{30} \) and \( \frac{1}{30} \), are practically unaffected excepting as regards the scotoma in the right field. For red there is complete bitemporal hemiopia for \( \frac{10}{30} \); for \( \frac{20}{30} \) there are islands in the temporal field also. The fields are thus symmetrical, except for the unilaterality of the scotoma, and they are vertically split.

9th April.—A test with blue \( \frac{10}{30} \) showed the presence of a scotoma in the left eye similar to that on the right, and also that the temporal island was joined to the nasal field below.

19th April.—Fields by Bjerrum’s screen at 2000 mm. (Fig. 2).—
(1) There is complete bitemporal hemiopia for a small white object.
(2) There are symmetrical scotomata.
(3) The scotoma on the right
The Study of Bitemporal Hemiopia

side is encroaching on the nasal field. (4) The lower temporal quadrant is still nearly intact in the left eye. In the right it is in the form of a hook-shaped process, which shows signs of failure below, leading to the formation of a temporal island.

**Fig. 3.**

1st to 5th June (Fig. 3).—The conditions are now sufficiently developed to be demonstrable with a small white test on the ordinary perimeter. The fields for \( \frac{5}{3^0} \) white show indentation above and below. Those for \( \frac{1}{3^0} \) white show the first stage of the splitting off of the temporal island in the left and complete separation in the right. A small central scotoma for \( \frac{5}{3^0} \) white is now present in the left field, while the right nasal field for \( \frac{1}{3^0} \) white is failing centrally and peripherally in its lower quadrant. Note especially the central loss of the lower nasal quadrant for green \( \frac{2}{3^0} \) on the right side. This test was still very dimly recognised on the temporal side in both fields.
The fields continued to develop along these lines, that of the right eye leading. On 10th June RV = $\frac{6}{50}$, doubtfully; LV = $\frac{6}{12}$, doubtfully.

21st June.—Fields (Fig. 4).—Note condition advancing as shown by white $\frac{1}{3}$ 0/5. The fields for green $\frac{2}{5} 0/5$ are a little smaller, and the upper nasal quadrant of the right field is now deficient centrally.

On 12th July the patient went home.

18th August.—She returned ill, and barely able to get out of bed for examination. A fortnight before she had had a severe headache. The right eye had turned completely outwards and had remained in this position for three days, then returning to its normal position. At that time it had been totally blind, but she could now see a little light with it.

RV = hand movements close to face. Almost no direct pupillary reaction to light, but good consensual. Optic disc pale. LV = $\frac{5}{10}$ nearly. No consensual, but good direct reaction to light. Disc normal. The left external rectus muscle is paralysed.

The field of the left eye only was charted. The same general type as in Fig. 4 was present, but much larger objects were required to mark its limits. Thus $\frac{4}{5} 0/0$ white gave a field resembling Fig. 4 L.E. $\frac{1}{3} 0/0$, and $\frac{5}{3} 0/0$ white a field resembling that for $\frac{1}{3} 0/0$ in Fig. 4.

RE. $\frac{3}{3} 0/0$ white gave a nasal field only, deficient in its lower quadrant, and $\frac{5}{3} 0/0$ red gave a small nasal field with central deficiency. There was therefore a general raising of the threshold of perception, or lowering of conductivity of the nerve fibres, with approximate retention of the same limits, as if a veil had been thrown over the whole field.

In the right eye it was only possible to ascertain that vision was hardly so depressed peripherally as centrally, and was still present on the temporal side.

13th November.—The patient is now very much better in every way, and looks almost a different person. The illness of August continued for three weeks, and then her health gradually improved until the middle of October, when she felt quite well. Headache still occurs occasionally, but not so severely as before.

REV = counting fingers—in temporal field only. Optic disc pale; vessels small. Pupil reacts sluggishly to light from the front, but quite well if the light is directed on to the nasal half of the retina. LEV = $\frac{6}{5}$ all but one letter. Disc normal; pupil reacts well; muscles normal. The vision of this eye is therefore better than ever since the first examination. The fields show a surprising change. That of the left eye resembles Fig. 3 L.E, though the upper outer quadrant defect for $\frac{1}{3} 0/0$ white is more extensive peripherally and less so centrally, where it ceases at $3^\circ$ from the fixation point, which is, however, divided by a test with red $\frac{2}{3} 0/5$.

By Bjerrum’s method the presence of the lower outer quadrant for $\frac{1}{10} 0/0$ white was established, complete hemiopia existing for $\frac{2}{2} 0/0$ green.
The Study of Bitemporal Hemiopia

There was no trace of the scotoma previously present.

The right field shows now absolute nasal hemiopia, with some loss of the mesial portion of the temporal field, which resembles in shape the temporal island for \( \frac{1}{3} \) white shown in Fig. 4, RE, but less defective centrally. The condition has therefore changed to nasal hemiopia of the right side, with an upper outer quadrant loss of the left side.

26th April 1913.—The patient is regularly at work, free from headache, and feeling well. Vision and pupillary reactions practically as in November.

The fields of vision (Fig. 5) show the same features as in November, but further improvement has occurred. The defect is now very slight for white on the left side, and the field for red is greatly enlarged, giving a quadrant loss for \( \frac{1}{3} \). The temporal field of the right eye is enlarged and shows an island for \( \frac{1}{3} \) red. The improvement in the central area is noticeable, as this part had been blind for six months.

Here the causal condition was evidently a pituitary swelling producing pronounced ocular symptoms and acromegaly, and the case falls therefore into the first division of Cushing's classification, in which both glandular and neighbourhood symptoms are prominent. In this class of case acromegaly is relatively rare and hypopituitarism more common, the great majority of acromegalics having only slight visual defects, while these are more marked in cases of hypopituitarism, which also more often show other indications of intracranial disturbance, such as optic neuritis or paralysis of external ocular muscles. The explanation depends upon the fact that a more actively growing tumour is usually associated
with hypopituitarism.\(^3\)\(^4\)\(^5\) Where, then, a tumour is producing bitemporal hemiopia, the presence of the scotomatous type may be taken as an indication of relatively active growth.

Features of interest in the clinical history are:—(1) The stage of gradual progress, with headache and steady increase in the visual defects. (2) The stage of severe illness with nerve implication (left sixth, right third) and great increase in the loss of sight, especially on the right side. There was evidently considerable intracranial disturbance at this time. (3) The stage of recovery, with alteration in the field defect, which became a modified left homonymous hemiopia.

It may be suggested that in the first stage the swelling was tensely pent up in the sella turcica, the surrounding parts being congested and oedematous. In the second stage the tumour may have burst forth and emerged on the right side of the chiasma so as to affect mainly the right uncrossed bundle, next the crossed fibres of the right eye, and least severely the crossed fibres of the left eye, the uncrossed fibres of the latter eye remaining intact. Or possibly the chiasma might have become compressed against the right carotid artery, though this seems less likely.

The subsequent improvement may be partly ascribed to the disappearance of the congestion and oedema subsequent to the displaced structures mutually accommodating themselves to some extent, but undoubtedly to a cessation of the growth of the swelling or even a diminution in its size—suggesting the bursting of a cyst.

In this connection the possibility of the future development of hypopituitarism deserves consideration, and the progress of the case is being watched with interest.

**Case II.**—6th August 1912.—Mrs. S., aged 30, had had a bad headache two weeks previously. Then her sight became dim. With the exception of occasional “bilious attacks” she seemed quite healthy. There were hypermetropia and astigmatism in each eye. After correction \(RV = \frac{6}{4} ; LV = \frac{6}{5}\). There was nothing of note on the pupils or optic disc.

7th August.—The fields of vision were examined by Bjerrum’s method, and symmetrical loss of the upper outer quadrants was found with a scotoma in each eye between the fixation point and the blind spot. The scotoma was larger and denser in the left eye.

9th August.—\(RV = \) counting figures at 3 metres, \(LV = \frac{6}{5}\).

Fields of vision (Fig. 6).—Note the similarity in type with Case I. (Figs. 3 and 4), especially in the right eye.
Acute suppuration of the right maxillary antrum, with signs of pus in the right middle meatus, was found by Dr. Fraser. The antrum was washed out, and next day the scotoma in the right eye was much smaller and the field somewhat enlarged.

10th and 11th August.—Fields of vision (Fig. 7).—Note especially in the right field the scotoma for \( \frac{5}{300} \) white occupying the apex of the upper outer quadrant. The apex of the lower outer quadrant responds faintly to this test; that of the lower inner quadrant well to a 5 mm. object, but not to a 1 mm. Red \( \frac{10}{300} \) is faintly seen in the temporal island and in the lower nasal quadrant, brightly in the upper nasal quadrant. In the left field red \( \frac{10}{300} \) is well seen in both nasal quadrants, less well in the lower outer quadrant, and dimly in the upper outer quadrant, especially near the vertical meridian. In the scotoma in this
field the part below the horizontal meridian was less dense than that above it. The intensity of the changes in the fields varied much from day to day, although the peripheral boundaries for \( \frac{5}{300} \) white were never severely affected.

12th August.—The scotoma in the right eye is nearly as big as in Fig. 6. For \( \frac{1}{300} \) white only the upper nasal quadrant and the temporal island, somewhat reduced, remain. The left field, however, is improved. Vision in both eyes much as on 9th.

Fig. 8, A, shows the field of the right eye by Bjerrum’s method. Compare with Case I. (Fig. 2). The upper part of the scotoma (coloured black) was blind to \( \frac{6}{2000} \) white, the remainder to \( \frac{6}{2000} \). The progressive diminution of vision is well shown, the field for \( \frac{1}{2000} \) white being represented by a small portion of the upper inner quadrant.

X-ray examination made at this time by Dr. Porter proved negative.

It was now proposed to explore the sphenoidal sinuses. The patient, however, refused operation, became hysterical after returning home, and went to bed for a fortnight.

24th August.—The condition was now much improved. RV = counting figures at 3 metres directly and \( \frac{6}{60} \) excentrically, LV = \( \frac{6}{36} \). Both optic discs now showed definite pallor. The fields showed practically no lesion for white. The left eye showed a temporal hemiopic scotoma for red \( \frac{10}{300} \), the right a similar condition, but more pronounced and affecting the apex of the lower nasal quadrant also (see Fig. 8, B). For green \( \frac{10}{300} \) the right field showed complete temporal hemiopia.

11th September.—\( V = \frac{6}{18} \) in each eye. Partial optic atrophy in each eye. Fields for white practically normal. Fig. 8, B, shows the field of the right eye. Note the scotoma for red \( \frac{10}{300} \) opening to periphery.
The Study of Bitemporal Hemiopia

upwards and affecting the apices of three quadrants. The improvement continued, and when last seen in February 1913 vision was \( \frac{6}{12} \), and by Bjerrum's method relative bitemporal hemiopia could still be detected, with a small scotoma just to the outer side of the fixation point in the right field. There is still post-nasal discharge, but the bilious attacks are less frequent.

This case apparently depended upon some inflammatory condition of the nasal sinuses, probably the sphenoidal, although this was not proved. Similar field changes have been reported by Grönholm, and Albrand's case may have been of this nature. It occurred after influenza, and the fields were of the type under consideration.

The rapid variation in the size and intensity of the scotoma is noteworthy. This is in accordance with the observations of others on scotoma of post-nasal origin. For a time blue vision was present, followed by yellow vision during recovery.

In the two cases the same general type and development of the visual defects occurred. The scotomata broke through to the periphery first upwards along the temporal side of the middle line and then downwards in the same position, the periphery dipping in to meet these extensions as they developed. Thus in the first stage the temporal field consisted of a hook-shaped or uncinate area extending from the lower quadrant of the nasal field outwards and upwards outside and over the blind spot. After separation from the lower nasal quadrant this area formed a vertically oblong temporal island, slightly obliquely disposed, outside the blind spot and mainly occupying the lower temporal quadrant. This island then became diminished, at first from above, then from below also, the part just below the horizontal meridian remaining last.

Before the changes in the temporal field became fully developed, failure of the lower nasal quadrant began to appear along its mesial border, while its apex began to be encroached upon in the same direction by the scotoma. The loss thus occurs from above down in the temporal field, from below up in the nasal field, and progresses round the fixation point clockwise in the right field and counter-clockwise in the left. In this respect the scotoma behaves in the same way as the general field.

The retention of normal peripheral boundaries for \( \frac{5}{60} \) white in the presence of well-marked changes for colour and small white objects indicates the active nature of the process, and also the necessity for the use of several tests, while the recovery of areas which had been quite blind for as long as five or six months, as in
Case I., shows that even total abrogation of function for a considerable period by no means indicates destruction of the nerve fibres. These points have also been noted by other observers.

By using test objects of different sizes the scotoma may be shown to be composed of areas, separated by vertical and horizontal straight lines intersecting at the fixation point, and thus corresponding to the apices of the affected quadrants, in which the defect diminishes in the same order as it does in the quadrants of the field as a whole. This feature seems to distinguish this form of scotoma from others, such as that of tobacco amblyopia, which may offer a superficial resemblance.

It is noteworthy that, after the papillomacular bundle, the fibres first affected are those terminating near the vertical meridian in juxtaposition to the unaffected uncrossed fibres. These fibres fail all along the nasal side of the meridian before those passing to more internal parts of the nasal retina are severely affected.

The regular sequence of the defect is in accordance with recorded charts, which frequently show survival of the upper inner quadrants to the last, though I have not found this point specifically referred to by any author. That the scotoma should behave in the same way is to be expected in view of the observations of Wilbrand and Rönne, and others. Until these observations have been confirmed and extended it would be premature to attempt any definite explanation of these points, which may, however, in the future be of some use in elucidating the anatomical and pathological problems of the subject.

The Non-scotomatous type of bitemporal hemiopia was present in the following cases:

**CASE III.**—Miss A. H., aged 33, has had acromegaly since she was about 20. The general appearance of the disease is very well marked. Her present complaint is difficulty in reading and sewing. The vision is nearly in each eye after correction for hypermetropia and astigmatism. Both optic discs are slightly pale, the left rather more than the right.

In 1906 bitemporal hemiopia had been observed, vision being at that time.

11th November 1912, Field of Vision (Fig. 9*).—Note the absence of implication of the macular region. While the hemiopia is only present for colour, the fields for white show considerable affection, that is to say, the discrepancy between the white and the colour fields

* In this and the following figure the upper outer areas enclosed by a thin line are areas in which functional response to the test employed was nearly, but not absolutely, absent.
The Study of Bitemporal Hemiopia

is less marked. In neither eye could a complete lower outer quadrant loss be found for even the smallest coloured objects, and these results were confirmed by Bjerrum’s method. These features indicate a stationary or very slowly progressing lesion.

**Case IV.**—Miss B., aged 54, gave a history of enlargement of the feet and hands for two years. Her features presented the usual signs of acromegaly, but only to a slight degree. The sella turcica is a little enlarged and deepened.

Her present complaint is pains in the legs. She was referred by Dr. Gulland to Dr. Sym, who kindly allowed me to test her fields. Vision was nearly \( \frac{5}{6} \) in each eye after correction for astigmatism.

**Fields of Vision (Fig. 10), 24th November 1912.**—The fields are slightly indented above over the upper outer quadrants. By Bjerrum’s method the outer part of each upper outer quadrant was found to
respond very doubtfully to $\frac{2}{2000}$ white (the areas are shown enclosed by thin lines), while with $\frac{1}{2000}$ blue hemiopic fields were found. On another occasion Dr. Sym found a definite temporal hemiopia in the left eye with $\frac{10}{1000}$ red.

Case V.—11th June 1912. Miss C. R., aged 34. This patient presents the appearances of acromegaly to a moderate degree. The sella turcica is enlarged and deepened. She complains of having had headaches for two or three years. She has had haemorrhoids for eight years. Menstruation is stated to be regular.

RV = $\frac{5}{3}$, LV with $-0.75$ D.Sph. = $\frac{5}{3}$. The optic discs are slightly hyperemic.

Fields of Vision, 19th June 1912 (Fig. 11).—There is nothing of importance in the fields for $\frac{5}{300}$ and $\frac{1}{300}$ white; that for $\frac{10}{300}$ red in the right eye shows a definite indentation. The fields for $\frac{1}{2000}$ white show definite signs of upper outer quadrant loss, also that for $\frac{1}{2000}$ green in the right eye. No test showed definite loss in the lower outer quadrants.

Case VI.—An elderly lady of about 60 years, whose fields I was enabled to examine through the kindness of Mr. Berry. She had had headaches and had noticed the visible signs of acromegaly in 1898, and in 1900 consulted a physician, who told her that the condition at that time had already existed for some years.

January 1913.—The appearances of acromegaly are obvious and well marked, but not extreme. Vision, after correction for myopia, RE = $\frac{6}{12}$; LE = $\frac{6}{9}$. The optic discs show no pathological changes.

Fields of Vision.—At 300 mm. the fields showed some flattening above, but no definite signs of hemiopia were elicited with white or colour tests.

By Bjerrum’s method (Fig. 12), March 1913, characteristic fields
The Study of Bitemporal Hemiopia

were at once forthcoming with $\frac{7.5}{2000}$ and $\frac{2}{2000}$ white in the right eye and smaller objects in the left.

In these four cases it will be noticed that the changes are more developed in the older cases, III. and VI., than in the more recent cases, IV. and V.

Case III. shows a fairly obvious condition of partial bitemporal hemiopia, detectable with the ordinary perimeter and a coloured test of the usual size. The others, however, show defects requiring Bjerrum’s method for their demonstration, defects which, though slight, are quite definite and of the same type in all the cases. Changes for colour in these cases were never markedly in advance of those for white, as in Cases I. and II., indicating a slowly progressing lesion. Two of the cases were examined after some months, and showed only trivial alterations.

These cases fall into Cushing’s Group III., in which gland symptoms predominate, while neighbourhood symptoms are inconspicuous or absent. That the visual symptoms are inconspicuous may be admitted; good vision is a feature of this class of case; their absence, however, depends upon the method of examination. The cases of acromegaly in this group recorded by Cushing had normal fields together with enlargement of the sella turcica. Uthoff’s statistics also give field changes in about 50 per cent. of cases of acromegaly, and cases are frequently recorded in which enlargement of the sella turcica and normal fields were associated. In the four cases described and two others which I have been able to examine up to the present, changes of the type illustrated have been present in all. It seems, therefore, certain that changes

Fig. 12.
in the visual fields are present in a very much larger number of acromegalics than present statistics show, and this is especially to be expected where the sella turcica is enlarged.

Another feature, which depends largely on the size of the test object used, is the presence of typical bitemporal hemiopia with fields bounded outwards by a vertical meridian. While this condition may be relatively uncommon for any one given size of object, it will be more often demonstrated if a series of objects is tried until a suitable size is found.

Similarly in regard to the scotomatous type of field, the use of a series of objects will probably greatly increase the number of such cases, and in all cases where central vision is definitely reduced, even though not greatly, an explanation should be sought in this direction.

That the fields in Cases I. and II. are not merely isolated instances, but members of a type, is suggested by a study of recorded charts, many of which show similar conditions in one or other stages. The cases of Albrand,8 De Lapersonne and Cantonnet,9 Grönholt,10 Story,11 Werner,12 and others, show these indications, and the same may be said of several fields in Cushing’s classic work. It is noticeable that the lesions in connection with these cases were always of a relatively more active nature than those which produce fields of the non-scotomatous type. Cases I. and II. show also that when the activity subsides the field becomes non-scotomatous (left field of both cases), unless actual atrophy has occurred.

Where the cause of the scotomatous type is not a tumour recovery usually occurs in a comparatively short time with or without some degree of permanent damage to sight. These cases usually depend upon some inflammatory disturbance such as sphenoidal cell disease or basal syphilis. On the other hand, where a tumour is present, as has already been mentioned, it is usually of a more actively growing nature. Where this field is associated with acromegaly the course has often been more acute, and in two of the six cases I have found in the literature a tumour described as a sarcoma was found post-mortem (Gubler,13 Pontoppidan14).

The prognosis in cases of acromegaly with the scotomatous type of field would therefore appear to be rather worse than when the non-scotomatous type is present. Since some cases of bitemporal hemiopia of the scotomatous type are associated with tumours while others are not, it is evident that the main factor in the pro-
duction of this type of field is neither pressure nor traction, but some condition common to inflammatory conditions in the chiasmal region and tumours of an active type. This is probably congestion and oedema of the structures in relation to the chiasma, a view put forward by Fuchs in 1895. At the same time it is not suggested that other factors have no influence; undoubtedly in some cases, probably in Case I., both pressure and congestion were acting together in varying proportions at different times. It seems not improbable that if observations of this kind are made in a number of cases it may be possible in the future to classify such fields in types according to the predominance of one or other causal factor.

The exact nature of the lesion of the nerve fibres which causes the scotoma is still not thoroughly established. Clinically the condition is allied to what is known as retrobulbar neuritis, and may be considered a chiasmal retrobulbar neuritis. The functional obstruction is quite evidently, as Cushing points out, a physiological blockage rather than a destruction of the nerve fibres, and the power of recovery of areas which have been blind for months is characteristic of the type. In this respect these cases of chiasmal affection come into close relationship with cases of retrobulbar neuritis dependent upon post-nasal sinus disease, which are characterised by rapid variations in the intensity and size of the central scotoma or other visual defect present. Such cases are ascribed by many, Birsch-Hirschfeld, de Kleijn, and others, to toxic influences dependent on local vascular or lymphatic congestion.

The circular course of the defect, clockwise in the right field, counter-clockwise in the left, no doubt depends upon the arrangement of the nerve fibres in the chiasma. These are known to open out in broad loops so that the crossed bundle is spread over practically the whole chiasma while the uncrossed fibres extend inwards to varying degrees. Thus it is possible that the uncrossed bundle may be affected while the crossed bundle is still partly intact, while the affection of the lower inner quadrant of the field third in sequence may be due to the fibres of the uncrossed bundle, which pass to the upper outer retinal quadrant, being those which are looped farthest inwards. In the present state of our knowledge, however, it would be premature to offer any definite explanation of this feature.

Conclusion.—The main points illustrated by this study may be summarised as follows:
1. Bitemporal hemiopia is much more common than present statistics show.

2. The frequency with which it is found depends upon the method of examination used.

3. The use of small objects and of Bjerrum’s method is essential.

4. There are two chief types of bitemporal hemiopia.

5. The scotomatous type is characterised by early loss of direct vision. Typical cases show regular progression of the defect around the fixation point. This field is associated with active lesions, or lesions active during the presence of the scotoma.

6. The non-scolomatous type is associated with good vision for a long time. The field changes occur slowly, affecting the quadrants in the same sequence, the defect diminishing in intensity from periphery to centre.

I gladly express my indebtedness to Mr. Berry, Dr. George Mackay, Dr. Sym, and Dr. Gulland for allowing me to examine four of the cases.

LITERATURE.—The following list includes only the more important of many papers and books consulted.

A. Referred to in Text.

1 Sinclair, Trans. Oph. Soc. U.K., 1905, vol. xxv. p. 384. 2 Rönné, Klin. Monatsbl. f. Augenheilk., 1911, Bd. xlix. S. 154; Ibid., 1909, Bd. i. S. 12. 3 Uhthoff; Graef-Saemisch. Handbuch, 2te Aufl., Bd. xi. Abt. 2a. 4 Cushing, The Pituitary Body and its Disorders, 1912. 5 Pick, Deutsch. med. Woch., 1911, S. 1931 et seq. 6 Wilbrand and Saenger, Neurologie des Auges, Bd. iii. Abt. 2. 7 Rönné, Klin. Monatsbl. f. Augenheilk., October 1912, S. 446. 8 Albrand, Berl. klin. Woch., 1892, S. 896. 9 De Lapersonne et Cantonnet, Arch. d’Ophtalmol., 1910, tom. xxx. p. 65. 10 Grönholm, Zeitschr. f. Augenheilk., 1910, S. 311. 11 Story, Trans. Oph. Soc. U.K., 1891, vol. xi. p. 196. 12 Werner, Ibid., vol. xxxii. p. 267. 13 Gubler, Correspond.-bl. f. Schweiz. Aerzte., 15th December 1900, No. 24. 14 Pontoppidan, Hospitalsd. December 1897, No. 40, ref. De Schweinitz, No. 24, and Bartels, No. 26. 15 Fuchs, Brit. Med. Journ., 1895, vol. ii. p. 949. 16 Birsch-Hirschfeld, Archiv. f. Ophth., 1907, Bd. lxv. S. 440. 17 A. de Kleijn, Ibid., Bd. lxv. S. 3. 18 Déjerine, Anatomie des Centres Nerveux, Paris, 1901. 19 Pichler, Augenärztliche Unterrichtstafeln, Heft xxii., Breslau, 1900.

B. Not referred to in Text.

20 Nettleship, Trans. Oph. Soc. U.K., 1897, vol. xvii. p. 277. 21 Bogatsch, Klin. Monatsbl. f. Augenheilk., August 1912, S. 136. 22 Fisher, Trans. Oph. Soc. U.K., 1911, vol. xxxi. p. 51. 23 Rönné, Klin. Monatsbl. f. Augenheilk., 1910, Bd. ii. S. 455. 24 De Schweinitz and Holloway, Journ. Amer. Med. Assoc., 1912, vol. lix. p. 1041. 25 Lenz, Klin. Monatsbl. f. Augenheilk., 1905, Beilageheft, S. 263. 26 Bartels, Zeitschr. f. Augenheilk., 1906, Bd. xvi. S. 407. 27 De Schweinitz and Carpenter, Journ. Amer. Med. Assoc., 1905, vol. xlv. p. 81. 28 Schnabel, Zeitschr. f. Augenheilk., 1905, Bd. xiii. S. 7.

In many of these references extensive bibliographies are given.