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HINTS

ON THE

DIAGNOSIS

OF

EYE DISEASES.

BY

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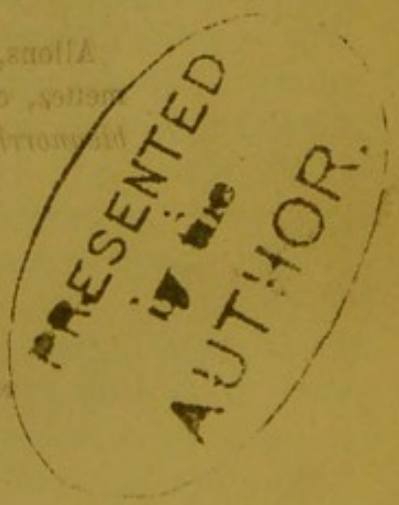

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HINTS

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DIAGNOSIS OF EYE DISEASES.

During the last few years the labours of ophthalmic surgeons have added considerably to what was previously known about the various imperfections and diseases of the organs of vision; and, as a necessary consequence, have multiplied the means and increased the accuracy of diagnosis. The results thus obtained have hardly yet been brought together in a form sufficiently compendious for ready reference; and, on account of the rapid growth of the subject, it would at present be scarcely possible to give to such a form a character of permanence, or to embody it in a systematic treatise. There are, however, many readers to whom a summary of the existing position of things would be occasionally useful; and hence I have been led to the attempt to frame one, as a contribution to periodical literature.

In order to facilitate description, it is customary to apply to the organs of vision certain technical expressions besides those which relate to their anatomical structure. We take an imaginary line, passing through the apex of the cornea, the centre of the eyeball, and the apex of the posterior hemisphere, and we call this line the *axis of the globe.* The two apices are called respectively the *anterior* and the *posterior pole.* An imaginary line, in a plane perpendicular to the axis, dividing the globe equally into an anterior and a posterior hemisphere, is the *equator.* An imaginary line, in a plane coincident with the axis, dividing the globe equally into a

superior and an inferior hemisphere, is the *horizontal meridian;* and a similar line, dividing the globe into a temporal and a nasal hemisphere, is the *vertical meridian.* The same expressions, *mutatis mutandis*, are applied to the crystalline lens. The point to which the eye is directed in the act of vision is called its *fixing point;* and a line drawn from this point to the foramen centrale of the retina is the *axis of vision.* The axis of vision and the axis of the globe are not quite coincident, but form with one another an angle of about 6°, which is usually increased in hypermetropia, and diminished in myopia.

If we except a few disorders of the surface of the eyeball, that is to say, of the conjunctiva and of the peripheral portion of the cornea, we shall find that all other diseases or imperfections of the eye are productive of impairment of function. The patient cannot see perfectly; and it is often from the diminution of his power of vision that he first learns his need of relief.

The degree and nature of this diminution are matters of primary importance to the practitioner, and require to be accurately tested. We investigate the state of vision with regard to its *acuteness*, its *extent*, its *range*, and its *co-ordination.*

The acuteness of vision admits of being expressed in German by the single word *Sehschärfe*, and the letter S., the initial of this word, has come to be used, in other countries also, as a convenient abbreviation of it. In order to determine the value of S. in abnormal conditions, it is first necessary to obtain a standard for health; and such a standard, together with the means of measuring any decadence from it, is furnished by the employment of test-types.

Until recently, the test-types in general use were those of Professor E. Jäger of Vienna; and, although they are now superseded in cases where exactness is required, it is still necessary to be acquainted with them. They are common printer's letters, of twenty different sizes, ranging from what is called "brilliant," (No. 1), to "8-line Roman," (No. 20). A normal eye should read No. 1 at ordinary reading distance; and should read No. 18, and words or letters of No. 16, at a distance of twenty feet.

Professor Donders, when engaged in investigating the phenomena of astigmatism, found the necessity of a more accurate test; and the want was supplied, on the same principle, and nearly at the same time, by Dr. Snellen, of Utrecht, and by Dr. Giraud-Teulon, of Paris. It has long been known that the visibility of an object depends, *cæteris paribus*, upon the visual angle under which it is

seen; and Dr. Snellen determined by experiment that "square letters, whose limbs have a width equal to one-fifth of the letter's height are generally distinctly visible at an angle of five minutes." On this basis he constructed a scale of letters, carefully drawn in exact proportion, and containing eighteen varieties. These are numbered consecutively from 1 to 8, and the larger numbers are 10, 12, 15, 20, 30, 40, 50, 70, 100, and 200. They are all so arranged that the letters are seen under a visual angle of five minutes, when placed at a distance from the spectator equal, in Paris feet, to their own distinguishing number. Thus a normal eye should read No. 1 at one foot; No. 3 at three feet; No. 200 at two hundred feet, and so on.

In using this scale the value of S. is found by dividing the distance between the type and the spectator by the number of the smallest letter that can be read with certainty. A person with normal vision will read No. 20 at twenty feet, and therefore, his S. will equal $\frac{20}{20}$, or unity, which is thus taken as the standard. Another person at the same distance will only be able to read No. 30, and another only No. 100. In the first case $S=\frac{20}{30}=\frac{2}{3}$; and, in the second, $S=\frac{20}{100}=\frac{1}{5}$; and the acuteness of vision is respectively only $\frac{2}{3}$rds or $\frac{1}{5}$th of what is natural to the eye.

To use the test-types, they should be suspended against a wall in a good light, and the patient placed at a measured distance from them. The smallest letter that he can read with certainty is then found by experiment, and the measured distance divided by the number of the letter. If it be desired to check the trial by another, the letter and distance may be varied. If a patient can read only No. 50 at ten feet, then his $S=\frac{10}{50}=\frac{1}{5}$. At twenty feet he should read No. 100; at eight feet he should read No. 40; and at two feet he should read No. 10. The Paris foot, by which the distances should be measured, is three-quarters of an inch longer than the English.[a]

There are cases, however, short of total blindness, in which no letter can be read at all. No. 200 of Snellen's types is a capital A, three inches and three quarters in height; and incapacity to decipher it would amount to incapacity to discern objects. We then can only test the perception of light. If the patient can discern the reflection from a white surface, such as a sheet of writing paper,

[a] Jäger's test-types are kept printed, on sheets, by Messrs. Harrison and Sons, printers, St. Martin's-lane, London, W.C. Snellen's may be obtained from any foreign bookseller.

we say that he possesses *qualitative*, but if he can only discover the direction of the window or the lamp, or can only distinguish between light and darkness, we say that he possesses only *quantitative* perception of light.

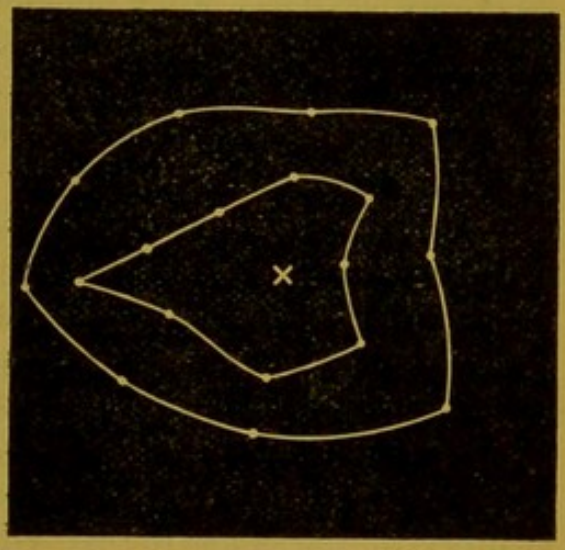
By using these tests we are not only able to describe in writing the exact degree of acuteness of vision, but we are able to measure with precision the changes that take place from day to day, and the benefit that has been derived from treatment. For cases of considerable impairment of vision, in which much exactness is not required, the fingers of the surgeon may be used as convenient test objects. Thus we say that the patient can count fingers at two feet, or at three feet, and the distance affords, as it increases, a rough measure of improvement.

The *extent*, or field, of vision, signifies the extent of surface over which objects can be seen, while the eye remains directed to a central fixing point. It furnishes, therefore, a measure of the functional activity of the peripheral portions of the retina; and its exact determination is of great diagnostic value in many cases.

The field of vision may be roughly tested by the index finger of the surgeon, moved upwards, downwards, to the right, and to the left, in front of the patient, until it passes out of his view in each direction. The eye of the patient must not follow the finger, but must be fixed upon the face or eye of the surgeon; and the finger may be about a foot in front of the patient's face. The eye not under examination must be closed or covered; and, where vision is very imperfect, the finger will be better seen if it be kept moving to and fro on its articulation with its metacarpal bone.

When such an examination as this reveals the need for a more precise one, or when a more precise one is required on account of the nature of the case, the field of vision may be exactly mapped out in the following way:—The patient must be comfortably seated in front of a black board, about a yard square, having its centre level with, and opposite to, the eye under examination, and eight inches distant from it. This distance may be maintained by some support for the head. At the centre of the board a mark is made with chalk, and the patient is directed to look at it steadily. The eye not under examination is covered by the hand. The surgeon then takes a piece of chalk, fixed to the end of a black rod, and, commencing from one side of the board, moves the chalk towards the centre until it becomes visible to the patient. At the point where it becomes visible a mark is made, and the chalk is moved

onwards until it becomes *clearly* visible, when a second mark is made. The chalk is thus drawn from the circumference to the centre in several directions, as many as may be required; and then a line is drawn to unite the outer or first series of marks, and another to unite the inner or second series. The latter line will include the field of clear vision; between the two lines will be a zone in which vision exists, but is indistinct; and the first line marks the outside boundary of the field. The annexed diagram shows the kind of map that may be obtained in the manner described; and it will be observed that the fixing point ×, although central on the board, need not be central in the field of vision. With proper care, the limits of the natural blind spot, situated on the temporal side of the fixing point, and corresponding to the surface of the optic disc, may be accurately traced; and sometimes morbid blind spots will be found in other portions of the field. These always require to be most carefully examined and defined. It is well to have the board divided into squares by slightly grooved lines, and to keep diagrams drawn in the same proportion on a reduced scale, on which a field of vision may be copied from the board, and preserved in a convenient form for future reference.



When very great accuracy is required, it is well to test the first map by a second, obtained by moving the chalk in a direction from the centre to the circumference. It is also often necessary to repeat the examination several times, in different degrees of illumination, in order to discover the sensitiveness of the retina under different amounts of light. The letters Se., that is, eccentric Sehschärfe, are used as an abbreviation to denote peripheral vision.

The *range* of vision refers to distance only, and is included between the far point, r, *punctum remotum*, and the near point, p., *punctum proximum*. The former signifies the farthest, and the latter the nearest point at which objects can be clearly seen. In normal eyes, there is really no far point, no distant limit of vision, and objects only cease to be visible when so far removed that they no longer yield sufficient light to stimulate the retina. For every

healthy eye, however, there is a distinct near point, within which fine print is no longer legible; and this near point naturally becomes more remote as life advances. Its distance is the measure of the power of the eye to *accommodate*, that is, to increase its refraction by volitional effort; and this power is chiefly due to an increase in the curvature of the anterior surface of the crystalline lens, effected by the action of the ciliary muscle. With the lapse of years, the lens becomes harder than in youth, and its shape is less easily modified; while the muscle itself must sometimes become less vigorous. In most people, therefore, the near point becomes inconveniently remote prior to old age; so that a newspaper has to be held at arm's length. This condition is called presbyopia. Within certain limits, it is strictly physiological; and it is arbitrarily defined to commence when the near point is ten inches from the eye.

When the far point is at some finite distance from the eye, that is to say, when vision becomes indistinct as the object is removed *beyond* some definite distance, as one foot, or six feet, we have the condition called myopia, or shortness of sight. The place of the near point can always be measured by moving the object of vision to and fro on a sliding scale, while the eye is kept stationary; but, in order to determine the far point in this way, a scale of inconvenient length would be required. It is shortened by making the patient look through a convex lens, which brings the far point of a normal eye to the principal focus of the lens, and the far point of a myopic eye *within* this focus. If the distance of the far point, as seen through the lens, be made into a fraction by placing 1 as its numerator, and if the focal distance of the lens be made into a similar fraction, and if the lesser of these fractions be subtracted from the greater, the result will be another fraction, the denominator of which will express the actual distance of the far point. If the lens chosen have a focal distance of six inches, and if the far point of a person looking through it be five inches, then $\frac{1}{5} - \frac{1}{6} = \frac{1}{30}$, and the actual far point will be at thirty inches. If the lens be of ten inch focal length, and the far point through it be at nine inches, then $\frac{1}{9} - \frac{1}{10} = \frac{1}{90}$, and the actual far point will be at ninety inches. In these experiments the distance of the object should not be measured from the eye of the patient, but from the centre of the convex lens.

The *co-ordination* of vision refers, of course, to the harmonious union of the two eyes in the visual act. When this union is disturbed, the first result is that the images formed upon the two retinæ are no longer blended, and diplopia, or double vision, is

produced. It is then necessary to determine whether the images are crossed or not—that is to say, whether the right hand image belongs to the right eye or to the left. For this purpose the flame of a taper is chosen as an object; and the patient holds a slip of red glass before his best eye, while he looks at the flame with both. The reddened image, whether it be on the right or the left, will belong, of course, to the eye before which the glass is held. If the images are crossed the eye in fault is deflected outwards, and if they are not crossed the eye in fault is deflected inwards. The extent of the deflection may be estimated by the distance apart of the images; and it may be sufficient to cause very troublesome diplopia without amounting to a visible squint. The most frequent cause is a partial paralysis of either the internal or external rectus muscle, arising from some affection, centric or eccentric, of its motor nerve.

Sometimes it happens that double vision ceases, and yet that proper binocular vision is not restored. When this is so the patient only uses one eye, and suppresses the image received by the other, If the eye be tolerably sound, and the images of normal brightnes, the latter can seldom be suppressed without a decided squint, which causes it to fall upon the peripheral and less sensitive portion of the retina. If the retina be from any cause torpid, the second image may be suppressed without a squint.

The presence of binocular vision is tested by placing before one eye a prism, with its angle to the nasal side, while the patient looks with both eyes at a candle flame eight or ten feet distant. If binocular vision be perfect the patient will either see two images, or the eye furnished with a prism will squint inwards to overcome its refraction. If neither result follow we conclude that the patient sees habitually with one eye only. Another and very simple test is to let the patient read, at his ordinary reading distance, and to hold a pencil, or other small object, half way between his eyes and the book. With proper binocular vision he will see two images of the pencil, neither of which will interfere with his reading. With monocular vision he will see only one image of the pencil, and this will shut out a part of the page from his view. It must be remembered, of course, that monocular vision does not imply blindness of either eye, but simply loss of the co-ordination between the two.

Next to impairment of vision the most prominent symptoms in eye diseases are pain and congestion.

The pain may be either referred to the globe itself, in which case it is most frequently produced by heightened tension, or it is felt

chiefly in the parts around the orbit, and especially in the filaments of the supra-orbital branch of the tri-facial nerve.

The congestion presents itself under three principal forms. In the first the vessels that perforate the sclerotic near the cornea, and pass backwards towards the equator, are distended and tortuous; in the second the cornea is surrounded by a delicate zone of redness; and in the third the general surface of the conjunctiva of the globe is covered by a network of vessels. The second of these conditions is sometimes concealed by the presence of the last; but they are all too well known to require any detailed description.

We will now suppose that a patient presents himself suffering from considerable bright redness of the conjunctiva of the globe of one or both eyes, and complaining of some smarting and discharge. We place him with his face towards a good light, and observe—first, that the cornea retains its natural polish and transparency; secondly, that the aqueous humour is clear; and, thirdly, that the pupil is freely movable.

The polish of the cornea is best tested by its action as a reflector. In the healthy state it reflects a perfect image of any object placed in front of it, such as a candle flame, or the sashes of a window, or the face of the spectator; and if this image be in any way blurred, broken, or distorted, we have to deal with some disturbance of the corneal epithelium, or some departure from the symmetry of the corneal surface.

The transparency of the cornea and the aqueous humour is best shown by the clear visibility of the peculiar fibrous structure of the iris, and by its natural colour. Sometimes, when the cornea is transparent, the aqueous humour will be yellow and turbid, so that the iris will be only indistinctly seen, and, if naturally blue, will appear of a greenish tint. In such a case a puncture of the cornea, by allowing the escape of the turbid and discoloured fluid, will restore the natural appearance of the iris.

Supposing, however, that the cornea is bright and the aqueous humour limpid, attention should next be directed to the pupil. The eye not under inspection being closed, the shadow of the surgeon's hand should be allowed to fall upon the other. The pupil, if healthy, will instantly dilate, and will contract again when the shadow of the hand is removed. If it does so we have only to find that the natural acuteness of vision is unimpaired, in order to arrive at the conclusion that the disorder is external to the eyeball, and strictly limited to the conjunctiva. If the acuteness of vision were diminished we should infer that the choroid was congested and that

there was danger of the external inflammation being complicated by some form of choroiditis.

In applying this test to a stranger, we must not hastily conclude that he possessed S=1 prior to the attack of conjunctivitis. It is very common to find the acuteness of vision below the natural standard in persons who are quite unaware of their own deficiency in this respect, and who suppose that they see as well as their neighbours. In any case of apparently simple conjunctivitis, with S. below unity, it is well to test the sight by some familiar object, and to make sure that vision is not only defective, but recently impaired, before suspecting choroidal complications.

There are several forms of disorder that implicate the cornea, and that do not affect vision unless they encroach upon the portion in front of the pupil, or unless they are attended by excessive photophobia. These disorders are mostly vesicles, pustules, ulcers, or various inflammatory affections, presenting many points of analogy to certain diseases affecting the skin; and their characters, as well as those of the varieties of purulent ophthalmia, are usually to be read at a glance. Modern researches have done little more than to clear up their precise anatomical and pathological characteristics and analogies; matters of great interest, but with which we have here little to do. It is necessary to remember that a corneal ulcer, especially when beginning to heal, is often surrounded by a considerable zone of cloudiness; and hence that this cloudiness, although the ulcer itself be quite eccentric, may encroach upon the pupillary space, and seriously interfere with vision.

There is, moreover, an affection principally of the cornea, although often implicating the deeper structures of the eye, which is attended with impairment of vision from its very commencement, and which has been placed in an entirely new light by the genius and the labours of Mr. Hutchinson. This is the corneal inflammation peculiar to persons who have inherited the syphilitic constitution (or in some cases, as I believe, have acquired it by vaccination); and its detection is of the highest importance, because the treatment it requires is of a special character. It is recognized in mild cases by a peculiar aspect of the cornea—an aspect that usually commences as a slight central haze, that becomes subsequently mottled or dotted, and eventually passes into an interstitial cloudiness. It is attended by a comparatively small amount of congestion, is prone to attack first one eye and then the other, and is associated with the peculiar facial conformation, the earthy complexion, the scarred angles of

the mouth, and the notched, crescentic, or peggy teeth that are so graphically described in Mr. Hutchinson's monograph.

When the surgeon is satisfied, by the tests already mentioned, that he has to deal with an inflammation that is external to the eye-ball, his next point is to ascertain whether there is any external cause to account for it. For want of this simple precaution I have several times seen patients who had been energetically treated, by local and constitutional means, for symptoms entirely due to the presence of a foreign body. The cornea should, therefore, be carefully scrutinized, to see that nothing is impacted in its substance; the growth and direction of the eyelashes should be noted; the upper eyelid should be everted and the lower drawn down, and the openings of the canaliculi inspected with the aid of a lens, in order to see that no fallen eyelash has become entangled in them.

Patients sometimes present themselves, however, in whom redness of the conjunctiva is associated with impairment of vision and with turbidity of the aqueous humour, so that the fibrous structure and proper colour of the iris are somewhat disguised. There is then acute congestion or actual inflammation of the choroid and iris. The extent to which the iris is inflamed may be seen by the number and size of the adhesions between the margin of the pupil and the anterior capsule of the lens; and these adhesions, if not readily discernible when the pupil is exposed alternately to light and shade, may be rendered manifest in a few minutes by the instillation of a drop of a solution of atropia containing four grains to an ounce of water. The surgeon will arrive at a conclusion as to how much impairment of vision is due to the turbidity of the aqueous humour, to the partial closure of the pupil, and to the effusion of lymph; and, if the actual impairment be much in excess of what can be thus accounted for, he will conclude that the choroid participates in the disease. When it does so its participation will usually produce increased tension of the globe.

In order to estimate *tension* the surgeon should familiarize himself thoroughly with the peculiar resilience of the healthy eye The method of examination is to make the patient gently close his lids, as if in sleep, while the surgeon places the tips of both forefingers upon the upper part of the globe a little apart, and by alternate gentle pressure, feels and estimates the degree of resistance. Mr. Bowman makes nine degrees of tension, four above and four below the normal, and expresses them by a scale of T's, as follows:

$$-T^3-T^2-T^1-T^n\ T^n+T^1+T^2+T^3.$$

This scale is easily intelligible. In—T' and +T' the departure from the normal standard is doubtful; in—T¹ and +T¹ it is no longer doubtful; in—T³ the globe is perfectly soft; and in +T³ it is as hard as a stone. The only difficulty about the T's is the impossibility of referring them to any common standard. The T³ of one surgeon might be the T² of another.

Disregarding this unavoidable difficulty, if a patient presents himself in whom there is manifest iritis, with greater diminution of vision than the iritis present will account for, and with evident but not extreme increase of tension, we infer that the choroid is seriously implicated in the disease.

Such cases must not be confounded with others, happily rare, and, still more happily, remediable by prompt treatment, in which the globe is as hard as stone, the conjunctiva injected, the cornea steamy, the pupil dilated and fixed, the pain intense, and vision almost abolished. This is *acute glaucoma*, and requires the immediate performance of a large iridectomy, in order to save the eye from speedy and complete destruction.

In order accurately to estimate the nature and the significance of tension, or in other words, of abnormal fulness of the globe, it is necessary to remember that it may arise either from the active congestion and the effusions due to acute inflammation, or in a manner more insidious, by a disturbance of the natural balance between secretion and absorption within the eye. The former condition, usually due to irido-choroiditis, is most frequently seen in the eyes of persons not past middle age, in whom the sclerotic coat retains a degree of elasticity that permits it to yield somewhat to the pressure from within. Partly from this yielding, and partly because inflammatory tension is seldom excessive in degree, it is not, as a rule, immediately destructive to the retina; but it imparts to the inflammation a very intractable character, so that if the tension be not relieved, the eye will usually be lost eventually; and, on this account, its early recognition is of the highest importance.

The more chronic form of tension that is produced by disturbance of the balance between secretion and absorption, is mostly seen in the eyes of persons past middle age, in whom the elasticity of the sclerotic is much impaired. It is the cause of the several varieties of glaucoma; and the precise character of the phenomena, in any case, will be chiefly due to the rate at which the tension increases, and to the degree of resistance that is opposed to it. The continued existence of excessive intraocular tension necessarily produces com-

pression of the retina, and consequent loss of sight. The whole surface of the retina suffers, but the peripheral portions suffer earlier than the central. Consequently, the field of vision becomes gradually contracted; and, although central vision is always impaired in some degree, it may remain comparatively good up to a late period of the disease. In the end, however, unless the tension be relieved, total blindness will be the result.

For some reason, either from weakness of the ciliary muscle by interference with its supply of blood, or from pressure upon its motor nerves, or from the production of a premature hardness of the crystalline lens, the early stages of increased tension are usually attended by rapidly increasing presbyopia. When this symptom presents itself, a careful examination of the degree of hardness of the globe should never be omitted.

The ocular tissues, like other textures of the body, show a marked tolerance of pressure that is only very gradually increased; and a decided intolerance of the same degree of pressure when suddenly or quickly produced. While, therefore, in cases of very gradually increasing tension, the only symptoms may be presbyopia, dimness of sight, contraction of the field of vision, cupping of the optic disc, and eventual blindness, it is more common to meet with patients in whom a more rapid rate of increase is productive of more or less inflammatory reaction. In such cases the dimness of sight is liable to be increased suddenly for short periods, which may be followed by partial improvement; and it is common for the exacerbations to be attended by ciliary and orbital neuralgia, by the appearance of coloured fringes around a flame, by congestion and inflammation of the ocular tissues, and by opacities in the crystalline lens and vitreous body. When the increase of tension is very rapid the symptoms are correspondingly severe.

The more typical examples of these three gradations of rapidity are called respectively, simple chronic glaucoma, sub-acute glaucoma, and acute glaucoma. They possess common characters, depending upon exalted tension, and differential characters, depending upon the rate at which that tension has increased, and upon the amount of resistance opposed to it by the sclerotic. In all of them the tension is the first demonstrable link in the chain of morbid action; and must be carefully distinguished from the tension that arises as a mere symptom of choroiditis. The history of the disease will usually clear up all doubt; and the important difference must be remembered, that the tension which produces glaucoma tends to

steady increase; while that which arises in the course of choroiditis would disappear with the disappearance of its cause, and may, therefore, sometimes yield without calling for any special treatment.

In cases where the surgeon decides that he is dealing with a disease that is primarily iritis, or irido-choroiditis, the question will often arise:—What is the character of the inflammation? Is it common or specific?

The forms of specific inflammation chiefly noticeable are those dependent upon syphilis and upon gout. I am not aware of any pathognomonic sign by which either of these forms may be recognized, and I am quite sure that many of the signs mentioned by authors are occasionally deceptive. If the frequent occurrence of these forms of inflammation be kept before the mind, if the state of the patient be carefully examined, if his history be carefully inquired into, and if tentative treatment be cautiously employed in doubtful cases, there will be little liability to any error of importance.

We may now pass on to the consideration of cases in which there is defective vision, without any striking change in the external aspect of the eye. There may be trifling congestion produced by straining efforts to see, but no intense redness, no ulcer or opacity of the cornea, no turbidity of the aqueous humour, and no visible change in the iris.

In such a case we have first to inquire whether there be any error of refraction, that is, whether the patient be myopic or hypermetropic. To determine this point the test types are used, and the patient is tried first with low-powered concave and then with low-powered convex glasses. If the concaves improve vision a succession of trials will determine what powers raise the vision to the highest attainable point. If the convex lenses are beneficial a similar trial cannot be accurately made until the accommodation is paralysed by atropine. For this purpose it is necessary to use a drop of the four-grain solution, and to allow two hours for its action.

In cases where either concave or convex glasses raise S. nearly to the natural standard we may usually be content; but if they produce a comparatively small amount of benefit we may suspect the existence of astigmatism.

Astigmatism sometimes depends upon irregular formation of the crystalline lens; but its usual cause is an excess of the natural difference between the vertical and the horizontal curvatures of the cornea. Its chief characteristics are—the inability of the patient to

perceive vertical and horizontal lines at the same time with equal distinctness—and the improvement of vision that is produced by looking through a narrow slit in a blackened card or a plate of metal, when this slit is placed in some particular direction, to be found in every case by trial. The estimation of the precise kind and degree of astigmatism, so as to be able to prescribe the nature and position of the glasses calculated to relieve it, is too intricate a matter to be here described. Full information may be found concerning it in the great work of Professor Donders, and sufficient information for most purposes in the smaller treatises of Mr. J. Z. Laurence and Mr. Soelberg Wells.

There is another form of corneal deformity that seriously impairs vision, namely, conicity. This condition, when developed, is too conspicuous to be overlooked; and, even in its early stages, it is usually very manifest when the eye is examined in profile.

If there be no evidence of the presence of astigmatism, or of any other irregularity of the cornea, the surgeon may next direct his attention to the crystalline lens, with especial reference to its transparency.

In order to examine this structure two methods are available—focal illumination and the use of the ophthalmoscope. For young people the former, and for old people the latter, will furnish the most uniformly satisfactory results; although it is always desirable to employ both. To use focal illumination a lamp is placed at the side of the patient's head, and somewhat in front of it; or a beam of daylight passing through a small hole in a screen may be used instead. However obtained, the light is concentrated by a bi-convex lens upon the part of the eye under examination, and the portion thus illuminated may be examined through another glass used as a magnifier. The management of the cone of light will need a little dexterity that only some practice can give; and in order to examine the lens the pupil must be completely dilated by atropine.

In the eyes of young people, who suffer from defective vision, we may find, at least, two forms of cataract, the first consisting of a filmy, or dotted, or stippled opacity, extending to the equator of the lens, and implicating the external cortical substance in some degree. In the second form the opacity is central, sharply defined, and surrounded by a zone of perfectly transparent tissue in which no trace of cloudiness can be discovered. The difference between the two forms is very important; since in the first the opacity will spread steadily over the whole lens, and in time produce blindness.

In the second the opacity has little or no tendency to extend itself, even though it may become more dense. The transparent zone will usually remain transparent, at least for many years; and, if it be wide enough, useful vision may be restored by the employment of atropine, or by displacement of the pupil without removal of the lens.

Among the more rare conditions that focal illumination may reveal must be mentioned dislocation of the lens, which may occur in almost any direction. Such displacements are usually found in both eyes, and in the same direction in both with regard to the median line. The displaced lenses are often not perfectly transparent.

The faint opacities of the lens that may be present in young people, and seriously affect vision, are readily seen under focal illumination by their greyish or whitish colour; but they may sometimes be so generally diffused as not to be very evident when looked for with the ophthalmoscope. The commencing cataract of the aged, however, which consists of densely opaque striæ not always differing greatly in colour from the rest of the lens, is most readily detected by the ophthalmoscope. The striæ appear as densely black lines on an illuminated ground, and can be recognized at a single glance with unfailing certainty. The only appearances liable to be mistaken for them are spots left on the anterior capsule by former iritic adhesions; and these, instead of being radiating lines, are disposed in a figure more or less circular.

When senile cataract is fully developed, and the amber-coloured nucleus is surrounded by a layer of milky or spermaceti-like cortical substance, an erroneous diagnosis is scarcely possible. But there are certain states of the eye, in elderly people, in whom the blackness of the pupil is lost, that are frequently mistaken for cataract. The pupil often presents a peculiar appearance of yellow cloudiness due to reflection from the fundus, and very likely, when seen by diffuse daylight under atropine, to deceive a hasty or an inexperienced observer. The distinctive character of this cloudiness is its uniformity. In focal illumination, in such a case, the pencil of light passes over the crystalline without a break; and this it never does when there is cataract. The ophthalmoscope will also afford conclusive evidence, by failing to show the opaque striæ mentioned in the preceding paragraph.

When the above methods of examination display a transparent condition of the lens, the cause of impaired vision may next be sought in turbidity of the vitreous body, or in the various diseases of the

retina, optic nerve, or choroid, recognizable with the ophthalmoscope. For a full account of all these conditions, of the methods of discovering them, and for suggestions with regard to their treatment, I must refer the reader to my translation of Zander on the ophthalmoscope. The subject is far too large to be contained within the limits of this paper; and no advantage could accrue from a very imperfect sketch of it.

There are however cases, still very obscure, in which vision is impaired or destroyed, and in which the ophthalmoscope affords but little information. By its aid, in such cases, we may often discover certain atrophic changes in the optic nerve; but the symptoms of impaired vision commonly precede the occurrence, or at least the recognition of these changes, and the atrophy may be an effect rather than a cause. Subsequent symptoms, or death, may occasionally reveal a source of blindness seated deeply in the nervous centres; and symptoms referable to the nervous centres may sometimes precede or accompany the first failure of vision. Still, we have not always even so much light as this; and, when we find defective vision that is not due to any visible change, inflammatory or otherwise, in the transparent media or the ocular membranes, or to any obvious mechanical interference, as by embolia, with the internal ocular circulation, we have no resource but to fall back upon the nomenclature of the pre-ophthalmoscopic period, and to describe the defect, according to its degree, as amblyopia or amaurosis.

It is evident that such cases, by reason of their obscurity, as well as by reason of the importance of their issue to the patient, require the most careful possible attention; and that the question of their probable termination must, at a very early period, force itself upon the mind of the practitioner. They have lately been made the subject of clinical lectures by Professor v. Graefe, from whose remarks upon them the following statements are derived.

According to v. Graefe, our opinion about a case of amblyopia or amaurosis should rest mainly upon three elements, namely, an exact investigation of the visual function, the appearance of the optic disc, and the manner of development of the disorder.

In the investigation of the visual function the degree of central vision is highly important; but, as regards prognosis, it is still more important to test carefully the limits of the field, and the state of of eccentric vision. Experience has fully shown that cases which tend to the progressive extinction of sight are distinguished by contraction of the field, or by obscurity at its limits; and

it is evident, *a priori*, that an increasing atrophy of the nervous elements of the retina would be first apparent in the parts most remote from the supply of blood.

For such cases the ordinary method of taking a field of vision is not of sufficient delicacy, and must be refined by the addition of a means of gradually decreasing the illumination. The piece of chalk may also be moved outwards, from the fixing point, as well as inwards from the periphery. The results of the examination may be arranged under three heads:—

1. The peripheral extent and acuteness of vision are comparatively identical with those of a sound eye—*absolutely normal.*

2. There is diminution of the acuteness of peripheral vision, alike in all directions, and very small in degree relatively to the impairment of central vision—*relatively normal.*

3. The impairment of eccentric vision is irregular—*i.e.*, exists in only one part of the field, or in one direction, or preponderates in certain directions, and is disproportionate in these to the central impairment—*abnormal.*

With absolutely normal eccentric vision we may exclude the fear of progressive atrophy in any case in which the disease has already made some progress. There may be a nascent stage of atrophy in which eccentric vision is not affected; and it is therefore necessary to form a guarded prognosis in cases of recent and undeveloped amblyopia. If the impairment of vision be only of a few weeks' duration, and not below two-thirds of the normal, and if the peripheral vision be absolutely normal, it is still possible that with greater diminution of vision the periphery may begin to suffer in a greater degree. But if the case be of several months standing, with S. depressed to one-sixth, or one-tenth, or less, and if the peripheral vision be then absolutely normal, we may say with certainty that we have not to deal with a case of progressive atrophy. The apparently worse condition will justify the more favourable prognosis, in so far as regards the prospect of eventual amaurosis, but without reference to probable recovery. For we find a number of cases of amblyopia, with unaltered peripheral field of vision, but with central or eccentric scotomata, which resist all treatment, and remain stationary at a certain point.

When the field of vision is relatively normal, this circumstance alone leads to no conclusion; and is only significant when considered together with the aspect of the optic nerve, and the duration and manner of development of the disease. The condition is such as

may be produced by the exclusion of one eye from the visual act, as in strabismus; and it may also occur in cases in which, the cause of the disease being in continued operation, as in amblyopia potatorum, an eventual progressive atrophy may ensue. But, when the field of vision is relatively normal, a progressive atrophy is not actually present in a characteristic form; and the case should be hopefully submitted to a rational and individual treatment.

If the field of vision be abnormal, an unfortunate issue is to be expected; but it would be going too far to say that it must necessarily ensue. We shall be guided to a right prognosis by the nature of the limitation of the field, by the relation of the eccentric to the central vision, by the aspect of the optic disc, and by the manner of development of the disease.

If the field of vision in both eyes be curtailed on the same side of the body—as to the right side, or the right upper, or right lower portion—with the central vision nearly or quite normal, the mischief is limited to one optic tract, and may proceed to complete hemiopia, but not to complete blindness. There are some very rare cases, which have as yet received no anatomical explanation, in which there is a defect in the upper or the lower portion of the field, in one or both eyes, the defects being in the latter case symmetrical; and in which, when the defect is sharply defined against normal retina, and when the central vision is normally acute, there is no tendency to progressive atrophy. Concentric narrowing of the visual field by successive diminutions without change of form, as in some cases of glaucoma, may sometimes go on to blindness; but more frequently will admit of arrest or of recovery. Recovery may be looked for with some confidence when the optic disc is of normal aspect, when vision is only moderately impaired, and when the field is enlarged by the use of dark blue spectacles, as in some cases of hysteric anæsthesia retinæ, and in some irritable children. The most unfavourable prognosis must be formed in cases of irregular lateral narrowing of the field, occurring simultaneously or successively in both eyes, and in such a manner that the field is most affected in both in the same direction, as towards the inner or towards the outer side, or in some intermediate situation, outer and lower, or inner and upward, as the case may be. The expression "most affected" suggests what is usually the case, that all parts of the field suffer in some degree. Such cases are distinguished from those of hemiopia already referred to, by the circumstance that the affected portions of the field are never sharply defined from other

portions that retain their normal function. The common course of amaurosis is for one eye to be already nearly blind, or with its field of vision contracted nearly to the fixing point, before the other begins to suffer. In order to establish the soundness of the second eye it is necessary to test its vision with great care, and to find it perfect, especially in the particular direction in which the first eye began to fail. Such examinations are highly important, because, for reasons at present unexplained, we sometimes see an interval of a year or two, or even of several years, between the failure of the two eyes; while, in other cases, the one follows the other rapidly. Most commonly, moreover, amaurosis first shows itself on the nasal side of the periphery; a fact possibly to be explained by the anatomical distribution of the fibres of the optic tract. The reverse obtains too frequently to be regarded as a mere exception, but only as a less usual occurrence. When the second eye begins to suffer in a direction not homologous with the point of commencement in the first, not both on the medial, or both on the temporal side, but on the same side with reference to the halves of the body, right or left, there may possibly be only a disease of one optic tract, showing itself in succession in the parts supplied by the lateral and by the cruciate fibres, and tending not to blindness, but only to hemiopia. This hope may be entertained if the failure of sight in the first eye does not transgress a vertical line drawn through the fixing point; and if the vision be not less than from one-third to one-fourth of the normal. Under other circumstances progressive atrophy is to be dreaded.

While the investigation of the periphery of the field of vision is thus of great importance, the investigation of its continuity is scarcely less so, especially with regard to the prospect of recovery. In a general way those forms of amblyopia present the greatest likelihood of complete recovery in which the conducting power of the nervous filaments has the smallest deviation from the normal. If in a given diminution of S. there is also a completely proportional state of Se., so that this, after the common rule, diminishes continually from centre to periphery, without interruptions or sudden diminutions at any point, we augur more favourably, *quoad* recovery, than when the diminution of central vision is itself circumscribed and sharply defined against the surrounding parts (central cloud, central scotoma, central defect), or than when, even with less lowering of S., there are any eccentric interruptions. In the cases of central or eccentric scotoma the

causes in operation seem often to produce permanent destruction of the conducting elements. At least we often see such defects remain unchanged, and hence our prognosis about them, although favourable, *quoad* blindness, is very doubtful, *quoad* recovery. A sound judgment upon the point may often be obtained by attention to the aspect of the optic disc, and to the mode of development of the disease. It is well to remark, however, that in order to justify a favourable prognosis, *quoad* blindness, either in central or eccentric scotoma, it is imperatively necessary that there should be satisfactory Se. beyond the defect. If we find a scotoma beyond which, towards the periphery, either generally or in certain directions, the Se. is reduced, the case will, as a rule, terminate in progressive atrophy. Scotomata placed symmetrically in both eyes call for very careful examination in this respect. If the scotomata be in the lower part of each field, and if beyond them, that is below them, the Se. is completely normal, the function of the conducting fibres corresponding to the defect must be complete, and blindness is not to be feared. Otherwise we must anticipate amaurosis.

The intensity of the illumination used is a matter that requires attention. In the normal eye we find that a very considerable diminution of light, from full day-light downwards, scarcely at all affects the clearness or extent of peripheral vision; while in many morbid conditions a slight diminution is productive of great decrease of visual power, indicating a very general torpor of the perceptive elements of the retina.

We proceed now to consider the appearances of the optic disc in cases of amaurosis; and we have chiefly to observe it with reference to four points, namely—colour, opacity, excavation, and dwindling of the vessels.

The *colour* of the normal optic disc, however much it may incline to white or yellow, is always modified by a stippling or tinting of red, and only here and there, as within a physiological excavation, displays the clear bluish white reflex of the lamina cribrosa. In many forms of amblyopia, and especially in the more threatening, the whole of the papilla loses its natural redness, and becomes more or less uniformly white, thus contrasting strongly with the surrounding choroid, and appearing more sharply defined than usual. The causes of this appearance are twofold—partly that with the wasting of the nerve elements the lamina cribrosa becomes more conspicuous, partly that some thickening of the connecting tissue of the nerve has taken place. These two causes may be either

separate or conjoined in their operation. If the first alone be concerned, we see an atrophic excavation presenting a bluish white colouring; if the second, an intensely white disc with a flat surface; if both, a superficial excavation, with the details of the lamina cribrosa clearly visible in the position of a pre-existing physiological excavation, but covered elsewhere by white connecting tissue. The preponderance of one or other form seems to depend, not on any difference in the atrophic process, but on the precise formation of the papilla, on the character of the intra-ocular pressure, and on the state of the circulation in the connecting tissue. The second test, the *opacity*, may be very briefly dismissed. The delicate semi-transparence of the healthy disc is of necessity done away with when the visible surface is formed either by the lamina cribrosa or by the thickened connecting tissue in front of it. It is then no longer possible to see the vessels sinking into the nerve tissue. The presence or absence of *excavation* depends upon the condition of the connecting tissue at the end of the nerve. Concerning the *diminution of the vessels*, it will sometimes happen that they all, including the larger trunks, become reduced in calibre; but, for the latter, this is not an invariable occurrence. We even see cases of old and complete amaurosis, in which the optic nerve exhibits all the marks of complete nervous atrophy, but in which the larger vessels retain their normal diameter. The case is wholly different when atrophy of the nerve is a result of certain intra-ocular processes, such as choroido-retinitis; for then the diminution of the large vessels is of invariable occurrence. The cause of the difference seems to be that in amaurosis, as in division of the optic nerve, only the fibrous and ganglionic layers of the retina dwindle, while the others retain their structure. In choroido-retinitis, on the other hand, all the elements of the retina perish. The different conditions of the main vessels, seen in atrophic amaurosis, probably depend upon different relations to the connecting tissue. The finer ramifications upon the papilla are, however, always either diminished or absent. The reddish tint of the healthy papilla, doubtless, depends upon a multitude of fine vascular twigs inter-penetrating its substance; and the want of these materially contributes to the bleaching of its surface. It appears that the very fine twigs are mainly subservient to the nutrition of the intra-ocular extremity of the nerve, and of the fibrous bundles surrounding it; and that these twigs share in the wasting of the fibrous layer, while the greater part of the retinal vessels are the channels of nutrition to the

remaining retinal layers. The pallor of the disc, produced by diminution of the fine twigs, is necessarily an important element in the production of colour changes; and, while the natural semi-transparence is retained, this pallor may precede all other changes; and may thus mark an initial period of the disease, in which coarse methods of testing the visual field afford, as yet, no result, and in which the most accurate examination is required in order to reveal the torpor of the periphery that is due to slight functional impairment of the fibrous layer.

The progress of development of all the above-mentioned conditions is briefly described as atrophic degeneration of the optic disc. It must be remembered that bare inspection cannot reveal, in any case, whether the atrophy be stationary or progressive; and that upon this depends its significance. An entire absence of atrophic change, however encouraging under certain circumstances, does not, under others, exclude the most unfavourable prognosis; while the presence of atrophy, to an evident degree, may sometimes depend upon a local error of nutrition, and may not necessarily lead to blindness.

The third important point on which our judgment must rest, is the mode of development of the disease and of the attendant symptoms.

We will first consider the occurrence of sudden or rapidly developed disturbance of vision—in the form of limitations of the field, sharply defined, and either hemiopic or concentric—of central scotomata—or of total blindness. It was formerly believed that all suddenly occurring pathological conditions were results of hemorrhagic effusion; but this belief is now greatly modified; and it is known that the causes of such conditions are not only various, but often very obscure. Even when impairment of vision follows hematemesis, or gastric derangement, or some exanthem, the connexion between antecedent and consequent is at present unexplained. In suddenly occurring cases we must usually be content to wait and observe before forming a prognosis; but, as a general rule, this may be more favourable in children than in adults; and even the total absence of perception of light does not preclude all hope of recovery, although it may continue for one or more weeks. Its longer duration, especially when associated with atrophic degeneration of the nerve, must be regarded as very unfavourable.

The gradually occurring cases are by very much the most frequent. As a rule, in cases originally favourable, the disorder occurs in both eyes at once. As regards our prognosis, *quoad*

blindness, we are greatly helped when the disease remains for some time stationary. The worst forms make, indeed, occasional pauses; but these pauses seldom last longer than a month or two. A long period of arrest in the same condition, with a normal aspect of the nerve, and with no contraction or interruption of the field of vision, will permit a hope of recovery; since such cases are often successfully treated by careful attention to their constitutional causes.

In cases of contraction of the field of vision the method of development is of great importance. Hemiopic contractions, when not occasioned by apoplexy or encephalitis, sometimes depend upon some idiopathic and transitory change in one optic tract. Such changes may be effects of syphilis, or of obscure nervous conditions, which the progress of the disease may not always clear up. In such favourable cases, the development of the disease is usually rapid; and the acme is reached in the course of a few weeks. Sometimes, but very rarely, we observe temporal hemiopia with rather quick development, and we may conclude, from the complete recovery of such cases, that some transitory affection of the cruciate fasciculi of the optic nerve has occasioned them. I will not affirm that it is always practicable to distinguish at first these forms from those fatal to vision; but we may take as guides the rapid, almost simultaneous, and symmetrical development of the disease in both eyes—the relatively good central vision, not reduced below one-fourth or one-sixth—and that there is still complete integrity of the optic disc, after some weeks have already passed away. When one eye becomes completely blind in a comparatively short time, and the other, some months afterwards, remains completely sound, the ultimate prognosis for the latter is far more favourable than if the disease in the first eye had progressed slowly, and had rendered it only partly blind. In the first case there would probably be atrophy of one optic nerve in front of the chiasma, since it is highly improbable that the lateral fasciculus of one side, and the cruciate fasciculus of the other, should both be diseased without the participation of neighbouring fibres.

When considerable impairment of vision follows acute cerebral symptoms, we must not be too hasty to give an unfavourable opinion; since in such cases improvement may take place, and a certain amount of sight is often retained. We even see cases of complete blindness from acute affections of the brain, in which, after several weeks, or, exceptionally, several months of complete absence of all perception of light, some vision will return. We must be careful

however, not to hold out delusive or groundless hopes; and, when long-continued blindness is associated with degeneration of the papilla, it is obvious that the chance of improvement is only slight, and can at best refer only to a small part of the visual field. But in the slowly advancing cases without marked brain symptoms, no improvement is possible, and only temporary arrest can be expected.

The worst possible cases are those in which, during some months or years, one eye becomes gradually blind, with irregular lateral contraction of the field of vision, diminution of S., and atrophy of the disc; and in which the second eye follows the first at an uncertain interval.

There are, finally, many patients who seek relief, not on account of obviously defective sight, but on account of fatigue and pain which attend upon, or even altogether forbid, any prolonged exertion of the eyes. Some of these cases depend upon unsuspected hypermetropia or astigmatism, either of which conditions would be detected by the methods of examination already laid down. Others depend upon hyperæsthesia of the retina, and are often relieved by blue spectacles. Others, again, depend upon weakness or insufficiency of the internal recti muscles, which become tired, and unable to maintain the convergence of the eyeballs required for close attention.

When the internal recti are weak, if we direct the patient to look steadily with both eyes at some object not much beyond his near point, and if we then interpose a hand, so as to shut out the object from one of his eyes, the eye thus excluded from the visual act will immediately lose its convergence, and wander outwards, usually beyond the median line. Distress from this affection is most common in myopic persons, who require to maintain habitually a greater degree of convergence than is necessary for others.