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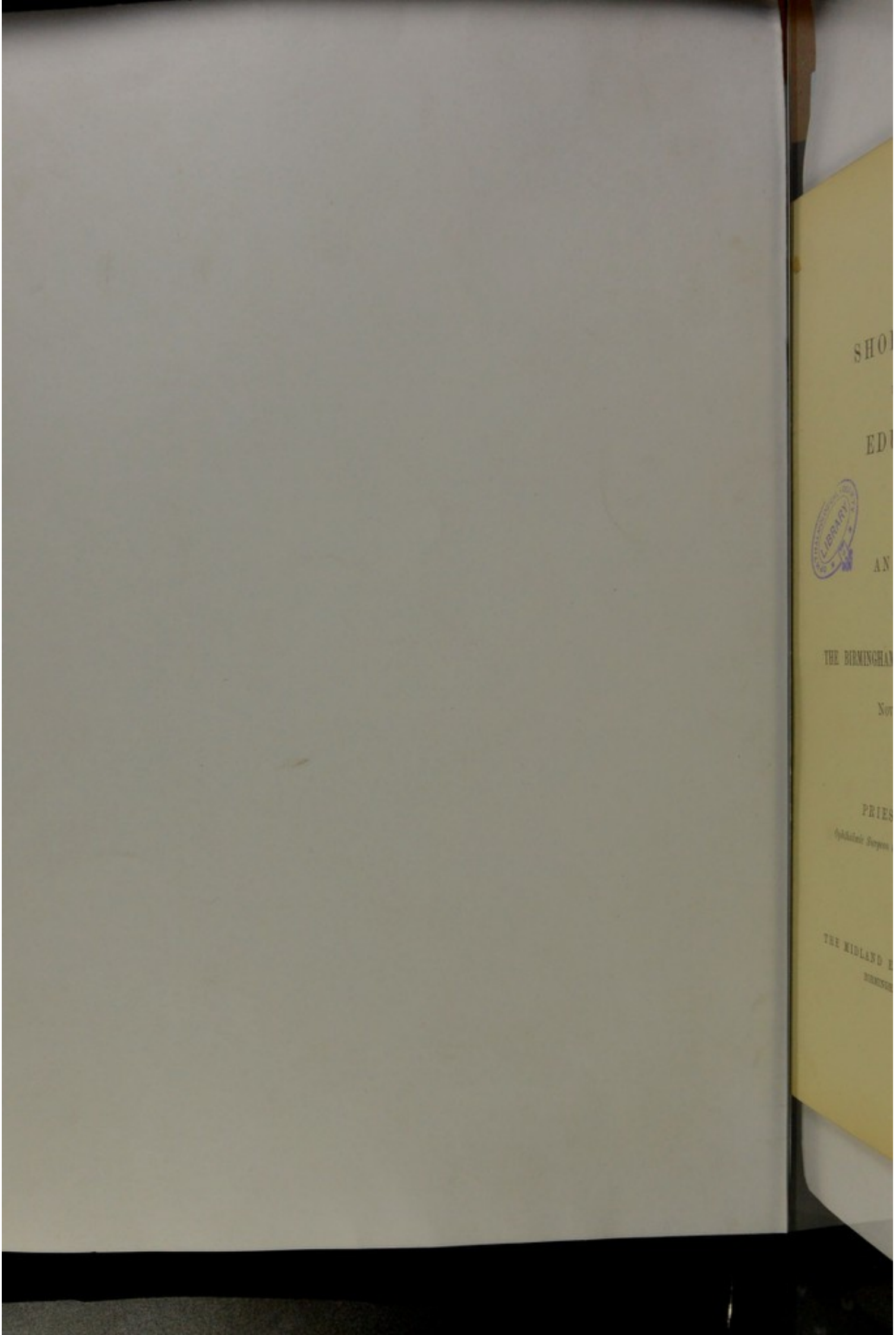

SHORT-SIGHT

IN RELATION TO

EDUCATION.

AN ADDRESS

DELIVERED TO

THE BIRMINGHAM TEACHERS' ASSOCIATION,

NOVEMBER 2nd, 1880,

BY

PRIESTLEY SMITH,

Ophthalmic Surgeon to the Queen's Hospital, Birmingham.

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PREFACE.

Since this Address was delivered an addition has been made to the statistics which it originally contained, by the examination of the eye-sight of the children in a third Board School, and of the students in two more Training Colleges. The addition is incorporated here. In one or two other respects that which was spoken is here slightly amplified.

On the last page is given a list of writings which deal with the connection between education and short-sight, and the measures necessary to the prevention of the evil. The list comprises only a very small part of the literature of the subject; it is given merely as a means of reference to some of the papers which have been published, as this address now is, with the object of bringing these matters under the notice of those in whose hands the great work of education lies.

BIRMINGHAM, *December, 1880.*

SHORT SIGHT

IN RELATION TO EDUCATION.

Mr. President, Ladies, and Gentlemen,

The invitation which I received from your Committee some months ago was a very welcome one for two reasons. In the first place I value very highly the honour which such an invitation carries with it, and in the second place I am extremely glad to have this opportunity of bringing forward the particular subject which is before us to-night. I believe that it is a subject of great practical importance, and I feel sure that its discussion by this Association cannot fail to do good.

The aim of my address will be this: To lay before you certain facts which show that the educational training of children and young persons, in so far as it requires the prolonged use of the eyes upon near objects, involves a tendency towards the development of short sight; and to point out the measures which are necessary in order to bring this tendency within the narrowest possible limits.

Let me state at once that there is very little that is new in what I have to say. The nature and the causes

of short-sight were described with scientific accuracy nearly 20 years ago by one whom all physiologists acknowledge as a leader, Professor Donders, of Utrecht. Since that time many careful investigations have been made, in Germany especially, concerning the part which school life plays in the production of short-sight. Addresses dealing with this question have been presented to learned societies both at home and abroad. The literature of the subject already constitutes a formidable pile. Nevertheless it is quite certain that, in this country at any rate, the subject has received less attention than it deserves. I therefore make no apology for bringing it forward again.

In order to understand what short-sight is, and how it is brought about, it is necessary, of course, to have a general acquaintance with the structure and the function of the eye. Those to whom these matters are familiar will, I hope, forgive me if I spend a few minutes in making sure the groundwork of my subject.

The human eye has been likened to the camera of the photographer, and certainly in some respects the likeness is a striking one. The essential parts of the camera are a convex lens to produce the picture, and a sensitive plate to receive it. Besides these the photographer must have a mechanism by which to adjust the focus of his instrument for objects at different distances, so that whether he is photographing a distant object or a near one he can cause its picture to fall accurately upon the sensitive plate. He requires a series of diaphragms by means of which he may admit more or less light into his instrument at pleasure. He requires a case to support and surround the whole, which case must be blackened internally, so as to prevent diffusion of the light within it. And, lastly, he requires some external mechanism

by which he can readily alter the position of his instrument so as to direct it higher or lower, to the right or to the left, as may be necessary. All these requirements are present in the eye also, and are admirably fulfilled by its several parts.

Near to the front of the eye (see Fig. I.), though at some little distance from it, lies the lens (L), the crystalline lens, as the anatomists used to call it. The lens consists of soft, gelatinous, living tissue, but as regards brilliancy and transparency it is little inferior to the brightest crystal; and in one important respect, of which I shall speak immediately, it is superior to any lens that was ever made, or ever can be made, of glass or crystal. At the back of the eye, and spread over the greater part of its internal surface, lies the retina (R.)—the sensitive plate, so to speak, upon which pictures of all things round about us are constantly being photographed. The retina is something more than a sensitive plate, however; it is part of a very complete and complex telegraphic apparatus. The retina is a delicate membrane made up of a vast number of minute bodies, placed together side by side like the squares of a mosaic. Each one of these minute bodies is capable of receiving a distinct photographic impression of its own, and each one is connected with a separate nerve fibre, along which it telegraphs its own particular impression to the brain. The optic nerve (O.N.) is merely a great cable in which all these minute telegraph wires are gathered together and protected during their passage to the brain. Deep down in the brain is the central office, so to speak, where the hosts of messages which are constantly pouring in from the retina are written off, read, and understood. Immediately in front of the lens hangs a coloured circular curtain, the iris (I.), in the centre of which is a round hole, the pupil.

This is the diaphragm of the camera. Enlargement of the pupil admits more light, contraction of the pupil admits less light to the interior of the eye, as may be necessary. The case which encloses and protects these parts is a tough, opaque, white coat, the sclera (Scl.). On the inner surface of the sclera lies a brown coloured membrane, the choroid (Ch.), which corresponds to the black lining of the camera. The choroid has also an important duty connected with the nutrition of the eye. The sclera is perforated at the back by the nerve fibres, which pass from the retina into the optic nerve, in front, it is completed by a strong transparent membrane, the cornea (C.), which fits into it somewhat as a watch glass fits into a watch. Between the cornea and the lens a space or chamber is left, so that the iris may have perfect freedom to dilate and to contract. This chamber is filled with a watery fluid, the aqueous humour. The other and larger chamber of the eye is filled with a gelatinous fluid, the vitreous humour. To the outer surface of the eye are attached certain muscles (M.M.), by means of which its movements are effected. These muscles enable us with marvellous ease, rapidity, and precision, to direct both eyes to any point within our field of vision.

We have still to notice the arrangement by which we are able at will to alter the focus of our eyes according to the distance of the object at which we look. Every one knows that the photographer must very carefully adjust the focus of his camera before he can obtain a clear picture. Perhaps it is less generally known that the eye in like manner is differently focussed for every different act of vision. A very simple experiment will prove the fact. I hold a piece of gauze at 10 or 12 inches from my face, and I look through it

at the clock at the far end of the room. While I look at the clock I cannot distinguish the meshes of the gauze. Now, if I look at the meshes of the gauze, the clock is blurred and indistinct. I cannot obtain clear pictures of both at once. In other words I must alter the focus of my eyes according to the distance of the object which I desire to see. How is this alteration in focus brought about? Entirely by a change in the shape of the elastic lens of the eye. When I look from a distant to a near object I make my lenses more convex; when I look from a near to a distant object I suffer them to return to their natural shape. There is no need for brass screws or sliding tubes such as the photographer makes use of, for our lenses are elastic and their shape is under our control. The effort by which we alter the shape of the lens so as to focus the eye for near objects is termed the effort of accommodation.

We have now to ask an important question. For what distance is the eye naturally focussed when no effort of accommodation is made? It is focussed for infinite distance, or in other words for parallel rays of light. That is to say, the retina lies at such a distance from the lens that if rays of light are to be accurately focussed upon the retina they must fall upon the eye in a parallel direction (see Fig. I.). Practically we may say that the eye is focussed without effort for all distances greater than 20ft., for rays which spring from a point as far away as 20ft. are so nearly parallel as they enter the eye that their divergence may be disregarded. Finally, it must be noted that the shape of the normal eye, excluding the cornea, is very nearly spherical.

Now let us turn from the normal to the abnormal eye. Unfortunately there are very many eyes which are not spherical in shape. Some are flattened so as to be

too short from front to back, others are elongated in the same direction. In either case the eye is out of focus. If the eye is too short the retina lies too near the lens, the rays of light fall upon it before they have met in a focus, the picture is ill defined. This error is extremely common, but inasmuch as it cannot be attributed in any way to improper or excessive use of the eyes it need not be considered in connection with our present subject. If the eye is too long from front to back (see Fig. II.) the retina lies too far from the lens ; the rays of light meet in a focus and again separate before they reach it. If the rays are to meet in a focus upon the retina they must fall upon the eye, not parallel, as in the case of the normal eye, but in a divergent manner ; in other words they must spring from a point near to the eye. The elongated eye, therefore, can only obtain clearly defined pictures of such objects as are near to it, and the more the eye is elongated the nearer must the objects be. This is the condition known as short-sight.

We know as a matter of fact that short-sight depends in a great majority of cases upon elongation of the eye-ball. The next step is to enquire what is the nature of this elongation, and what are the causes which bring it about. Three facts must be noted : The first is that the elongation is never present at birth. Even in children of five years of age it is very rare. It commonly begins a few years later than this, but having once begun it is very apt to increase from year to year until adult life is reached. It very rarely begins later than the 20th year. The second fact is that the elongation is not a healthy variation from the normal form ; it is a morbid condition due to overstretching of the tunics of the eye. The sclera is not strong enough to resist the pressure

which falls upon it from within. It yields, and as it yields, the eye elongates. Moreover, this overstretching of the sclera never reaches a high degree without causing damage to the more delicate membranes within—the choroid and retina. Such damage is visible in every highly short-sighted eye. The third fact is that the predisposition to become short-sighted is strongly hereditary.

A general explanation of these three facts is not difficult to find. In order to put the matter before you in as clear a light as possible, let me sketch the course of a typical example of short sight.

A child is born with eyes which to all appearance are perfectly sound and good. The father, we will assume, is short-sighted, but it soon becomes evident that the child has not inherited the defect, for he can see distant objects as well as any one. In due time he goes to school and learns to read and write. Day after day he uses his eyes for some hours upon his book, his paper, or his slate. Now, in looking at a near object the eyes assume a position of convergence. Each eye is turned or pulled inwards by the muscle which is attached to its inner side. This pull, inasmuch as it has to overcome a certain amount of resistance, increases the tension of the tunic of the eye—in other words it puts the sclera more tightly on the stretch. Besides this, in reading and writing the head is commonly bent forward over the work, and this position increases the fullness of the blood vessels inside the eye, and thereby increases the pressure which falls upon the sclera from within. From these two causes then—the convergence of the eyes and the bending of the head—it comes about that during the hours which are spent in reading and writing, or in any kind of near work, the tension of the sclera is somewhat greater than at other

times. Very slowly and by imperceptible degrees the sclera yields a little. A very slight elongation of the eye is the consequence, and the boy can now no longer distinguish distant objects quite so clearly as his companions can. For a while this attracts but little notice either from the lad himself or from those about him. As time goes on he rises from class to class and devotes more and more time to his books. The elongation of his eyes progresses slowly but surely. He begins to stoop more than before over his work, and is probably rebuked for doing so both at school and at home. The rebukes are of no avail however; he persists in stooping over his book for he cannot see to read it unless he does so. It now becomes clear that the boy is short-sighted. And now the mischief is apt to progress more rapidly than before, for cause and effect have begun to act and re-act the one upon the other in a vicious circle. The more short-sighted the youth becomes the more he stoops; the more he stoops the more short-sighted he becomes. And in another way the effect is apt to intensify the cause. Being unable to join on equal terms in the out-door games of his fellows, the youth is driven more and more to his books for company. He becomes the quiet, pale, near-sighted student whom we all know. This is no fancy picture. It truly represents what is going on continually in our schools and colleges.

Fortunately the process by which the eye elongates is not an interminable one. With every year of life the sclera naturally gains in toughness and resisting power, and by about the 25th year it is usually firm enough to resist further distension, unless it has been greatly weakened by previous attenuation, in which case matters inevitably still go on from bad to worse. It is usually between the 15th and the 25th years that short sight progresses most rapidly, for on the one hand at this age

the sclera still retains much of its youthful elasticity, and on the other hand it is during this period that the student works his hardest.

In the illustration which I have just given I assumed that the boy was born of short-sighted parents. What does this imply? It implies that he inherited not eyes which were already elongated at birth, but eyes in which the resistance of the sclera was below the mark;—eyes which were prone to elongate even under a strain which healthy eyes would have borne with impunity.

May we then console ourselves with the belief that provided we ourselves are not short-sighted, our children run no risk of becoming so? Unfortunately experience is against us. Even though hereditary predisposition to short-sight be entirely absent, there is always a danger of creating the defect *de novo* where young people are educated "not wisely but too well." And, in accordance with the laws of heredity, if fresh cases of short-sight are created in one generation, we may expect an increased predisposition to short-sight in the next. This is the theory which connects the educational progress of a people or of a class with the prevalence of short-sight amongst its members. In order to convince you that the theory is well founded I must trouble you with a few figures.

The first observation of importance relating to the prevalence of short-sight appears to have been made by a countryman of our own. In the year 1812 James Ware read a paper before the Royal Society, in which he pointed out that short-sight affects chiefly the educated classes. "I have enquired," he says, "for instance, of the surgeons of the three regiments of Foot Guards, which consist of nearly 10,000 men, and the result has been

that myopia" (*i.e.*, short-sight) "among the privates is almost utterly unknown. Not half-a-dozen men have been discharged, nor have a dozen recruits been rejected, on account of this imperfection, in the space of nearly 20 years." On the contrary, in the colleges of Oxford and Cambridge a considerable proportion of short-sighted persons was met with: in one college at Oxford 32 out of 127. Ware's mode of obtaining statistical information was not a very trustworthy one, nevertheless he shows clearly that in his day the educated classes were more subject to short-sight than the uneducated. Let me quote briefly the results of a more precise investigation made quite recently by a German physician, Dr. Seggel. He examined the eyes of 1,600 soldiers; he divided the men into classes according to the occupations they had followed previous to entering military service, and ascertained the percentage of short-sighted individuals in each class. It was as follows:—

Among countrymen who had been educated only in village schools	2	per cent.
Among day labourers, porters, &c., from towns	4	,,
Among artisans	9	,,
Among tradesmen, clerks and compositors	44	,,
Among university students .	58 to 65	,,

In the year 1865 Dr. Hermann Cohn, of Breslau, undertook a very extensive and laborious investigation, concerning the prevalence and the causes of short-sight amongst school children. He was led thereto, as he tells us in his preface, partly by observing how large a number of cases of short-sight came under treatment at the Eye Hospital of the town, partly by the fact that he is himself a sufferer from the defect. His results, published in 1867,

are of great value, as will be readily understood when it is stated that he examined the eyes of no less than 10,000 scholars of all grades, and that he very ably and thoroughly analysed the results so obtained. I can here do no more than mention the leading facts which he elicited. Short-sight existed in 10 per cent. of the whole number. It was much more frequent in the town schools than in the village schools; it was much more frequent in the advanced than in the elementary schools. Omitting fractions, it was present in 1 per cent. of the children in village schools, in 6 per cent. in the elementary town schools, and steadily increasing in frequency from the lower to the higher, it reached 26 per cent. in the highest classical schools or gymnasiums. In the higher schools the percentage rose from class to class in a striking manner. In the highest class of the gymnasiums—*i.e.*, taking all the gymnasiums together—it rose to the astounding height of 55 per cent. In other words more than half the scholars in the top class were short-sighted. To this it must be added that Dr Cohn did not include very slight degrees of short-sight. Eyes focussed for any distance greater than 3-ft. were classed with normal eyes.

Having examined the scholars, Dr. Cohn proceeded to examine the conditions under which they worked, especially with regard to the lighting of the class-rooms, and to the school furniture. The result was to show a clear connection between unsuitable seats and desks and bad lights on the one hand, and short-sight on the other. Other things being equal, where the light was worst there short-sight was most prevalent.

Investigations similar to those made by Cohn in Breslau have since been carried out by others in St. Petersburg, Lucerne, Wiesbaden, Bern, New York, and

some other cities. In all cases the results have pointed in the same direction. I will not trouble you with the figures. I will only say that to anyone who has the figures before him, it is impossible to doubt that in the countries to which they refer education has been largely, though, of course, not exclusively responsible for the prevalence of short-sight.

The most striking evidence of this connection is seen in Germany. Short-sight is more prevalent among the Germans than among any other nation in the world. Education is and has been for a long time past more general and more extensive in Germany than in any other country. Let me read a passage from a letter which Mr. Sonnenschein, of Anerley, was good enough to write to me in answer to a question upon this point. He says: "Actual compulsion, legally enacted, has existed in most parts of Germany for a century or more. * * * The hours of work in German elementary schools vary very considerably according to the different countries of Germany, and according to the locality of the school, namely whether it is a rural or a town school; but, on the whole, you are safe in assuming that the German school hours are longer than the English, and that the work is incomparable more arduous. There is hower, a reaction springing up in Germany against this severe pressure; parents, teachers, and, of course, children are raising a loud outcry against *Ueberarbeitung*—overwork." Bearing these facts in mind we need feel no surprise when we see that the wearing of spectacles is almost a characteristic of the highly-educated German. Great attention is now being given to measures of prevention, and if an enlightened school hygiene is able to arrest the further increase in the prevalence of short-sight, such an arrest ought now to occur in

Germany; but, on the other hand, where the active causes have already operated upon many successive generations, hereditary predisposition is doubtless strongly established, and this would seem to preclude the possibility of any but a very gradual disappearance of the evil.

Now, let us turn our attention nearer home and enquire what is our own condition in this respect. Foreign writers give us the credit of being remarkably free from short-sight. When Ware made his observations seventy years ago this was certainly true, at least as regards the lower classes, but we must not forget that at that time, and a good deal later, our lower classes were remarkably free from education also. This opprobrium is now in a fair way to be removed—are we to lose with it our prestige as being an exceptionally far-sighted people?

Although no systematic enquiry as to the prevalence of short-sight in this country has hitherto been made, there is not the slightest doubt that here, as elsewhere, it is much more frequent among the more educated than among the less educated classes. This is well known to those whose practice it is to treat disorders of the eye. I have recently had the curiosity to compare my registers of cases examined in hospital practice with those of cases examined in private practice during the last five years. Short-sight accounts for a little less than three per cent. of the former, eighteen per cent. of the latter. These figures, of course, possess no accurate value, for the number referring to hospital practice is swelled by cases due to accidents and other causes which are comparatively infrequent among the well-to-do, still the contrast is sufficiently striking to be worth noting.

It appeared to me that it would be both useful and

interesting to obtain accurate statistics as to the prevalence of short-sight at the present time in our newly-established Board Schools. If once such statistics are obtained on a sufficiently large basis, it will be possible at any future time, by repeating the examination, to ascertain whether in succeeding generations any increase of the evil has occurred. The Chairman and the Education Committee of the School Board readily granted the permission necessary for the prosecution of this enquiry, and, at the same time, asked for a report of the results, together with any suggestions which might arise therefrom for improvements in rooms, apparatus, or methods, with regard to the eyesight of the children. The Clerk to the Board and the Head Teachers of the schools visited furthered the object by every means in their power.

For the sake of comparison with the results obtained in the Board Schools, I sought permission to make a similar enquiry among the students of certain of the Colleges, in which young men and young women are trained for masters and mistresses of elementary schools. As in the former case, this permission was readily and courteously granted by the Principals. My reason for selecting the Training Colleges was this: The majority of the students have been pupil teachers in elementary schools — that is to say, they are drawn from the same class, or nearly so, as the Board School children, while not a few come from country districts, where short-sight is decidedly less frequent than among the population of large towns. It is, therefore, not unfair to assume that, on the whole, they inherit no greater tendency to short-sight than do the Board School children, and that any difference in this respect fairly indicates the effects of the additional years of study.

As yet I have examined the children in three large Board Schools, and the students in four Training Colleges.

The ages of the Board School children ranged from seven to thirteen years, the large majority being between eight and eleven. The children in the Infant Schools were not examined. The ages of the students in the Training Colleges ranged from eighteen to twenty-three. In all cases each scholar was examined separately, and each eye separately. Very slight degrees of short-sight were not taken into account, eyes focussed for any distance greater than forty inches being classed with normal eyes.

These are the results :—

1,636 children were examined ; viz., 873 boys and 763 girls. 86 were short-sighted in one eye or in both—generally in both.

In other words, short-sight was present in about *5 per cent.* of the children.

The girls presented a higher percentage of cases than the boys, viz. :—

Girls, 6·6 per cent.
Boys, 4·1 per cent.

This difference was present in each of the three schools.

357 students were examined ; viz., 183 male and 174 female students.

72 were short-sighted in one eye or in both—generally in both.

In other words short-sight was present in about *20 per cent.* of the students.

The percentage was nearly the same amongst the male as amongst the female students.

In round numbers, therefore, short-sight was four times more frequent in the Training Colleges than in the Board Schools.

The following table exhibits the results in somewhat greater detail :—

School A ...	Boys	261	Short-sighted,	13 =	5·0 per cent.
	Girls	259	"	20 =	7·7 "
	Total	520	"	33 =	6·3 "
School B ...	Boys	330	Short-sighted,	14 =	4.2 per cent.
	Girls	250	"	18 =	7.2 "
	Total	580	"	32 =	5·5 "
School C ...	Boys	282	Short-sighted,	9 =	3·1 per cent.
	Girls	254	"	12 =	4·7 "
	Total	536	"	21 =	3·9 "
Schools A, B, and C together ...	Boys	873	Short-sighted,	36 =	4·1 per cent.
	Girls	763	"	50 =	6·6 "
	Total	1,636	"	86 =	5·3 "
College A ...	Male Students	99	Short-sighted,	21 =	21.0 per cent.
College B ...	Female "	115	"	25 =	21·7 "
College C ...	Male "	84	"	17 =	20·2 "
College D ...	Female "	59	"	9 =	15·2 "
Colleges A, B, C, and D together ...	Male Students	183	Short-sighted,	38 =	20·8 per cent.
	Female "	174	"	34 =	19·5 "
	Total	357	"	72 =	20·0 "

The numbers upon which these percentages are based are, it must be confessed, small for statistical purposes—with time and opportunity I hope to extend them—but I think they suffice to show that the development of short-sight in connection with school and college life is a matter which demands the same careful attention in this country as it is receiving elsewhere.

Let us then proceed to consider what are the rational measures of prevention.

A sound *physique*—a healthy vigorous condition of the body generally—is antagonistic to the working of almost every morbid process, and even in the case of short-sight,

the causes of which are mainly local rather than constitutional in their operation, it has a powerful deterrent influence. An ill-nourished, pale, and lax condition of body lowers the resisting power of the eye, as of every other organ. It is no part of my present purpose, however, to speak of school hygiene in general. Ventilation, temperature, cleanliness, amusement, exercise, rest—these are matters the essential importance of which to scholars and students of all ages and of both sexes is universally recognised, if not universally respected. I will merely point out in passing that an impared *physique* brings with it, amongst other evils, an impared resistance to the active causes of short-sight.

We have seen that the principal active causes of short sight are:—

1. *Convergence of the eyes.*
2. *Stooping of the head.*

If therefore we are to prevent the malady we must diminish the action of these two causes; we must prevent young people from using their eyes too long and too closely upon near objects, and we must prevent them from stooping over their work. How is this to be done? It is not difficult to lay down the general principles, and beyond general principles I shall not attempt to go very far.

In the first place, a reasonable limit must be placed upon the time which the scholar spends daily in near work. To do this is not necessarily to devote all the remaining hours to idleness or play. Certain kinds of knowledge may be taught either by means of book, pen, and paper, or by the voice of the teacher, by question and answer, and by demonstration. I believe I am correct in saying that it is the tendency of the enlightened teaching of the present day to substitute the latter method for the former. Apart from any

educational advantages which it may carry with it, I would point out that such a substitution is an unmixed good for the eyes of the learners.

Further, it must be especially noted that the book work which the scholar does at home in the evening is done under less favourable circumstances than that which he does in a well-lighted and well-appointed school-room by day. One German writer goes so far as to say that no home work ought to be given to school children. How far such a restriction is compatible with a reasonable rate of progess in learning it is not for me to decide, but I learned with much satisfaction that this principle is actually adopted and practised by the Head Master of one of our Birmingham Board Schools. It is probably an older class of students, however, who err most seriously in this respect. Young men and young women, too, who pore over their books half through the night, should know the risk which they incur. A high place on an examination list is an object well worthy of ambition, but those who can purchase it only at the cost of permanent damage to their eyes, would do well to consider the penalty beforehand.

Let us suppose, however, that all unnecessary and immoderate use of the eyes upon near objects has been discontinued. A considerable amount of near work still remains inevitable. How is this to be done to the best advantage? The requirements are not difficult to state. They are these:—

1. The object looked at must be well illuminated.
2. It must be of a nature to be easily distinguished.
3. It must be so placed as to be viewed without stooping.
4. It must be viewed at a distance of not less than ten inches from the eyes.

An amply supply of light is the first requisite. Barring the direct rays of the sun, against which blinds should be employed, there cannot be too much light. Diffuse daylight is never, in this country at least, too strong for purposes of study. In bright daylight near to the window of a room a certain type is read easily at a certain distance; in a dark corner of the room the same type must be held much nearer to the eyes in order to be read as easily; and since the scholar naturally and habitually chooses the distance which enables him to read most easily, it follows that if it is our object to prevent undue approximation of eye and book the school-room must have large windows and plenty of them. A formula by which to regulate the size of the windows of a class-room has been arrived at by more than one practical investigator. It is said that the total window surface should be equal to not less than one-fourth (or at the worst one-sixth) of the floor surface. Even if such a rule is not universally applicable, it affords at least a useful standard for comparison. There are class-rooms the window surface of which might be doubled or even trebled, and still remain deficient according to this test. Further, it should be noted that since light which comes direct from the sky is far more powerful than that which is reflected from surrounding objects, it is the upper portion of the window which is of chief importance. The beauty of the narrow, mullioned, pointed Gothic window, especially if its upper part be filled in with coloured glass, is paid for by a heavy sacrifice of light.

Then, again, if light from the sky is to enter the room freely there must be a considerable space between the windows of the school-house and the opposite buildings. Here, also, a formula has been laid down for the ideal school; it is to the effect that the width of this external

space shall be equal to twice the height of the neighbouring buildings.

The direction in which the light falls upon the scholar and his book is manifestly a matter of great importance.

Light from above is perhaps the best in theory, but in practice it is hardly to be obtained. If every class-room is to have a glass roof the school-house must consist of one storey only; moreover, the accumulation of snow in winter, and the vertical heat of the sun in summer would commonly forbid such an arrangement.

Light from in front is, of all possible arrangements, the worst. The eyes of the scholar are dazzled by a full light, while his book, if placed in a sloping position as it ought to be, is comparatively in shade, or at best receives the light at a very unfavourable angle—an angle under which the illumination is very feeble, while every unevenness in the paper becomes visible and helps to obscure the type. The scholar inevitably brings the book nearer to his eyes than would be necessary in a better light. If, on the other hand, he places his book in a horizontal position or even slopes it forwards in order to catch the light, then he must bend down over it while he reads. In either case he adopts a posture which, as we have seen, favours the development of short-sight. It ought to be an invariable rule, that while engaged in reading, writing, or any kind of near work, the scholar shall not sit or stand directly facing the light. This rule, I would point out, does not apply with equal force to desks which are placed immediately under the window, an arrangement commonly adopted in offices, for in this case if the windows are fairly high the light comes chiefly from above.

Light from behind is manifestly bad, for the shadow of the head falls upon the work.

Light from the side is, then, the only mode remaining open to us, and this is the mode universally adopted by those who have given attention to the subject. If the light is to come from one side only it should come from the left, for then the hand of the scholar throws no shadow upon what he writes. Experts are still at variance, however, as to whether the class-room should be lighted from one side only or from both. There appears to be little valid objection to bilateral illumination, provided always that the light which comes from the right does not overpower that which comes from the left. Under this condition the admission of additional light from the right is a distinct advantage.

The conditions under which a class-room is lighted most advantageously are these:—The room is oblong in shape; the desks of the scholars are placed across the room parallel with its ends; the long wall to the left of the scholars contains windows as large and as high as possible; the long wall to the right of the scholars may advantageously contain additional smaller windows, placed high up in the wall, so that the light falls upon the desks rather from above than from the side.

The fundamental rule with regard to the direction of the light, I will venture to repeat, is this, and it is applicable no less to school-rooms as they now exist than to the ideal school-rooms of the future:—*The scholars should be placed so that the chief light falls upon them from the left.*

One word as to *artificial light.* Since artificial light even at the best is greatly inferior to daylight, it is all the more important to employ it to the very best advantage. A central crown or circle of burners, such as one sometimes sees, high above the heads of the scholars, is not a good arrangement. The light is wasted in proportion

to the square of the distance between the burners and the desks. For example, if a burner which hangs at a height of twelve feet above the desks is lowered to a height of six feet, the light enjoyed by the scholars is increased thereby, not twofold merely, but fourfold. And moreover, light which issues from a central source must fall in wrong directions in certain parts of the room. The desks should be illuminated by a row of burners placed not many feet above them, and somewhat to the left. Ground glass globes, which greatly diminish the intensity of the light, should be replaced by transparent chimneys for the sake of clearness and steadiness; and reflectors may be added with great advantage. Under certain circumstances the reflectors may play the part of screens also, to prevent the light from falling in unfavourable directions.

Our second requirement related to the *nature of the objects looked at.* Within certain limits objects are distinguishable in proportion to their size. If a given type is legible at 24 inches from the eye and no further, a type of half that size will be legible at 12 inches and no further. Again, objects are distinguishable in proportion as they form a contrast with the surface on which they stand. Black letters on a white ground are legible at a greater distance than similar letters on a grey or yellow ground. Bearing always in mind that our object is to prevent undue approximation of eye and book, it is obviously desirable that school books should be printed in type of good character and size, and upon paper of a good white and of a sufficient thickness to conceal the letters on the other side of the leaf. I have before me the very extensive works of a well-known writer, complete in one volume, which is sold for a shilling, subject to a liberal discount. The type is

extremely small; the paper is extremely thin. Even in bright daylight the book must be held very near the eyes in order to be read with ease. I have no doubt that those who brought out this work believed that they were conferring a benefit upon the public. From my point of view they were conferring an injury—an injury wide spreading in proportion to the demand for the book. This work is mainly of a theological character; possibly it may not as yet have injured the eyes of very many youthful readers; but as surely as books which are freely read by the young, whether for pleasure or for instruction, are published in this form, so surely will short-sight increase amongst us.

It is not merely the size of the type which should engage the attention of printers of school books. The proportions of the letters, the proportionate thickness of their different parts, the distance which separates each letter from its neighbours, and the distance which separates the lines — all these affect in a remarkable degree the legibility of the type. A distinguished French physician, Dr. Javal, has quite recently been experimenting upon these points, with special reference to the welfare of school children. His results when published will, it may be hoped, effect some valuable improvements in the school books of the future. There can be hardly any doubt that one of the causes of the excessive prevalence of short-sight in Germany is the nature of the characters in which German school books are printed. As compared with Latin characters of the same dimensions, the Gothic must be placed considerably nearer to the eye in order to be read with equal ease.

Slates must not be passed by without mention. A slate is not black, letters written upon it with a slate pencil are not white, the contrast between the two is

therefore, very feeble as compared with that presented by black letters on white paper. As a matter of fact the writing on a slate is almost invisible in the darker parts of some school-rooms, or only visible when held very close to the eyes. I have seen a row of little boys, standing up, their faces directed towards the window, their slates hugged against their chests and within a few inches of their eyes, striving with greasy pencils to unravel the mysteries of arithmetic. Surely the subject is hard enough without unnecessary difficulties. It would be well, if it were possible, to abolish slates entirely in favour of some kind of permanent-pointed pencil and cheap paper. Economy will probably forbid. But at least it is possible to provide that children using slates shall do so when light is brightest and not when it is worst, and that they shall be so placed that the light may fall upon their slates and not upon their faces.

The same remarks apply to needlework, perhaps even more forcibly than to slates, for the contrast between the stitches and the stuff is feebler still than that presented by the writing on the slate, and stitches are, or ought to be, smaller than any written letters. I cannot help surmising that it is needlework which explains the fact that among the Board-school children examined by me, short-sight was in each of the three schools more frequent among the girls than among the boys.

This is hardly the place to refer to the excessive devotion to fancy needlework which is sometimes met with in a higher class of life. I will only say that it is hardly less injurious than an excessive devotion to study.

Our third requirement was that *the object looked at shall be so placed as to be viewed without stooping.* If I desire to read, standing as I do now, with head erect, I instinctively hold my book in a sloping position and on

a level somewhat below that of my eyes. Both the slope and the level are chosen, not by chance, but in accordance with physiological demands. In no other position of the book could my eyes scan the whole of the page so easily. If I hold the book horizontal instead of sloping, the axis of my vision falls very obliquely upon the page, the upper lines are much farther away from my eyes than the lower lines, and the letters are reduced in height by foreshortening. It is most unpleasant to read with the book in this position. So, as the book will not wait upon the head, the head must wait upon the book, and I bend forward until head and book form the same angle with each other as before. It is evident that if school children are not to stoop over their work they must read and write, not at flat tables, but at sloping desks, Dr. Liebreich prescribes an inclination of 40 degrees for reading and an angle of 20 degrees for writing. The well-known Liebreich desk is so constructed that by the turning down of a flap the reading slope is converted into the writing slope.

But in order to prevent the scholar from stooping while he reads and writes, it is not enough to provide him with a sloping desk; his body must be supported in the erect position. In the absence of such support he cannot and will not for long together sit upright on his seat. He will lean forward, sometimes with chest against the desk, sometimes with arms and elbows upon it, generally with rounded back and lowered head, and always with eyes unnecessarily near to his work. Occasionally a child may be seen laboriously writing on his slate or in his copybook, while his head positively rests upon the desk with nothing but a hand or fist between. Bad positions such as these involve a tendency to permanent distortion and curvature of the spine, as well as a tendency to short-

sight, and if either of these defects be developed it serves to confirm and to increase the tendency to the other. Dr. Liebreich especially insists upon the inter-action of these two conditions, and forcibly expresses their connection in words which at first sight seem paradoxical. He says, "A back rest is necessary to avoid short-sightedness, and good light is necessary to avoid curvature of the spine."

I will not venture to give a positive opinion as to which are the best of the many patterns of school desks and seats which have been devised during the last few years. I will simply point out, so far as the published opinions of others and my own observations enable me to judge, what are the essential features of a good desk and seat.

1. The seat should be of such a height as to allow the feet to rest flat upon the floor, or upon a foot board, and it should be broad enough to support the greater part of the thigh.

2. The seat should have a back shaped and placed in such a manner that it fits into the concavity of the back below the shoulder blades, and supports the body in a vertical position.

3. The seat should be so placed with regard to the desk that the support to the back may be maintained during writing; and to this end the edge of the desk should be vertically over the edge of the seat, or still better should overhang it to the extent of an inch or two.

4. The desk should be just so high above the seat that when the child sits square and upright with elbows to the sides the hand and fore-arm may rest evenly upon the desk without raising the shoulder.

5. The desk, as used in writing, should have a slope of from 15 to 20 degrees; as used in reading it should

support the book at an angle of about 45 degrees, and at a distance of not less than 12 inches from the eyes.

6. The desk and seat should be so arranged that the child may be able to stand upright in his place, and this in spite of the fact that the desk should overhang the seat while he writes.

7. The desks and seats should be of various sizes in order that the foregoing conditions may hold good for scholars of different ages.

Much ingenuity has been devoted to carrying these desiderata into effect. Of the merits of the different schemes the practical teacher will unquestionably be the best judge, provided that he thoroughly appreciates the physiological aspect of the matter.

If much home-work is to be done, a suitable arrangement for reading and writing is almost more necessary in the home than in the school, for in the evening the scholar has to work under the unfavourable condition of artificial light; being tired he is even more apt than by day to assume faulty positions of head and body; and he is commonly under no skilled supervision. Of course we cannot expect to see expensive and cumbersome school furniture introduced into the sitting-rooms of private houses. What is wanted is a small, light, and inexpensive desk, which may be placed during lesson-hours upon the sitting-room table, and which will provide the requisite slopes for reading and writing. For young people in whom short-sight is already present and shows a progressive tendency, such an appliance is a *sine quâ non* of safety. This very simple desk which stands before me on the table (Fig, 3) is one which I have recently designed for home use. As used in writing it presents an even surface, 17 inches square,

which has a slope of 16 degrees. For reading, the further part is raised by a stop to an angle of 45 degrees, the act of raising it creating a groove in which a book will rest securely. The position of the reading slope at the further part of the desk aids in preventing an undue approximation of eye and book. In copying from a book, or in using two books simultaneously, as, for example, in translating with the help of a dictionary, the two slopes may conveniently be used together.* In using this or any other form of desk, the height and position of the seat should be adjusted in accordance with the rule already given.

Our fourth and final requirement was that *a distance of not less than ten inches shall be maintained between the eyes and the work.* This distance, and the erect position of the head, are the end and aim of all the foregoing regulations for near work. Place the normal-sighted scholar from the commencement of his school life under the conditions which have been set forth, and he may be taught to study in a healthy and natural position, which will involve little if any undue strain upon the eyes—little if any tendency to the development of short-sight.

The question has been seriously asked whether any nation or community can hope to enjoy the blessings of a liberal education without paying the penalty of a steady increase in the prevalence of short sight. I would say in answer: It is the abuse, and not the use, of the eyes in near vision which does the injury. It is as natural and as healthy an act to bend the gaze upon a near object as to direct it to a point upon the distant

* The Midland Educational Company, of New Street, Birmingham, have undertaken, at my request, to make a desk similar to the model exhibited.

horizon—the mechanism provided for the purpose proves that it is so—and in this case, as in all others where natural healthy actions are in question, it is the over-doing, and not the doing, which we have to fear. There is, as yet, no evidence to show that education, rightly and reasonably pursued, is incompatible with the permanent preservation through one generation after another of the healthy form and function of the eye. At any rate let us not declare the dreaded evil to be inevitable until we have fairly tried the rational measures of prevention. To bring these measures into full operation will of necessity be a difficult task. Perfection as to every detail is hardly to be looked for even in the schools of the future, while in many existing schools it is manifestly impossible. Still there are places where certain sorely-needed reforms might be introduced at once, without much difficulty and without much expense. I respectfully but very earnestly suggest that the matter is one which well deserves the attention of the members of this Association.

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4. Die Zunahme der Kurzsichtigkeit an den Hoeheren Unterrichtsanstalten. By Dr. Seggel. 1878. Finsterlin, Munich.
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N.B.—In many of the above-named publications, references are given to other works not included in this list.

Fig. 1.

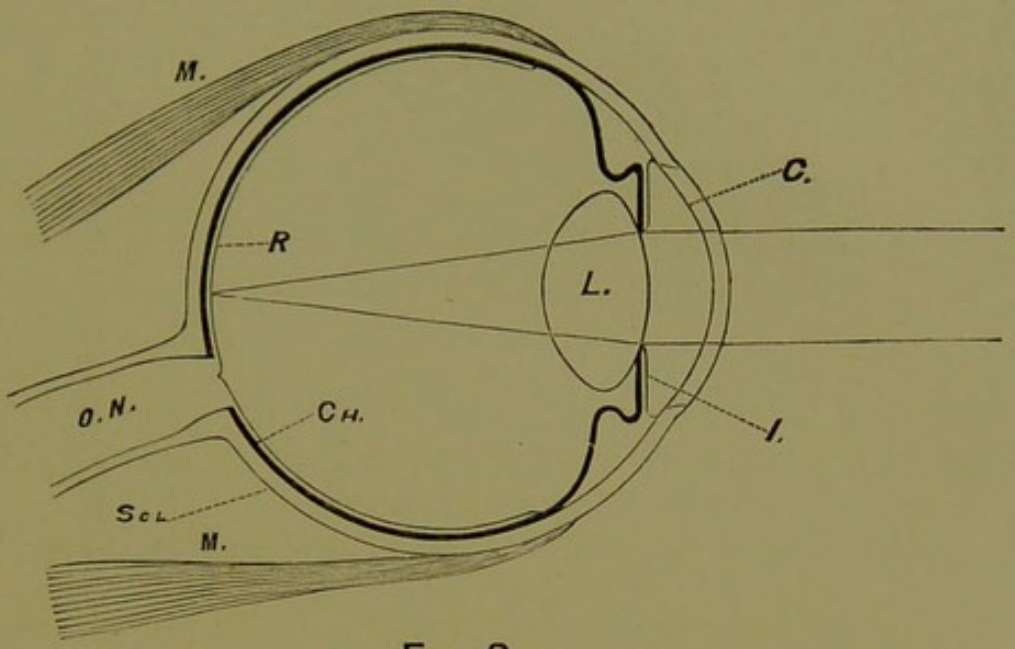

Fig. 2.

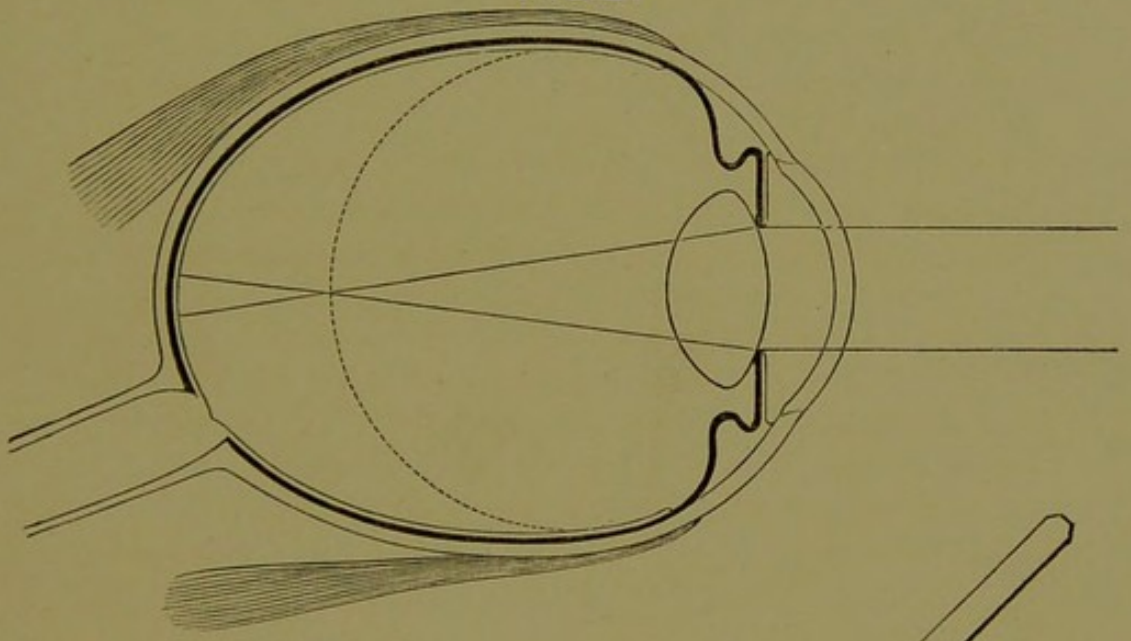

Fig. 3.