**Eyesight in civilization / by Robert Brudenell Carter.**

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# CIVILISATION.

BY

ROBERT BRUDENELL CARTER, F.R.C.S.,

LATE HUNTERIAN PROFESSOR OF PATHOLOGY AND SURGERY TO THE ROYAL COLLEGE OF SURGEONS OF ENGLAND;
OPHTHALMIC SURGEON TO ST. GEORGE'S HOSPITAL;
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# PREFACE.

A LETTER which I contributed to the *Times* paper, on "The Influence of Civilisation upon Eyesight," and which appeared in the impression of the 16th of September, has received so much attention that I have thought it desirable to re-issue it in a separate form. I have availed myself of the opportunity to add a few lines to the original text, and also to introduce diagrams where they seemed likely to assist in rendering clear my meaning.

27, QUEEN ANNE STREET W.,
*October*, 1884.

# EYESIGHT IN CIVILISATION.

A FEW weeks ago, I was deputed by the Medical Society of London to defend, at a conference upon "Over-pressure in Schools," held at the Health Exhibition, the proposition that "long hours of confinement in what is too often a vitiated atmosphere, coupled with the other ordinary conditions of school work and discipline, exert a hurtful influence upon the physical development of the frame, especially upon the heart and lungs and upon the organs of vision, and that this influence is so considerable that it must already be regarded as a matter of national importance."

In considering the full meaning of this proposition, I was compelled to admit to myself that, as far as the organs of vision are concerned, its terms might with propriety have been more comprehensive. The evil effects of some kinds of schooling upon the sight, and upon the development of the eyes, form only a part, and probably not even a chief part, of similar effects which are incidental to many conditions of civilised life, as these are brought to bear both upon adults and upon children. I believe the conditions in question would in many instances admit of being modified, or that the influence which they now exert might be counteracted; and that, for this purpose, the chief thing required is the direction, to the eyes and to their functions, of the same amount and kind of attention which is at present bestowed upon other physical

capabilities of the human race. What I may fairly describe as national neglect of the culture of the eyes, and of efforts to improve the faculty of seeing, is chiefly due to the ignorance which prevails concerning the proper range and scope of the visual function, and hence concerning the powers which the eyes ought to possess. To quote what I have written elsewhere, few things are more remarkable than the imperfection of common knowledge about all matters which relate to the use and functions of these important organs. In most other respects, it may be said that the majority of parents have a fair notion of what ought to be the average capabilities of children. They know, approximately at least, how far a boy of ten years old could reasonably be expected to walk, how high or how far he could jump, how fast he could run, what weight he could carry, what force he could exert. There is not one parent in 500 who has the smallest notion how large an object, say a capital letter, a boy ought to be able to see clearly at 100 feet away; or who could tell at what distance he ought to be able to see and describe the characters of an object of given magnitude. There is not one parent in 500 who can say off-hand whether his children possess natural acuteness of vision, or to whom the phrase, "natural acuteness of vision," would convey any definite idea. There is not one parent in 500 who can tell whether his children possess natural colour vision; or who, if the inquiry were suggested to him, would know how to discover the truth. Mr. Francis Galton has pointed out, with great force and lucidity, that one of the most important duties of man, at the present stage of his development, is to regulate the progress of the evolution of his race; and one consequence of want of knowledge about vision is that the evolution of the eye has been left to be the sport of accident, or that it has even been injuriously affected by many of the circumstances incidental to civilisation. I think there can be scarcely a doubt that these circumstances might to a great extent be controlled.

It is recorded by Humboldt that he was travelling in South America under conditions which rendered it necessary for the party to divide, and to reach their destination by different routes. As he and those who remained with him approached the appointed meeting place, he said to the Indian guide that he wondered what had become of the others. The guide looked at him with some surprise, and pointing across a wide mountain gorge, one side of which they were traversing, replied "There they are." Humboldt himself could see nothing but rocks and verdure, but ultimately, being assisted by the guide as to the position of the other party, succeeded in discovering them by the aid of a telescope; and then, by making the guide describe the order of march and the relative positions of the several individuals, obtained proof that he actually saw them plainly with his unaided eyes. An experience of equal significance, if of a less striking character, may be had in any Highland deer forest, where deer, which are conspicuous to the eyes of the keeper, can only be seen with difficulty and uncertainty, and after much pointing out of neighbouring land marks, by visitors who are habitual dwellers in towns. In other words, the acuteness of sight of the average citizen is much inferior to that of the average Scotch forester; while the acuteness of sight of the forester is probably much inferior to that of the savage. People are too prone to accept this as something necessary or inevitable, and to think of the forester or the savage as the possessor of some special acuteness which has been conferred upon him by training and practice, instead of thinking of the citizen as a person who by reason of unfavourable circumstances falls short of the acuteness of vision which he ought to possess. The view thus taken is the more remarkable, since the average citizen of the better classes, say, the average member of a volunteer corps, would be fully equal to the forester or the savage in other points of physical efficiency; and the selected English citizen might be confidently expected to hold his own against any

athlete in the world. In running, in jumping, in rowing, in every game which requires skill, strength, and endurance, the young urban Englishman excels; but his sight has been suffered to decline in acuteness by sheer neglect; and the conditions of his life have also produced two kinds of deformity of the eyeball, the short-sighted eye and the flat or hypermetropic eye, each of which constitutes a serious deterioration in the organs of the visual sense. It is worth while to inquire why the eyes have been thus neglected, notwithstanding the attention so rightly paid to other matters of physical training; and to inquire also whether it may still be possible to retrieve the consequences which this neglect has already occasioned.

In order to understand the practical bearing of the subject, it is not necessary to have any minute knowledge of either optics or anatomy, but it is necessary to have a general notion of the way in which seeing is accomplished. The essential parts of the eye have their analogues in a photographic camera. They consist of a lens which produces a diminished image or picture of external objects, and of a screen on which this picture is received. In the camera, the lens is of glass, and is contained in a tube which is inserted into the front of a wooden box; while the screen is of ground glass, and forms the back of the box. Assuming the lens and the screen to be so placed in relation to each other that the former would cast and the latter would receive a perfect picture of a distant object, the picture of any intervening nearer object would be blurred or indistinct; and, in order to render it perfect, either the strength of the lens would have to be increased, or else its distance from the screen. In the camera, the glass lens being of invariable strength, provision for obtaining clear pictures of either near or distant objects is made by arranging that this lens may be moved nearer to or farther from the screen; but in the eye, the lens being of elastic living tissue, the same provision is made by a muscle which increases the degree of its convexity, and

thus increases its optical strength. In the normal or ideal eye, with which at first we are concerned, the proportions are of such a kind that the screen receives a perfect picture of distant objects when the eye is passive, and a perfect picture of near objects when the lens is rendered more convex by its muscle. The muscle is called the muscle of accommodation, and its effect, the placing the eye in a state to see near objects acutely, is called the act of accommodation.

In the eye the screen which receives the picture, and which is made of ground glass in the camera, is composed of a delicate layer of nerve tissue; and the perceptive portion of this layer consists of a fine mosaic, so to speak, formed by the terminations of nerve fibres. The finer the mosaic, or, in other words, the smaller the terminations of the fibres, and hence the greater the number of such terminations which fall within a given area, the greater will be the acuteness of sight; something in the same way that if the ground glass of the screen were very coarse, it would only show with distinctness the outlines of a tolerably large picture; while if the ground glass were very fine it would show with distinctness the outlines of a picture comparatively minute. In a general way it may be said that the size of the nerve terminations which form the mosaic bears a definite relation to the smallness of the smallest point or object which can be seen; so that a person in whom these terminations were of a given magnitude would see a smaller object than would be visible to one in whom the terminations were larger. Besides form, however, objects are rendered visible by colour; and the power to discover slight differences of tint between objects and their surroundings implies a corresponding development of the colour-sense, which appears to be a special endowment of a particular group of nerve-fibres. The importance of this endowment in relation to acuteness of vision will be perceived when it is remembered how much some animals are defended by their power to assimilate themselves to the colour of the objects among which they move—fish to the

colour of the bed of the stream, birds and insects to the colour of foliage and other surroundings, and so forth. In the human eye, the nerve terminations upon the screen, or, as it is technically called, the retina, are of two kinds, distinguished by their shape as "rods" and "cones," and the cones are more sensitive to colour than the rods, besides possessing a more delicate susceptibility to other sensory impressions. The cones are most abundant in the central part of the retina, and are comparatively sparingly distributed over its lateral portions; with the result that vision with the central part is much more acute, both as regards form and colour, than vision with the lateral parts. The portion of the retina in which vision is most acute differs from the surrounding portions in tint and in thickness; and hence is called almost indifferently, the "central depression," or the "yellow spot." The size of the yellow spot probably varies in different persons; but the limit of acute vision is usually about sufficiently large to include the width of the nail of the forefinger, when the hand is held as far as possible from the eye The image formed upon the retina by the optical apparatus of the eye is complete in all its parts; and embraces an area of about 160 deg. from side to side and of about 120 deg. from above downwards; but of this comprehensive image only the small central portion is in reality accurately seen. We obtain clear definition over a space which, at the distance of a yard from the eye, would include perhaps five letters of the type in which this page is printed. Within such a space a normal eye should be able to distinguish two points separated by about a 60th part of the space itself, or by one minute of angular measurement; but, beyond its boundaries, vision becomes progressively less and less distinct up to the limits of the field. The image perceived by the consciousness has been well compared to a drawing the centre of which is exquisitely finished, while the marginal parts are merely sketched in outline. Of these we see, indeed, enough to call our attention to any noteworthy objects, towards which, as soon as we are thus warned of

their presence, the direct gaze will be immediately turned, allowing the previous object of regard to pass out of sight, or to lapse into marginal indistinctness. The mobility of the eye almost neutralizes, so to speak, the narrowness of the field of exact vision : insomuch that the fact of this narrowness is unknown to the majority of persons, and becomes a matter of surprise when shown by observation or experiment. In technical language, the acute vision with which we see the objects to which the gaze is directed is called direct vision ; and the imperfect vision, which renders us conscious of the main outlines of lateral objects, is distinguished as indirect. The former is the function of the region of the yellow spot only, the latter, of the whole of the lateral portions of the retina.

Assuming the eye to be of proper shape and proportion, the degree of acuteness of vision in the central part depends mainly upon two elements—namely, the size (or rather the smallness) of the nerve terminations, and the acuteness of the sense of colour. There is reason to believe that a nerve termination is not stimulated or impressed by an image smaller than itself ; and that therefore, the finer the mosaic of the terminations, the smaller will be the images of which they can take cognizance. The influence of the colour sense needs no demonstration. A person who was colour blind would be unable to see any indication, at a comparatively short distance, of soldiers clothed in red who were standing among foliage, or to discover ripe cherries among the leaves around them ; and it is obvious that, when the colour sense is unusually acute, objects may be distinguished by its help when they would be undiscoverable by mere outline.

The magnitude of the retinal image formed by any object, and therefore the visibility of that object, depends partly upon its size, and partly upon its distance from the eye, and hence admits of angular measurement, and of simple numerical expression. Assume the object to be a vertical column, such as a flag-staff. The height of its image upon the retina would be the distance between two

straight lines, proceeding originally from the base and the summit of the flag-staff, meeting at an angle at a point a short distance within the eye, overcrossing from that point, and impinging upon the retina at a distance from each other determined by the magnitude of the angle. This is called the visual angle; and it is obvious that a small object near at hand will be seen under as large an angle as a larger object which is more remote. In Fig. 1, let C represent the crossing point of the lines within the eye, and A B the flag-staff. A C B will then be the visual angle of the flagstaff, and *a b* will be the height of its image upon the retina. But the smaller flag-staff, A′ B′,

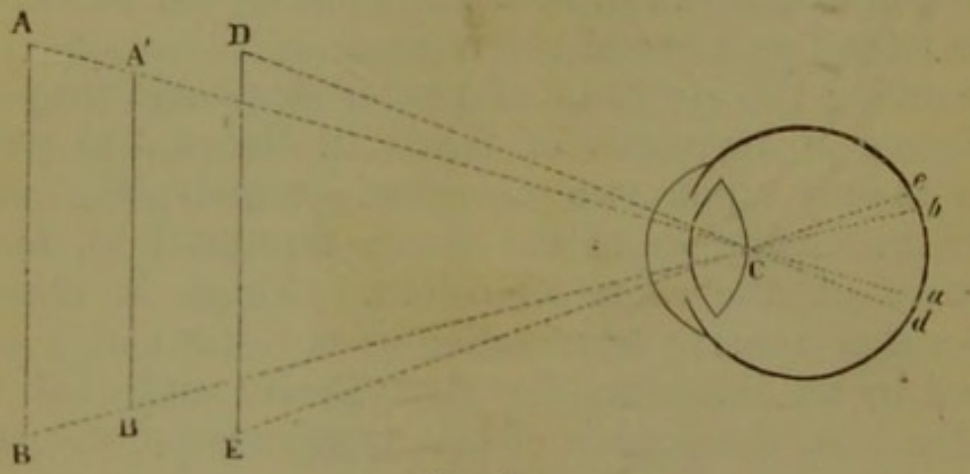


Fig. 1.

which is nearer the eye, will be seen under the same visual angle, and will form an image of the same magnitude; while the flag-staff D E, which is equal in size to A B, but nearer, will be seen under the larger visual angle D C E, and will form the larger retinal image *d e*. The mental conception of the magnitude of any object of vision is therefore dependent upon the idea which is at the same time formed of its distance; and size and distance are the two elements by which visibility is determined. The size of the object which can be seen at a given distance, or the distance at which an object of given size is clearly visible, are used as tests of what is called the "acuteness of vision."

Of this "acuteness" it is necessary to have a standard;

and it is found that, among dwellers in towns, whose eyes are properly shaped, letters of block type can be clearly seen when they are of such a size, and placed at such a distance, that their limbs or parts subtend a visual angle of one minute, and the letters as a whole an angle of five minutes. Such letters are shown in Fig. 2, in which the larger L fulfils the required conditions at a distance of eighty feet, while the smaller L fulfils them at a distance of thirty feet. To read the former at eighty feet is the same thing, and indicates the same acuteness of vision, as to read the latter at thirty feet; and a person with sound

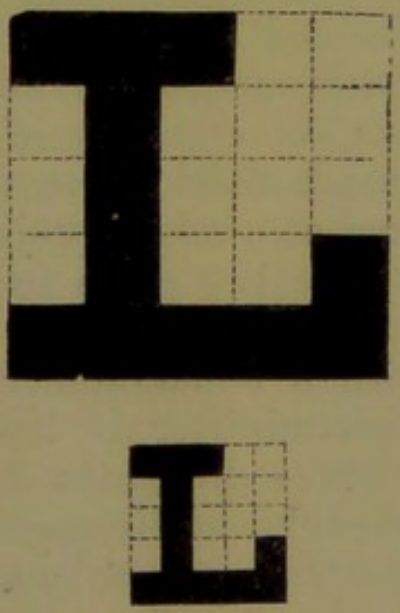

Fig. 2.

and well formed eyes should be able to do either. Upon the same basis we have what are called "test-types," of many sizes and arranged for many distances; and persons who cannot attain to the prescribed standard are said to have "sub-normal vision" It should be observed, moreover, that the standard itself is of a very moderate kind, and that it falls below the average vision of young and healthy townspeople by almost one-eighth.

If we now turn to the consideration of the circumstances by which acuteness of vision is produced or promoted, we find that the eye consists essentially of the same structural elements as the skin, and that these elements have been

modified, in the course of ages, in such a manner as to specialise them for the discharge of a particular function. It requires but a small exercise of the scientific imagination to go back to the time when the common ancestor of man and of many other animals was in the visual condition which we now see exemplified in the earthworm—that is to say, possessing at its anterior extremity a nerve covered by the common integument of the body, but capable of being stimulated to sensation by the influence of light. From this stage onwards the development of the eye has been a matter of evolution and natural selection, with the general result that in some animals, as in the raptorial birds, vision has attained a degree of acuteness to which the human race affords no parallel, and that in civilized man, from sheer neglect and lack of cultivation, it has fallen below the standard which savages still maintain, and to which civilized men might probably in time return, if they would but take the pains to do so. The great acuteness of vision of some of the lower animals is manifestly associated with a remarkable development of the nervous organs which minister to the colour sense, and there are therefore three directions in which the human eye might be improved by wisely-guided evolution. The retinal region of acute vision might be enlarged, and within that region vision might be rendered more acute, first by a finer structure of the nerve terminations and by an increase of the number of the cones relatively to the rods; and secondly, by a development of special organs of colour sense.

I have already spoken of the function of accommodation as that which arranges the eye to obtain clear vision of near objects, *e.g.*, of such as are held in the hand; and in all testing of vision for scientific purposes we exclude accommodation and near objects, and use only tests which are at least eight or ten feet away, or preferably still more distant. I have also referred exclusively to eyes of proper shape and proportions, otherwise called normal or "emmetropic" eyes. These have their full acuteness of distant

vision when they are at rest or absolutely passive, and only require their shape to be modified by "accommodation" when they are directed to quite near objects. They may also be said to be approximately spherical in outline.

Not only has the acuteness of vision of civilized man fallen below the standard common among savage nations, but at the same time the eyes of civilized man often depart from the normal or approximately spherical formation. They depart from it in two opposite directions; either becoming flattened from front to back, so as to bring the retina too near the surface, or elongated from front to back, so as to remove the retina too far from the surface. The former condition, technically called "hypermetropia," demands the exercise of accommodation even for distant objects, thus becoming a source of fatigue to the eyes; and it is also the common cause of squint. The latter, technically called "myopia," is the cause of short sight. These two malformations may be said to have come into existence within historic times, and into prevalence almost within living memory.

Hypermetropia, or "flat-eye," may be regarded as a matter of arrested development. The eye is flat because it has not attained its full proportions. It is stunted, and the imperfection is seldom limited to the shape of the organ as a whole, but usually extends also to its component parts. The retina of a flat eye is commonly defective, so that vision, even when assisted by glasses which correct the fault of shape, falls short of the normal standard. It goes without saying that hypermetropia is favoured by all circumstances which interfere with complete bodily development, and that it is most common among a population living in unwholesome conditions.

The original cause of myopia, on the other hand, seems to be the application of the eyes to near objects; in other words, the poring over books and handicrafts. When the eyes are directed to a near object they are turned in, or rendered convergent, so that the axes of vision meet upon it, and this position is maintained by a muscular effort

which, if continued, alters the shape of the eye in the direction of elongation. Manifestly, the alteration will be most easily affected during youth, when the tissues of the body, including those of the eye, are comparatively lax and distensible, and it will also be most easily affected among those young people whose tissues are exceptionally weak, by reason of inadequate food or of unhealthy descent or surroundings. Badly lighted schools are the great manufactories of myopia, the bad light compelling approximation of the books or other materials of study.

There is yet another defect of shape, called astigmatism, which merely means that the surface of the eye is differently curved in different directions. All three, flat-eye, myopia, and astigmatism, however produced originally, are peculiarities of shape which are constantly handed down by parents to their offspring.

With regard to the actual prevalence of the enumerated defects, comple information is still wanting. Dr. Cohn, of Breslau, in the years 1864 and 1865, examined the eyes of 10,060 scholars, and found 1,630 of them with eyes of defective shape. Of these 1,072 were myopic, 139 were flat-eyed, 23 were the subjects of astigmatism, and 396 were suffering from the results of previous disease. Dr. Cohn further found that faulty shape of the eyeballs, especially in the direction of myopia, increased steadily, both in numerical prevalence and in degree, as school life was prolonged; being least frequent and least pronounced in the elementary schools, more frequent and more pronounced in the intermediate, most frequent and most pronounced in the finishing schools. His researches have since been repeated and extended by many other observers, and his results have been fully confirmed in other parts of Germany, in Russia, and in America; while the American observations have shown not only that flat eyes have a tendency, from the strain thrown upon them by their defect, to pass into the opposite condition of short sight, but also that this change occurs with the greatest certainty in underfed or unhealthy children, and in schools where

sanitary conditions are neglected. In England, as far as I am aware, no precise or extended observations of the same kind have hitherto been recorded. My colleague, Mr. Adams Frost, lately examined for me a Board School in the south of London; and he found that 73 children out of 267, or rather more than one-fourth, had sub-normal vision. Among these 73, 26 were myopic, 16 were manifestly flat-eyed, and in 31 the defect was due to other causes. Of the 194 children with normal sight, 40 were flat-eyed, and would be called upon for excessive exertion in the act of seeing. We may contrast with these results some observations upon the sight of different classes of people which were communicated to the Royal Society in 1812 by the late Mr. Ware. In the three regiments of Foot Guards "short sight was almost utterly unknown. During 20 years, and among 10,000 men, not half-a-dozen soldiers had been discharged nor half-a-dozen recruits rejected on account of it." In the military school at Chelsea, among 1,300 children, Mr. Ware found that there were no complaints of short sight; and, on closer investigation, there were "only three children who experienced the least inconvenience from it." It is impossible to make a fair comparison between the patients of an ophthalmic surgeon and the members of a school or other community; but I lately had occasion to examine my own records of 4,000 patients seen in private practice, and I found that the instances of astigmatism amounted to almost precisely 10 per cent. of the whole number. In view of the great importance of the question, I applied a few weeks ago to the London School Board; and offered, if the Board would give me the necessary facilities, to undertake in London an investigation co-extensive with that of Dr. Cohn at Breslau, and to test the sight and examine, as far as might be necessary, the eyes of 10,000 children. The reply was that my letter had been laid before the School Management Committee, and that this Committee did not "see their way clear to sanction the proposed inquiry." Possibly the letter went at an ill-chosen time, and may

have found the mind of the Committee engrossed by an endeavour to lighten educational pressure by the elimination of adverbs from the English language. I suspect, however, from the circumstance that no preliminary inquiry was made with regard to the time which would be consumed, the method of proceeding, or any similar details, that the Committee were really influenced by fear of the results which might be disclosed, and that they made no attempt to "see their way," either "clear" or in any other and more congenial manner. My hospital experience leads me to think that the school examined by Mr. Frost would be an average specimen of those in which poor children are taught, while I have no doubt that better results would be obtained among the children of the more wealthy classes. An examination into the state of colour vision in England was carried out a year or two since by a committee of the Ophthalmological Society, and it was found that the percentage of defect, say among Eton boys, was decidedly smaller than in the labouring population. The same would probably hold good as regards acuteness of vision and the shape of the eye; but, at the same time, the amount of defective sight in some of the great public schools is a matter which is beginning seriously to engage the attention of masters. Unfortunately, it is often overlooked in all schools, and the children who suffer from it are liable to be treated with injustice.

The defects of shape of the eyeball, whether flatness, elongation, or astigmatism, may to a greater or less extent be corrected by optical appliances; and, when they can be completely so corrected, the mischief which the defects produce may almost be said to be limited to the trouble and cost incidental to procuring and using the appliances. In some positions of life this trouble and cost are prohibitory or nearly so, and then the defects of shape become great evils. The flat-eyed person is terribly handicapped in any calling which requires close visual application; and the strain thrown upon his eyes becomes a frequent source of disease; while the myopic, confined

within a limited physical horizon, often fails to develop the power of observation, gains but little experience from life, and acquires but little knowledge of character or of events. He is blind to the expression of the human face, or to the larger beauties of nature or art, and his mind, even when intelligent and acute, is apt to display an acuteness which expends itself upon details, and which is incapable of taking hold of principles. Moreover, the popular notions that myopic eyes are "strong" eyes, and that they improve with age, are entirely erroneous. The myopic person can frequently see a smaller object than another, the object being close to his eye; but this depends upon the circumstance that, being able to bring it so near, he sees it under a larger visual angle than a normal sighted person, who would hold it farther away. This slight advantage, if such it be, is but a poor compensation for many disadvantages; and an eye which is myopic in a high degree, if not actually diseased, is at least always on the threshold of disease. The elongation of its shape has been arrived at by the gradual stretching out of its deeper hemisphere; and, in this stretching, the parts essential to sight can seldom escape injury. When sub-normal vision is independent of faulty shape optical appliances can do nothing, but a remedy may sometimes be found in diligent exercise of the defective organs.

The question remains whether a civilised community should acquiesce in the prevalence of sub-normal vision, and in the increase and perpetuation, as well as in the prevalence, of defective shapes of the eyeball, without any effort to bring about a better state of things? I think not; and I think also that the first step towards improvement must be the recognition of the nature and extent of the evil. As I have already said, people neglect the visual function because they have no knowledge of what it ought to accomplish. There can be no doubt that the high standard of acuteness attained among savages, although partly the result of use dictated by necessity, has

been at least partly due to the praise and admiration which keen sight would receive in the tribe. The epithet "Hawkeye," bestowed by Cooper's dying Indian upon his conqueror, is an illustration of the esteem in which the perfection of vision would be held.

Is there any reason why acuteness of sight should not be made a point of physical excellence in all athletic contests? The example might be fitly set by the Volunteers, who might thereafter in time diminish the diameters of the bull's-eyes of their targets; and it would soon be followed by public schools and by athletic clubs. The tests would be easy of application, the value and uses of superiority would be unquestionable. A first effect would be to make people understand what they ought to be able to see, and a powerful counteracting influence would be brought to bear against those conditions which at present render it doubtful whether the majority of the dwellers in large towns ever look at a distant object. Important good results would not be immediate, nor could they be fully attained except in more than one generation; but I think it is sure that they would ultimately follow. In the meanwhile parents would take note of the state of the eyes and of the sight of their children, would seek for exercises by which acuteness of vision might be increased, and for modes of instruction or of work by which a tendency to faulty shape might be controlled. To whatever extent the evils which I have described are due to neglect, either to the neglect of former generations, or to neglect still operating, the first step would be taken towards their removal.

The diagram in (Fig. 3) gives a view of a very simple and convenient apparatus, which is, I believe, of American origin, and by which the acuteness of vision of a large number of persons, say of scholars, can be quickly and correctly tested. The apparatus consists essentially of a card on which four sizes of test-type are printed in concentric circles, the smaller type nearer the centre. This card rotates behind another, which has a vertical slit

above its centre, and which thus leaves only four letters visible. On the covering card, at the margin of the slit, the distance at which each letter should be read is printed. Suppose the distances, for the four sizes, are ten, twenty, thirty, and forty feet. The card should be hung against a wall in good daylight, and a mark should be made on the floor, ten feet away from it. The persons to be tested should be kept more than ten feet away, and each one in turn

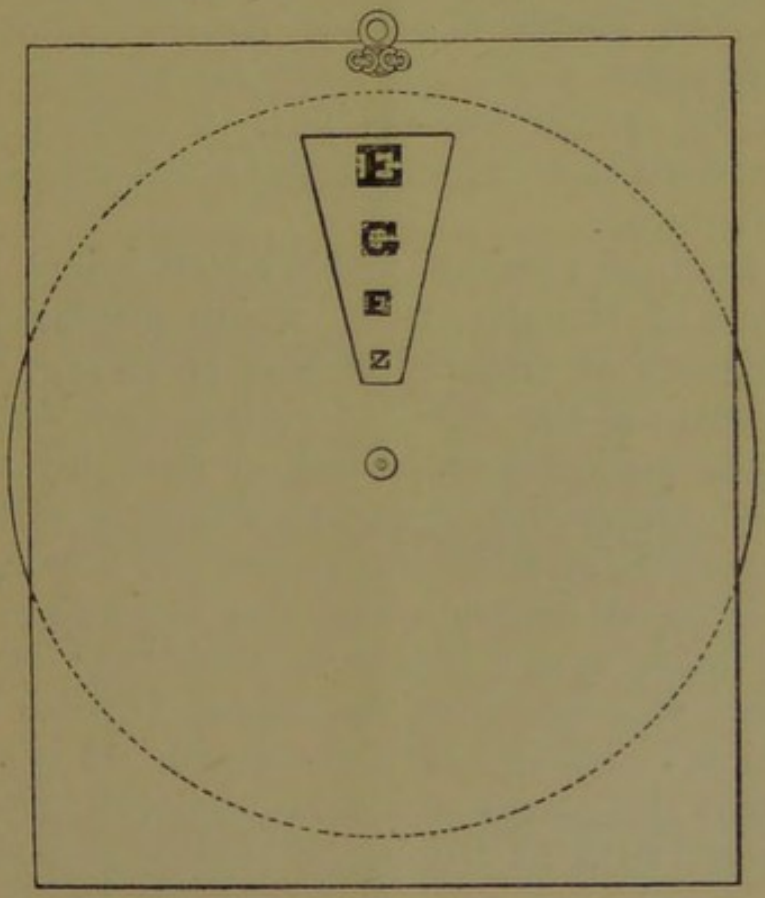


Fig. 3.

should come up to the mark, and should read aloud the four letters which are then exposed to view. All who do this correctly, have normal vision; all who fail have sub-normal vision. A person who could read the third letter, but not the fourth; that is, who reads at ten feet only what he ought to read at twenty, would have vision equal to ten-twentieths, or one-half of the standard. A person who only read the second letter would have vision equal to ten-thirtieths, or one-third of the standard; and a

person who only read the top letter would have vision equal to ten-fortieths, or one fourth of the standard. Any one who was unable to read the top letter would have vision of less than one-fourth; and the degree of his defect would require larger objects for its determination. As each person stepped back from the mark, the inner disc should be turned, so as to bring four fresh letters into view for the next. This little apparatus is made by Mr. Baker, of 244, High Holborn, and may be obtained from him. Of course it affords no clue to whether the defects of sight which it may reveal are capable of correction by optical means; but, in order to determine this, a considerable set of lenses and much practice in using them are required.

In the original version of this letter I just glanced at another class of visual defects, which display themselves chiefly by want of endurance, that is to say, by want of power to sustain the effort of seeing, and which depend mainly upon weakness of, or lack of harmony among, the muscles by which the eyes are directed and adjusted. Many of these defects have an important bearing upon the correct judging of distance, and also upon the question of the use of both eyes together in shooting; but I do not propose, on this occasion, to travel beyond the limits within which I at first confined myself. It is sufficient to say here that the games which require close attention to a flying object, such as tennis, battledore and shuttlecock, and in a less degree, cricket, are among the most powerful agencies by which the muscles in question can be strengthened and improved.

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