

# SCHOOL VISION



JAMES KERR



AMERICAN FOUNDATION  
FOR THE BLIND INC.

SCHOOL VISION  
AND THE MYOPIC SCHOLAR

BY THE SAME AUTHOR

NEWSHOLME'S  
SCHOOL HYGIENE

THE LAWS OF HEALTH IN RELATION  
TO SCHOOL LIFE

*Rewritten for School Workers*

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# SCHOOL VISION

AND THE MYOPIC SCHOLAR

A BOOK FOR TEACHERS AND  
SCHOOL WORKERS

BY

JAMES KERR, M.A., M.D., D.P.H.

FORMERLY HONORARY SURGEON BRADFORD ROYAL EYE  
AND EAR HOSPITAL, MEDICAL SUPERINTENDENT  
BRADFORD SCHOOL BOARD, SCHOOL MEDICAL  
OFFICER FOR LONDON, ETC., ETC.



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TO THE

National Committee for the Prevention of Blindness

NEW YORK

IN RECOGNITION OF THEIR GOOD WORK

*For the Conservation of Vision*

AND IN GRATEFUL ACKNOWLEDGMENT

OF FREELY GIVEN HELP

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## PREFACE

THE history of the beginnings of medical care of school children as a public duty is almost the history of the oculist's researches into the origins of troubles which he has to combat in everyday practice.

I have found, and Mr. B. P. Jones, the Superintendent of the Blind and Deaf Schools of the Metropolis, to whom I am much indebted for aid and help regarding especially the Myope School, has pointed out, how some enterprising teachers, filled with a divine curiosity about their work, have found difficulties in getting simple knowledge about the details of visual conditions which have such practical and controlling importance in education. This book is, therefore, intended to help teachers in school to lighten the strain of educational tasks, to select those who should be considered for special examination, to aid the myope teachers in developing their work, and all who co-operate with them, and especially in the case of secondary and higher schools, where lasting damage is often being done by heedlessly sacrificing visual needs to academic aims for want of precautions, occasionally even in scholarship children.

Information is given not only on points which may arouse interest, but also on matters which will enable workers to think and reason for themselves and find the right way in devising arrangements and school technique, not only for the benefit of myopic children, but for all who frequent the class-room.

A glossary has been added giving some explanation of terms likely to be found on medical record cards. There has been no attempt made to go beyond matters of purely practical value to teachers. Detailed explanations of the ophthalmic points in school hygiene will be given in a forthcoming work on the general subject, the preparation for which has made the present an easy task.

JAMES KERR.

26 MECKLENBURGH SQUARE, W.C. 1.

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# SCHOOL VISION

## I

### THE ANATOMY AND COMMON DEFECTS OF THE EYE

#### **Historical.**

THE school work in regard to vision, around which this book is written, depends on the managers, inspectors, and teachers being thoroughly imbued with its purpose, or educational success will fail to attain its best. Ten per cent. of the children are myopic when leaving the primary school, so that eye hygiene is a pressing subject. In the case of the myope schools it is still more important, as no one is fit to inspect, administer, or criticize the work of such a school justly without being fully seized of the topics set out hereafter.

The suggestion of such a type of school was first made to the writer by his predecessor as surgeon to the Bradford Royal Eye and Ear Hospital, Dr. J. H. Bell, who had examined the refraction of many children in a school at North Bierley about 1889, and concluded that myopes needed special educational provision.

After ten years of handling the children with defective vision in the Bradford schools, either as school

doctor or as hospital surgeon, and after a general survey of the visual conditions in the London schools, and a personal examination of each pupil at that time in the blind schools of the Metropolis, the author set out the general proposition in the last *Report of the Medical Officer to the School Board for London in 1904*, page 33 :

“ At almost every examination for admission to special schools, candidates are presented and returned to the ordinary schools, who have visual defects of such nature that some modified education is desirable, apart from being treated as blind.”

And in the following year he reported further (*L.C.C. Med. Off. Ed. Rep. for 1905*), in the first complete statement of the need for conservation of vision or sight-saving classes, a need which has now obtained world-wide recognition.

“ It is commonly supposed that almost every child with defective visual acuity requires glasses ; but there could be no greater mistake. Some get no improvement from glasses, some will do better without glasses, a very small number are found with defective visual acuity and no refractive error, and in the course of one or two years attain normal vision. Looked at from a wide public health point of view, it ought not to be necessary for a considerable percentage of children to wear glasses.

“ The rational treatment for most of these children should rather be an educational modification which avoids the necessity for glasses. There is a considerable number of children with permanently damaged or diseased conditions who are not blind, and not



ever likely to benefit by the training as given at blind schools, who yet may be actually harmed by the ordinary school education.

“Children with diminished visual acuity—seen in cases with considerable corneal opacities, with chronically recurring phlyctenulæ, with interstitial keratitis, old choroiditis, high myopia, congenital cataract, congenital absence of iris, some albinos, children with nystagmus. This group is probably as large a group in totality as that of the blind, and from the results to be obtained much more worth educating. Some are in blind schools, some in ordinary schools, and others sometimes away for weeks or months under medical certificates, sometimes a short time in school. Special school classes with modified tasks are required for these children, the literary element being eliminated from their work as far as possible and attention given to fit them for tasks in which vision is not chiefly involved, but yet of subsidiary use.”

Next year it was noted that very high myopes are offered places in blind schools. “In at least forty out of forty-four cases, if the parents refused the educational treatment offered to them nothing further could have been done, as there are no proper educational facilities for these children, and it may be added that there are twenty times the number of other eye cases equally in need of schools adapted to their conditions.”<sup>1</sup>

Bishop Harman, inspecting the blind schools, now took up the subject at the International School Hygiene

<sup>1</sup> Twenty years later the writer found that Maddox had suggested such myope schools in the year 1884. His suggestions appear to have been lost sight of until reprinted by Sir James Barrett in the *Medical Journal of Australia*, 1924, i. 344.

Congress in 1907, and as a fortunate result fourteen myopes and six others with very defective vision were gathered into a class, which was opened at Boundary Lane in January 1908. From this the whole system has been developed by watching every possibility. This was a class for "helping lame dogs over stiles," to use Harman's phrase; but as most of its attendants were short-sighted, and it was out of the agitation for special education for high myopes that it had come, the name "myope class" became established. This title is to be regretted, but it has become fixed. "Sight-saving classes" would have been better in the way of expressing their work. The Americanism "Conservation of Vision Classes," first used at Boston in 1913, is a grandiloquent form of the same idea. With the root ideas at the start there might at first have been inscribed over the doors, "Books, paper, pencils or pens cannot enter here," but experience has somewhat modified this veto. A working compromise between medical requirements and educational necessities is being slowly evolved.

### **Administration.**

Whatever administrative method may be followed the work of the sight-saving class must be wholly directed by a specially trained teacher, free as regards actual school-work from the control of any other person untrained in this respect. Especially must there be protection from its functions being sacrificed to the academic rule-of-thumb ideals of the ordinary teacher, school inspector, or occasionally even medical officer. Scoring, marking, and valuation of the work

must be entirely different from the ordinary school. Unfortunately most teachers in myope schools are not specially trained, and still there are many mistakes in the treatment of their pupils. These causes at present make the classes only a modified success, and in some cases children are marking time for their last year or two. The educational value must be maintained to the last moment of school life just as much as the ophthalmic protection.

The children admitted should come in at as early an age as they can be detected, and are those who have ocular defects unfitting them to benefit properly by ordinary school education. Section 15 of the Elementary Education (Blind and Deaf) Act, 1893, gave a very elastic definition of blindness, "The expression blindness means too blind to be able to read the ordinary school-books used by children." It was this definition which secured the future of these classes, as the children in them obtained grant as for blind scholars. In many of the statistical returns the semi-blind are included as blind.

The further history of the classes may be followed in descriptions by Harman in the *British Medical Journal*, 1910, ii. 1320, and a later account, *Roy. Soc. of Med.*, 1913, vol. 6, p. 146, and in *School Hygiene*, 1919. Dr. Angus MacGillivray describes the kind of cases suitable in "The Educationally Blind Child" in *School Hygiene*, May 1921. Dr. Wright Thompson describes the Glasgow classes in the *British Medical Journal*, December 30, 1922. An account of American classes published in *The Child*, January 1923, has illustrations which unwittingly show that they are

much less strict in following the canons of sight-saving than in our schools. In Germany *Schwachsichtige Klassen* were started in Strassburg, Mülhausen, and Dortmund in 1911, where children were said to attain the same standards as in the ordinary school with writing lessons restricted to fifteen minutes. In this myopic land they have extended rapidly.

Before the war, Cleveland had started Conservation of Vision Classes, and Boston, Illinois, New York, and other localities followed, so that they are now quite common. The American Association for the Prevention of Blindness has done much to diffuse knowledge as to sight-saving education.

Dr. MacDonald, of Toronto, reviewed the American practice in a work published in 1923. Copenhagen has "sight-saving" classes not specially devised for myopes.

### Plan of the Book.

The trained certificated teacher or inspector is a danger in the classes, unless they can be included in the category of those who work or administer with—

1. A knowledge of the material facts about the visual functions which are to be conserved.
2. The various kinds of defects of vision from which the selection of pupils is made.
3. How school-work affects vision.
4. What special educational modifications should be insisted on in these classes.
5. The outlook for myopes from the earliest ages, and general rules for guidance.

6. The inspection of myope classes, and methods of assessing their work.
7. The work of the blind schools, not dealt with specially in this book.

### Visual Function to be Conserved.

The eye and the ear are the chief academic portals. Other sensory organs are of enormous importance when these are interrupted, and even subconsciously these other organs aid eye and ear to a greater extent than most teachers are aware; for instance, the author found by tests at Frizinghall that blindfolding children diminished acuity of hearing for spoken numbers by about 20 per cent. The importance of these other means has to be remembered and developed in the myope class.

### Structure of the Eye.

The eye represents an outgrowth of the brain. When the brain is forming, two vesicles are pushed out, one on each side, towards the skin. The tip of the vesicle becomes involuted to form a cup-like mass on a narrow stalk. Ultimately other tissues push in from below and across the opening of the cup, and a hollow round mass is formed, which becomes the nearly spherical eyeball on the optic stalk. The folded-in part of the cup forms the *retina*, or nervous net, which is sensitive to light, and is thus seen to be really an outgrowth from the surface of the brain. From the skin is developed the lens, and the other structures of the eyeball and its coverings formed

from surrounding tissues are accessories for retinal protection or effective working.

Examining an eyeball, in front about one-sixth of its surface is occupied by the slightly more curved part, the clear and transparent *cornea*, this, however, is surprisingly hard. It cuts almost like a finger-nail softened in hot water. From a little below and to the inner side of the posterior pole of the eyeball the

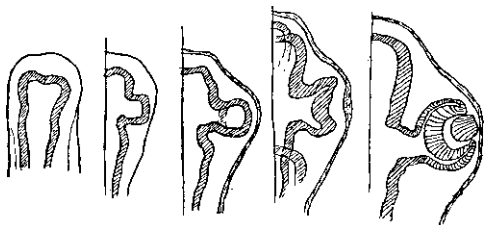


FIG. 1.—The cerebral vesicle forms on each side an optic vesicle, which is pushed out towards the surface, the tip then is involuted, forming a cup on a stalk, this becomes the retina. A mass of epithelial tissue pushed in across its opening becomes the lens. The other tissues develop to form cornea, sclerotic, and so on.

*optic nerve* passes to the *optic commissure* at the base of the brain.

A nearly horizontal section of the globe through the nerve will show the main structures.

The tough white *sclerotic* coat, made up of strong fibrous tissue, helps to preserve the form of the globe. Inside this is a thick layer of small blood-vessels in the *choroid* coat, and on its inner surface a single layer of densely pigmented black cells. These are like tesserae of a pavement, and hexagonal when looked

at from the surface. Although called *choroidal epithelium*, these cells are part of the next layer which is spread over the inner surface of the dark chamber thus formed. This is the retina. It is made up of a stratum about 0·06 mm. in thickness, of radially

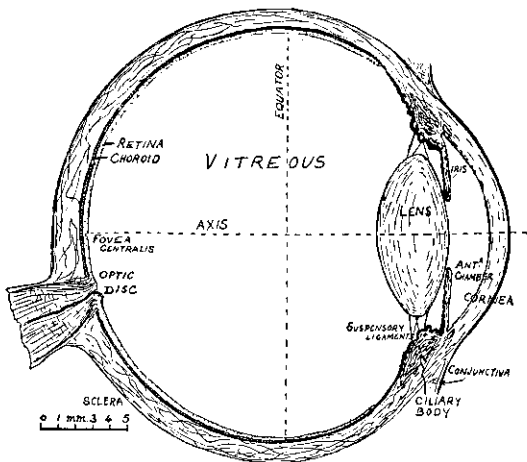


FIG. 2.—Section through the optic disc and macula to show the various structures of the eyeball.

disposed nervous receptors, the *rods* and *cones*, closely packed and light sensitive. The rods are about 0·0018 mm. and the cones about 0·004 mm. in thickness. Each is connected in front with the nerve cell strata, where all the nervous associations of vision in the mind begin, and which form the so-called *nuclear* and *granular* layers of the retina. The light passes

through these nervous layers to reach the retinal rods and cones, except at the optical centre, the macula, where the nervous layers are absent.

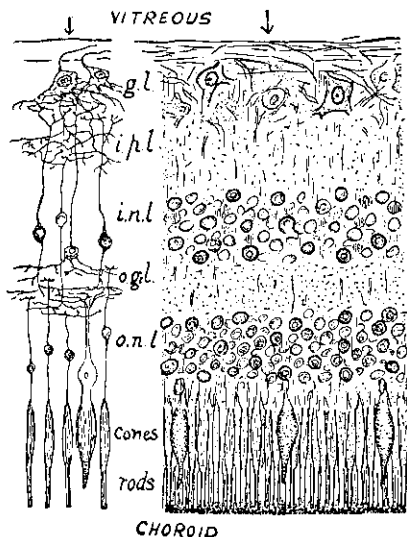


FIG. 3.—General structure shown in section of retina. The arrows show direction of incident light. g.l. ganglionic layer; i.p.l. inner and o.g.l. outer plexiform or granular layer; i.n.l. and o.n.l. inner and outer nuclear layers.

At this one area, exactly at the posterior pole of the eye, the nervous layers thin out, and then vanish, except the rods and cones, which, indeed, in the centre at a small oval spot about one-fifth of a millimetre



across, called the *fovea centralis*, the layer consists only of cones.

From the slightly yellowish appearance around this, the area was called the *macula lutea*, now usually abbreviated to macula. It is the part of the retina most sensitive to form. The optic axis of the eye, the



FIG. 4.—Ophthalmoscopic view of fundus oculi, showing a magnified image of retinal arteries, fine, and veins, broader; with the optic disc or nerve head, and towards outer side indication of the macula.

line approximately passing through the centre of the cornea and lens, should also pass through the macula.

About three millimetres from the macula, towards the nasal side, where the nerve fibres converge to pass down the optic nerve, the nuclear, granular, and rod and cone layers disappear. This is the *disc* or *nerve head*, and can be seen by an ophthalmoscope on looking into the properly illuminated eye (p. 59).

When the normal fundus of the eye is thus examined, a small portion is seen considerably magnified. By practice the observer soon learns to piece together what he sees, and an image is built up in his mind, which is represented for a typical case in the figure. The blood-vessels and general background appear in various tints of red. The white disc is almost pearly on its outer half, the inner half is usually bluish tinted in patches, and with some black pigment granules round its periphery. The macula is seen as a small spot, surrounded by more deeply tinted retina, which it has been attempted to represent in the figure by stippling, on the outer side of the disc, about twice its diameter away.

In the process of vision by which a picture of the external world is seen, the "*field of vision*" is thrown on the retina by light which falls upon the eye. The light passes through an optical system of curved transparent surfaces formed by the cornea and fluid media, and by a laminated transparent ovoid structure, suspended in a clear *capsule* in the front part of the eye, across the opening in the globe behind the cornea. This ovoid structure is the *lens*. It separates the contents of the eyeball into an anterior chamber, with *aqueous* humour, and a posterior chamber with a thinly gelatinous *vitreous* humour. This last, the vitreous humour or body, spoken of as the vitreous, is in contact with the retina and the posterior surface of the *lens capsule*.

Round the interior of the opening in the globe, which the cornea covers, is a thick and radially rugose collar of tissues made up of processes formed by the

continuation forwards of part of the sclerotic and choroid coats. This is the *ciliary body*, or *uvea*, as its inner surface is sometimes called. From these tissues continued farther forward into the anterior chamber and a little in front of the lens, is formed a thin annular membrane, the *iris*. The variable circular opening in this is the *pupil*, which by its widening or narrowing, through the action of the muscular fibres it contains, regulates admission of light to the eye. The inner surface of the iris is coated with dense black pigment cells, which shining through the iris fibres give it the various colours from black, brown, green to blue, characteristic of different individuals and families. The lens lies parallel to, but behind, the pupillary plane. It is slung by numerous fine radial fibres, the *suspensory ligaments*, stretching from the posterior central edge of the *ciliary processes*, to where the capsule passes over the edge of the lens.

### The Two Eyes.

The eyes are placed symmetrically in each orbit, the thick bony upper edge of which protects them well. Each eye can move freely about its centre. These movements are accomplished by six small muscles attached to each globe. There are two lateral muscles ; an *internal rectus*, which turns the front pole of the eye directly towards the nose, and its opposite, the *external rectus*, turning the eye directly outwards. The two vertical muscles to each are the *superior rectus*, turning the front pole upwards and a little in, and its opposite, the *inferior rectus*, turning down and also in. There are two oblique muscles which tend

to rotate the eye. The *superior oblique* or pulley muscle, *trochlearis*, acting to turn the cornea down and out, and the *inferior oblique*, which acts in the opposite way. The muscles acting together steady the eyeball, and act practically instantaneously in the various adjustments; for instance, the rectus superior and inferior oblique raise the centre of the cornea directly up, acting together, so that their actions are really more complicated than the simple movements suggested by their names, and the study of after-images shows

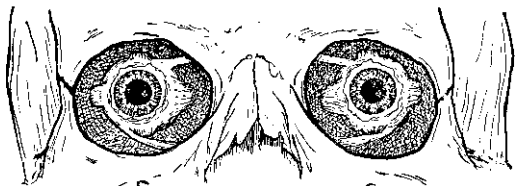


FIG. 5.—The bony orbits, with all tissues removed, but the eyeballs with their muscles left in position.

that the eye does not rotate around the optic axis. The two internal recti may act together, converging the direction of the ocular axes. This action is of extreme importance for stereoscopic vision, or the judgment of solidity obtained from the slightly different picture seen by the two eyes. Much of our mental supremacy in the scale of life is due to this stereoscopic vision, which attains its highest excellence in man.

The globe and these muscles are packed around with loose connective tissue, held in place by firmer layers of fascia. The interstices are filled with cushions of fat.

In front the eyelids protect the globes; towards their edges they have a dense fibrous layer, the *tarsus*, which gives them solidity. The upper lid is the largest, and mainly covers the cornea when the lids are closed,

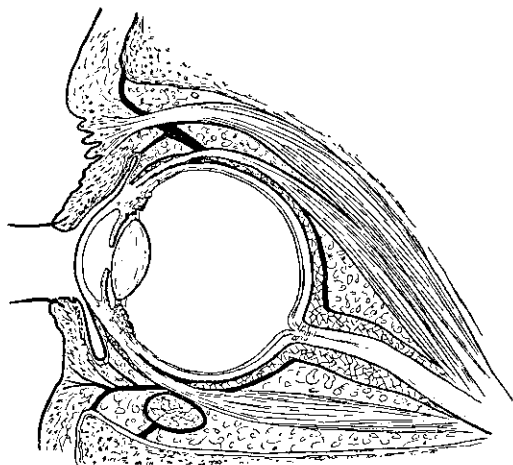


FIG. 6.—Vertical section through orbit, showing the fibrous fascia holding the eye and its muscles in position, and the relations of eyelids, levator palpebræ muscle, etc.

or in winking, which is done by contraction of the *orbicularis* muscle. The upper lid is raised by a muscle, the *levator superioris*, which is sometimes very feeble or ill developed, so that the cornea is only partly uncovered. This is known as *congenital ptosis* of the upper lid. Patients with ptosis, which often

runs in families, have to throw back their heads to see the person they are talking to. This gives them a somewhat supercilious expression as they look down their noses at their interlocutor.

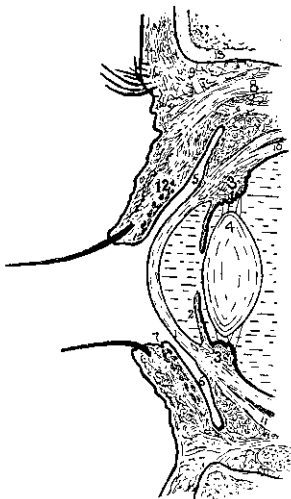


FIG. 7.—Section through front half of eyeball and its coverings 1, cornea; 2, iris; 3, ciliary body; 4, lens; 5, superior, and 6, inferior conjunctival sacs; 7, opening of a Meibomian gland; 8, levator palpebrae superioris; 9, fascia of orbit; 10, sclerotic; 11, tendon of inferior rectus; 12, on Meibomian gland; 13, frontal bone.

The visible part of the white of the eye is covered by a delicate ocular *conjunctiva*, which is reflected on the inner surface of the eyelids, the palpebral *conjunctiva*. The potential spaces between the

lids and the globe form the upper and lower *conjunctival sacs*.

The lids unite at the outer *canthus*. At the inner canthus there is an angle on each eyelid, where the position of the opening of the *lachrymal duct* is placed, through which the moistening secretion drains into the nasal passages.

Sometimes a slight fold of skin runs from the upper eyelid round the inner canthus to the skin of the cheek or nose. It is known as an *epicanthic fold*, and the condition is shortly termed *epicanthus*. It is very common in the so-called "mongols," and is often regarded as one of the stigmata of degeneracy.

The lachrymal gland secretes the moistening fluid, which in excess forms tears, and is tucked away in the upper and outer angle of the orbit. Its edge can sometimes be seen on turning back the upper lid. The upper lid is best everted if the lower lid is first pushed well under it; this is sometimes useful in removing a foreign body.

The lid edges have the eyelashes growing forwards, and they protect the globe from insects and foreign bodies. On the margin of the lids, within the row of eyelashes, are the openings of the *Meibomian glands*, a row of small sebaceous glands whose oily secretion lubricates and softens the lid margins.

### External Diseases of the Eye Structures.

Many hindrances to vision are the result of scarring produced by inflammation of the surface of the eyes or lids.

The commonest form of inflammation is *conjunctivitis*,

due to the irritation of prevalent germs, which in healthy people are speedily destroyed. In those of poor health or defective nutrition they may set up inflammatory reactions ; some very chronic, as, for instance, the *blepharitis*, which leads to crusting and chronic thickening of the margins of the lids.

Other forms are dependent on poverty of the food in such matters as the fat vitamins or antiscorbutic vitamin, leading to cedema, haziness or softening of the cornea. In one form, the *Xerosis* bacillus is able to establish itself and flourish. Little whitish frothy patches are seen, often in a triangular form with the base on the inner and outer edge of the cornea. Cod-liver oil and fresh milk are wanted in all these cases.

The worst form from the point of view of future vision is the *ophthalmia neonatorum*, a purulent conjunctivitis set up in the first hours of life through neglect to cleanse from infectious secretions of the mother at birth. Sanitary care works wonders in preventing serious results, but many cases have such violent inflammation that dense white scars on the cornea damage vision. More rarely inflammation in the globe results in blocking of its lymph channels, so that the eye becomes gradually distended, *buphthalmos*, or ox-eye. This may have to be removed in later childhood. Some cases again have destruction of the cornea, so that the eye shrinks and is lost. When the writer first noted the conditions of the pupils in the blind schools of London in 1903, he found at least 42 per cent., nearly half the cases there, blind as the result of *ophthalmia neonatorum*. Since then the proportion has been somewhat lowered, but yet is



nowhere near what it can be reduced to by efficient care, and which is actually attained in some large American cities. Many cases are not blinded. They appear to a superficial glance as if the eye had been stirred round, haziness or milkiness of opacities from scarring showing in parts of the cornea. These are slighter cases, most of which are fit for the ordinary school. The educational treatment depends entirely on how well they can see, as the opacities may vary from the faintest cloud or *nebula* up to a dense milk-white patch or *leucoma*, and they represent disease whose active stage is long past and gone.

There are other causes of defective vision also from opacities in the cornea. A fairly common one is where during some illness, like measles, an ulcer has formed in the part farthest away from the blood supply at the centre of the cornea, and a little scar is left just in the line of sight and very damaging to vision. Similar ulcers may have formed on other parts of the cornea, apart from acute illnesses, generally in poorly nourished children with catarrhal conditions of the nose and throat, and sometimes discharging ears. These are *phlyctenulæ*, small inflamed papules like a millet seed, which often break down to form the ulcers. They recur in unwholesome children, and are a common cause of much permanent damage to vision; fortunately they appear to be getting less common than in former years.

### Diseases of the Globe.

Sometimes from constitutional disease there is exudation deep in the layers of the cornea, *interstitial*

*keratitis*. If neglected this can be very damaging to vision ; if properly treated it may sometimes leave scarcely a trace. Both the interstitial and phlyctenular forms of keratitis tend to relapse, and sometimes the first sign of this is its intolerance of light falling on the eye, *photophobia*. This may be so painful that the eye is firmly shut by a spasm of the orbicularis muscle which closes the lids, *blepharospasm*. Children with these conditions require protection from the light, and should be at once excluded from school till quite better.

Occasionally from obscure septic or other causes, possibly it may be unhealthy tonsils or decaying teeth, the iris becomes inflamed. It has a curious muddy look, and is not quite clearly seen, pain is complained of. This is probably *iritis*, and the child should not be in school. The inflammation if neglected at first may cause the edge of the iris to adhere to the front of the lens capsule, and afterwards may interfere with vision ; or it may leave the iris all irregular and incapable of contracting or dilating. Anyone with even the faintest suspicion of iritis should urgently see the doctor, who will probably apply atropine drops and relieve the pressing symptoms. If there has been old iritis which has left adhesions to the front of the lens capsule these are called *posterior synechiæ*. There may also be adhesions to the inner surface of the cornea called *anterior synechiæ*. These are more common as the result of some perforation of the cornea from a wound or an ulcer which has healed.

Septic results from a chip of stone, a scratch with a branch, a flick of a whip, belt or towel, or any other such accident, may cause deep ulceration of the

cornea, and sometimes there is risk of violent inflammation of the whole eyeball, *panophthalmitis*.

Injuries or cuts of the eye, by the points of scissors, by a fork prong when a child is trying to undo a boot-lace, the jab of a pen, or in a mother's eye from scratch of baby fingers, from whatever cause and however slight, they may be very dangerous. The most dangerous region is a penetrating cut just beyond, but within the zone of two or three millimetres beyond the corneal edge, "the danger zone." The ciliary body lies under this, and any damage in the ciliary region is often followed by *sympathetic inflammation* of the other eye, with probably blindness of that eye and serious visual defect if not actual blindness of the first injured eye. All cuts of the eyeball should, therefore, urgently see the surgeon. Cases of children with sympathetic ophthalmia are likely after some months to find their way to blind schools.

A few other cases suitable for the sight-saving classes, of children who have been affected from birth may be mentioned here.

Occasional members of some families have the dark body pigments so badly developed that sometimes these seem to be absent. The hair is white, there is little or no pigment in the hexagonal choroidal cells of the retina, and the iris is without pigment behind it. The red blood-vessels show through, so that these folk appear to have a pale iris, and the light may shine through their pupils, giving them a pink glow. They are *albinos*. Owing to the irregular distribution of light in the eye they do not see well. They are unable to fix the eyes properly on looking at an object.

Nervous control has not developed, and the eyes appear to have a regular jerking movement through a small angle, termed *nystagmus*. In other rare cases the iris is not well formed, it almost appears absent, although careful examination will show little buds of tissue where it should have been; this is *aniridia*. Vision here is very poor. Again, one little segment of iris may remain undeveloped. This, usually downwards, may be up or inwards. Either condition is known as a *coloboma* of the iris. It resembles the results of *iridectomy*, an operation sometimes done, where there is much corneal opacity and the periphery clear, in the hope of improving vision. It is also done in elder people without opacities for other reasons. The fact that the cornea was clear in a child would suggest a *coloboma*.

Sometimes the eyeball has developed insufficiently, and there is merely a tiny sightless globe, *microphthalmos*. During the growth of the eye, referred to earlier, the optic cup occasionally does not close properly below, and a large patch inside remains without the retina and hexagonal pigment cells. It is insensitive to light, and when seen by looking through the pupil in retinoscopy is recognized as a *coloboma of the choroid*.

The lens may also be displaced, generally in both eyes, so that vision is seriously interfered with; there is *ectopia lentis*, a *congenital dislocation of the lenses*. The edge can often be seen as a circular greyish line in the pupil, particularly if light be thrown in with the retinoscopy mirror, when it shows up as a black line between two differently illuminated parts of the

pupil. The lens is built up of sections, and when it has been preserved and hardened these roughly resemble the laminated structure seen in an onion. Whilst it is forming, sometimes little portions are interfered with in their nutrition, so that they are not clear, and fine flocculi, or radial and circular striæ, are seen. This condition constitutes *congenital cataract*, or according to its form lamellar cataract. It may interfere with vision, but often this can be greatly improved by operation. Again, but fortunately very rarely, at the

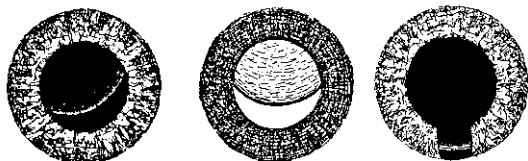


FIG. 8.—Dislocated lens (*ectopia lentis*), left ordinary illumination, centre with mirror, right figure of coloboma of the iris.

posterior poles, behind the centre of the lens capsule, a little mass of cells which should have been absorbed before birth remains as a small opaque spot in the line of sight: a *posterior polar cataract* for which, as a rule, nothing satisfactory can be done to improve vision. When the deeper structures of the eye are considered, the commonest disorder is the result of inflammation due to the same constitutional disease as interstitial keratitis. This inflammation attacking the retina in patches, both the nervous structures there and the black pigment cells are destroyed and disappear, and the white sclerotic can be seen shining

through when the interior is examined by retinoscopy. This is the condition called *disseminated choroiditis*. It may appear at any time in school life, and is most commonly due to *congenital syphilis*. Like the interstitial keratitis, it may have been arrested, or it may go on getting worse. In any case, a constitutional disease requires every means of securing good health by aids to nutrition, and cod-liver oil and fresh milk are the most useful. There is one form of retinitis where, beginning with the periphery which is farthest away from the blood supply, slow changes in gradual degradation of function go on year in year out till practical blindness is the result. As fine masses of pigment can be found sprawled out in spidery patterns in the parts most affected, it is known as *retinitis pigmentosa*. It is often an hereditary affair, and its victims find their fields of vision getting smaller and smaller till they cannot find their way about by sight. At first, when looking at a person, they may see the whole of their head, but as time goes on this diminishes, till they can only see a little bit of the mouth or nose, or perhaps half an eyelid at a time. An accompanying symptom is difficulty in seeing in poor light, night blindness, or *hemeralopia*. There is no remedy for this affection. At the same time if tested by test type they may read the normal size, although only seeing perhaps one letter at a time.

### Trachoma.

A class of case which has not been mentioned is *trachoma*. This is a rare disease in England, and has to be distinguished from the chronic granular con-

conjunctivitis of unhealthy children. It chiefly affects foreigners, or in the North some of the Irish. During the week in which this was written the author saw more trachoma cases, from a limited outbreak, than he had done in the previous twenty years in London. Half the school children in Egypt suffer, and in some districts in America it flourishes, especially among the Indians. A dozen years ago there were sixty trachoma inspectors in New York, but by now they have destroyed their occupation by their own efforts. The school children of Southern Illinois had 2 per cent. trachomatous in 1921.

There is often a curious half-shut, drooping look about the eyes of a case as it develops. The conjunctival surface of the lids becomes a red granular velvety-looking mass, in which are probably seen greyish granules, the "*sago grains*," and if this is under the upper lid as well the case is certainly trachoma. It is infectious. Both doctors and nurses got infected in the New York clinics. Later the lids become thickened and deformed by cicatrices, and the cornea may get rough red and nearly opaque *pannus*, so that a bad case is blinded. It is very unlikely that any case will come into a myope school, but even the suspicion of the disease calls for urgent expert examination with a view to exclusion. Serious cases are rare in England.

## II

### THE PROCESS OF SEEING

NORMAL healthy eyes are so developed that when a person is looking straight forward without any effort a clear picture of the objects in front is thrown on the retina. This picture affects the rods and cones by the differing quantity and quality of the light in its various parts. The nervous retinal elements send a volume of impulses through the optic nerves to the visual centres in the occipital lobes of the brain, from whence they are relayed to other brain regions, to be built into the mass of memories and impressions which are a large part of the foundations of mental life.

In the centre of the macula, the yellow spot of the retina (p. 23), about a fifth of a millimetre across, is hundreds of times more sensitive to form than the parts of the retina beyond. The rods and cones of the retina when at rest accumulate in their bodies a chemical compound, the *visual purple*. This is bleached rapidly by light, and it is this action which seems to initiate the function of vision. When in feeble light this visual purple accumulates; when exposed to much light it is gradually exhausted, and the eye becomes fatigued.

Another action also takes place, the choroidal pigment cells, which were described as like hexagonal



tesseræ, fit like caps on the peripheral ends of the rods and cones, and send up processes surrounding them. Both the cells and their processes are loaded with the black pigment granules. When the eyes are protected from light these processes are retracted, but when exposed to light they are protruded to shield or shelter the rods or cones, or else to re-establish the visual purple. When they are withdrawn the eye is exceedingly sensitive to light, and is said to be *dark adapted*. This is a process that takes about ten

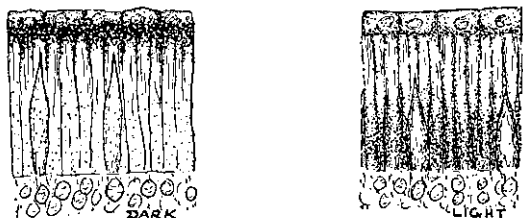


FIG. 9.—Adaptation of retina.

to fifteen minutes to accomplish, and, indeed, still goes on to a slight degree for a half-hour. When the processes are fully protruded, as during bright sunshine, the eye light adapted is hundreds and thousands of times less sensitive than when dark adapted. This adaptation takes place chiefly about the macula and much less at the periphery. One can demonstrate it to themselves by going from a brightly-lighted room to the dark; on looking at a luminous watch face it cannot be seen as the image falls on the still light-adapted macula, but looking a

few inches to one side of the watch the glow of its face is at once seen, now falling on the much less light-adapted periphery of the retina. The figures probably cannot be made out, as the periphery is not sensitive enough to form, but in a few minutes on looking directly at them they are seen clearly by the macula, which has now become more sensitive by dark adaptation.

The light *adaptation* of the eye is of the greatest importance in school problems, and must be thoroughly grasped if illumination is to be understood. It helps us to see how in the daytime an electric lamp can burn in front of us almost unnoticed, which at night could not be endured for its glaring blaze, although the amount of light it is giving out is the same.

A playground shed of an otherwise well-lighted school was complained of and condemned as too dark, although when tested by the photometer it was nearly twice as well illuminated as the school class-room. The difference of adaptation indoors and outdoors accounted for the impression of relative darkness.

The quick response by contraction of the pupil on coming into bright light helps to protect the eye. These two functions of pupil contraction and of retinal adaptation are important in considering glare (p. 77).

### Accommodation of the Eye.

The axis of the normal eye is about 23 mm. from the centre of the cornea to the centre of the retina, and the various refractive surfaces of the cornea, aqueous humour, lens, and vitreous are so arranged that parallel rays from an infinite distance are focused

accurately on the retina. Infinite distance in respect of the eye means more than 6 metres, or 20 feet, away. Rays from objects within this distance are divergent, and the refractive power of the normal eye at rest is insufficient to bend them enough to focus on the retina.

The greatest effect in refraction is produced by the lens, and as the rays passing through the centre of a lens are more exactly focused than those passing through the periphery, the iris acts as a diaphragm and cuts off the extreme peripheral rays which might otherwise blur some of the image formed, thus minimizing spherical aberration.

When one is looking at a distance even with only one eye, and then looks at some object almost in the same line, but nearer, there is a sense of effort. Something has been done in the eye. The near object is now seen distinctly and the distant object not so well. The image from the near object has been focused clearly on the retina, whilst the image of the distant object has gone out of focus. This has been done by *accommodation* of the lens. The lens has gained in its power of bending the diverging rays from the near object sufficiently to bring them to a clear focus on the retina.

The mechanism of accommodation depends on the elasticity of the lens, which is built up of layers of clear and transparent fibres enclosed in a transparent capsule under considerable tension. The capsule is suspended in the opening in the globe which has the collar of the ciliary body round.

Muscular fibres in the ciliary body can cause this

body to be drawn slightly forward and towards its centre, so that the tension of the suspensory fibrils

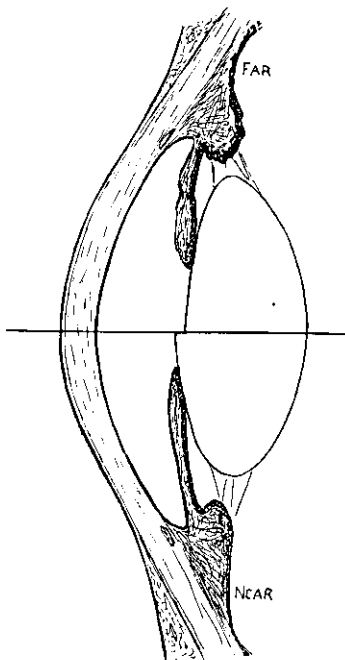


FIG. 10.—Mechanisms of accommodation.

on the capsule edge is a little relaxed, and the elasticity of the lens comes into play and it thickens at the centre, the anterior surface becoming more curved.

The amount of accommodation exerted is just sufficient to get a clear image on the retina of the object looked at. Associated with this accommodation, too, is a certain amount of pupillary action to cut off the spherical aberration of the lens, more noticeable with diverging rays, the pupil being a little contracted when near objects are seen, compared with its condition when looking at a distance.

### Convergence.

To get the best effect the image of the object looked at should fall upon the macula, more sensitive to shape and form than the rest of the retina. This is done by adjustment of the globe by the six external muscles. They turn the globe so that the *optic axis*, which for our practical purposes may be taken as the line through the centres of the cornea, lens, and macula, also passes through the object looked at. These movements are so automatic, free, and unceasing, that no one realizes what a small extent of the field of vision is seen clearly at once. Unceasingly the eye is running over an object looked at, and piecing the images together in the mind, to form a conception of the whole.

If only one eye is used and a newspaper held up a foot off, making a small dot on the paper as an object on which to direct the gaze, it will be found whilst the eye is kept steady and the gaze not allowed to wander, the area of the newspaper over which single letters can be distinguished clearly can probably be covered by a sixpence, certainly by a shilling. That is the area of which the image falls on the macula. The

more careful the fixation by the observer, the smaller the area appears (p. 107).

So far only one eye has been regarded, but images are formed in both eyes. Whilst the eyes are at rest their axes are parallel and distant objects are seen clearly. When near objects are looked at the optic axes are no longer parallel; they are adjusted so that each axis passes through the object, which means that they converge and intersect in the object. This is called *convergence* of the eyes. The work falls mainly on the internal recti muscles. The amount of convergence means increased muscular work, and increases with the nearness of the object looked at. From long association the convergence and the accommodation have got so linked together that they are proportioned, and the convergence amount nearly corresponds to the accommodation and vice versa.

### Measurement of Accommodation and Convergence.

With normal eyes it has been seen that objects at an infinite distance are clearly imaged on the retina. If an object is only a metre away accommodation has to be exerted, the eyes have also to be converged. If the object is only half a metre off then still greater convergence and more accommodation have to be effected. So far as accommodation is concerned, this is equivalent to making the lens more powerful by the action of the ciliary muscles allowing its elasticity to come into play to greater or less degree. The amount can be measured in terms of lenses, which can be

used to replace the accommodation in focusing the objects.

It is possible to paralyse the internal muscles of the eye temporarily, by placing in the conjunctival sac a drop of a solution containing 1 to 2 per cent. of atropine, or homatropine. In half an hour the internal muscles of the eye are so paralysed that usually by that time the eye cannot accommodate. The constricting circular fibres of the iris being also paralysed the pupil becomes fully dilated. This dilated condition of the pupil is known as *mydriasis*. Agents like the belladonna alkaloids which produce the dilating effect are called *mydriatics*. Probably it is to this property that the plant owes its name.

The normal eye under a mydriatic will see things quite well at a distance. It can only see an object clearly at a metre away if this is viewed through a convex lens of one-metre focus. The bending powers of such a lens are then equivalent to the accommodation exerted when the eye (without the mydriatic) accommodates for an object a metre away. The refractive strength of the lens is called one *dioptre*. If the object were only half a metre away another lens would be required of half a metre focus, instead of the first one. It would have double the bending strength, that is, two dioptries.

The strength in dioptries of any lens which is equivalent to the accommodation exerted to see an object at the corresponding distance, will be obtained by dividing a metre by its focal length, or, what is the same thing, the distance of the object from the eye.

Strength of lens in dioptries

$$= \frac{100}{\text{Focal length in centimetres}}$$

$$= \frac{100}{\text{Distance from eye of object}}$$

= Dioptries of accommodation of eye for object

When the eyes are converged normally on the object the convergence can also be expressed in the same notation of dioptries. The dioptries of convergence

$$= \frac{100}{\text{Distance of object from eye}}$$

#### Differences between Juvenile and Adult Eyes.

The eye grows up from a flattened mass of tissues in the foetus, its rate of growth is proportionate to that of the brain. This grows at an enormous rate at first, gradually slowing off till by about seven to eight years old it has reached within 3 per cent. of its full weight. In the young child with undeveloped eye, fortunately the lens is very elastic and accommodation easy. With increasing age the power of accommodation decreases, as the lens becomes less elastic and fails to bulge out sufficiently when the tension on the capsule is relaxed.

The total accommodation capable of being exerted at the age of ten years is about 14 dioptries; by fifteen this is reduced to about 12·5 D.; by twenty years of age it is at 10 D.; at thirty only 7 D.; and at forty-five years old 3 D. But for continuous work the ciliary



muscles cannot manage anywhere near these amounts. One-third the amounts would be within safe limits without producing annoyance or pain from overtaxing reserve powers.

The great power of accommodation in childhood

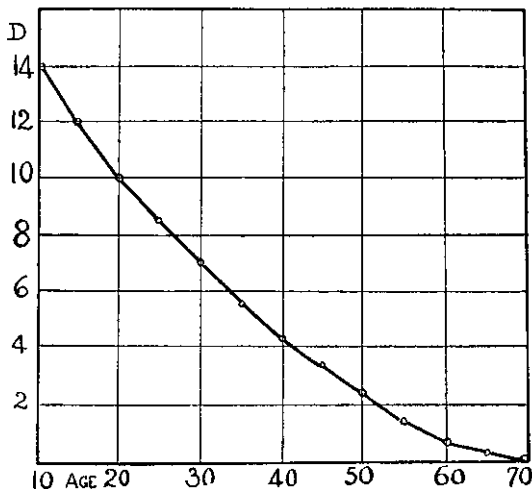


FIG. 11.—Chart of accommodation at different ages.

decreases steadily, and by late middle life fails. For the normal person about forty-five years of age reading-glasses become necessary to aid or replace the failed accommodation, a condition called *presbyopia*. The young child has to accommodate to see clearly with its undeveloped eye, and this is largely true, too, of

the inferior races of mankind who live a wild savage life and have eyes of an immature type.

For every millimetre that the axis is short of the normal 23 mm. there is required an extra 3 D. of accommodation. This condition, where the axis is too short or the retina relatively too near the lens, is called *hypermetropia*.

### Vision of Young Children.

A young child in endeavouring to look at a distant object has to exert a little accommodation; if the object is near it has to exert still more accommodation. The amount of convergence is proportioned to the accommodation, and the young child's power of working the two eyes together is not very great. If it endeavours to see well it accommodates; firstly, to compensate for the shortness of its eyeball; and secondly, to compensate for the nearness of the object. Whilst visually it needs only converge for nearness of the object, there is a tendency to converge also in proportion to the accommodation needed to make up for the shortened eyeball. This would result in an excess of convergence, and there would be two overlapping images, one for each eye, so only the image is attended to in which the optic axis passes through the object. The other image is mentally neglected or suppressed, and there is inward squint or *strabismus* of the eye whose image is thus unused. All children if unobtrusively observed in the babies' room soon show temporary squinting during occupation with near work. Outward squinting may also occur, it does so chiefly in myopia, but is rare in children.

The most useful observation of anyone beginning school-work, and interested in the real essentials which underlie either teaching or learning, is to sit for half an hour in an infants' class, apparently occupied with something else, but in reality observing the children. If the class is occupied with some near eye-work, like the old kindergarten "embossing," threading beads, or sewing, the strain of the work being attempted shows in the postures of the children. In five minutes scarcely one child will be sitting on its seat. Most of them will be squinting either from time to time, or nearly continuously. The effects on their eyes and tongues and fingers, and evidences of early fatigue, and then of boredom are all instructive. The fine finger muscles and the eye muscles are both heavily strained by attempts at education of the ordinary scholastic type before seven years of age. Even in Standards I and II children learning to read will hold their books a few inches from their noses, when if any single child be tested it will be able to see the letters well 12 or 15 inches away. This near vision habit is still one of the things that damage in school, and is much neglected by the certificated, but in this respect untrained, teacher, who thus ignorantly in some measure may set a train agoing that eventuates in later days in a child being refused a scholarship. This is very important, if as many believe myopia is caused, or even seriously aggravated, by close attentive eye-work.

For a child at the usual age of learning to read, to see clearly with the book a good distance away, means the effort of accommodating, and then a small clear image is formed on the retina, and from the compara-

tively few nerve elements affected a relatively small volume of nervous impulses travels up to the brain, requiring mental concentration of attention. If the book is held 4 inches off instead of 12, there is not only the leverage of the arms if held in the hands, but also the accommodative strain. Unconsciously the child takes the easiest way, it sacrifices a clear mental image, saves the strain on attention and accommodative strain, and sees a big image indistinctly, which affects many nerve endings and sends a voluminous if hazy message through to the brain. This probably saves some mental effort, with corresponding fatigue, and although the image seen is hazy it is recognized easily. This may be suggested as the beginning of bad educational training, the indirect education in slipshod habits in matters where precision should be looked for, and ultimate indifference to detail.

The reason why a child who can see a pin on the floor yards away still grubs with its nose in its book, and its head bent over, compressing its chest and rounding its back, is to save fatigue in a task for which it is as yet unfitted in both eye and brain. It is not realized generally how enormously the accommodative effort is increased as the object looked at comes nearer the eye. The figure may help to make this more evident. If the eye is at the lower right-hand angle in the figure, and the object at 1 metre (the 40 inches) distance, then a normal eye has to exert 1 dioptré of accommodation to focus it. This is represented by the height of the vertical line from the 40-inch mark. At  $\frac{1}{2}$  metre, 20 inches, it needs 2 D. At half this distance, 10 inches, it takes

4 D. to focus it. Beyond 4 D. even children's eyes cannot maintain the constant working strain, so the rest of the curve and its rapid rate of increase is put

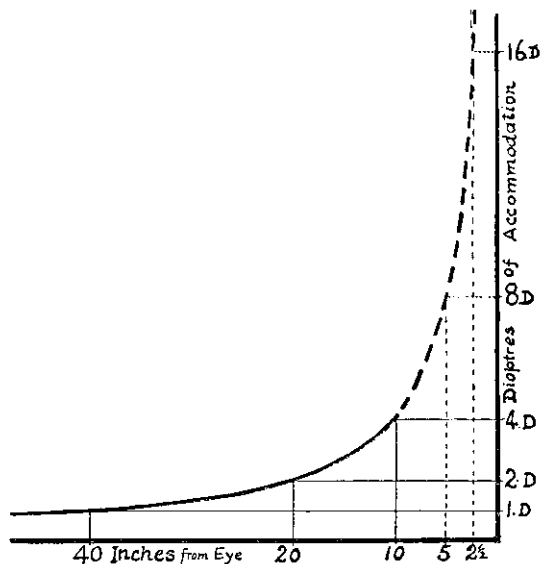


FIG. 12.—The danger zone of overstrain of accommodation on bringing work nearer to the eye.

in with a broken line, and work nearer than 10 inches is in the danger zone of overstrain of accommodation. With the younger children must be added on what has not been taken into account in the figure, a certain

amount of accommodation exerted to make up for the hypermetropic condition of the juvenile eye. The hypermetropic eye is this shortened undeveloped condition, seen in the young child and very commonly among uncivilized races. It is an eye where accommodation has to be exerted to see even distant objects. The theoretic condition of the eye at rest, forming a clear image on the retina, is the ideal perfect eye which scarcely exists except as a transient phase of growth. The ideal condition is described as *Emmetropia*, and the eye is called emmetropic. With continued use and growth, in many eyes as time goes by the eyeball stretches so that the axis is relatively longer, and the farthest point at which print can be seen clearly comes nearer to the eye. This condition is closely associated with civilization. As the individuals who have such lengthened eyeballs often half-shut their eyes in the effort to see afar, it is called *myopia*, from the Greek word *muein*, to blink, and *ops*, eye.

### Visual Acuity.

The judgment as to seeing clearly is measured by the visual acuity as tested by different sized objects. Snellen, the Dutch ophthalmologist, constructed types to be seen at different distances, from each of which the selected type subtended a visual angle of five minutes. If  $D$  is the distance in metres at which the types subtend the angle of five minutes, and  $d$  is the distance at which they are clearly seen, then the visual

$$\text{acuity V.A.} = \frac{d}{D}.$$

To eliminate accommodation the test is always

taken with distant test types, preferably at 6 metres, that is, 20 feet.

The Snellen test types are constructed so that by taking  $d$  as 6 metres the letters of each line of type downwards subtend five minutes at 60, 36, 24, 18, 12, 9, and 6 metres respectively, sometimes 5 and 4 are added. The heights of these letters are 87, 52.2, 34.8, 26.1, 17.4, 13.05, and 8.7 millimetres, and the thickness of stroke one-fifth the height. The letters used are plain Egyptian block letters.

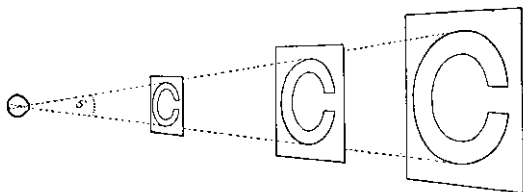


FIG. 13.—Method by which test types have been prepared of different sizes to subtend 5° angle at the various distances.

If the child reads to the fourth line its visual acuity is  $V.A. = \frac{d}{D} = \frac{6}{18}$ . The visual acuity should always

be expressed in this crude fraction. The top number then gives the distance in metres at which the child was tested, and the denominator the distance of the smallest letter if seen under an angle of five minutes. This is found printed on the test card in fine letters just above the line of test letters to which it refers.

All test letters are not equally visible, and the general shape may be distinguishable when the letter

is not clearly seen. The square letter E has, therefore, been suggested in various positions for testing young children or illiterates, as they have simply to indicate which is the open side. These types have been called Cohn's hooks, or Cohn's E's (Fig. 14).

It is important that care be taken to have enough light. The Middlesex returns, analysed by Dr. Palgrave some years ago, showed different returns for summer and winter due to the average differences in day-lighting. For this reason the author chose April



FIG. 14.

and September for his original inquiries in Bradford in 1893-4.

The position of the test card should be about 6 or 8 feet above the floor, and not near any visible source of light, like an open window or a brightly lighted object. The child to be tested is then brought up to a mark of 6 metres, equal to 20 feet, away from the card as measured horizontally. Covering the unused eye with a large card or a small screen on a rod, the child is told to read the letters, beginning at the top and going on until it cannot read any more. The visual acuity is then represented by 6 metres divided



by the distance in metres printed on the card at which the smallest letters correctly read should be read by the normal eye.

### Precautions in Testing.

Many children can see much better than one would first suppose, when they are tested by reading the types at the 6-metre distance. The younger ones often give up, when a little pressure gets another line from them. It is the old story, they will not make the effort, but it is chiefly a mental effort. Unless special precautions are taken the error due to this is at least 30 per cent. The vision testing in the ordinary school inspection in London in 1917 showed that at the age of eight 37·9 per cent. boys and 34·6 per cent. girls had normal vision. The numbers should probably be double this. Fifteen years earlier the oculists, trained ophthalmic surgeons, found over 60 per cent. normal, and the writer by careful inquiries was able to show that 81 per cent. boys and 72 per cent. girls had normal vision. Dr. Margaret Hogarth by special precautions was able to raise this percentage still higher. It is therefore possible to say that the routine vision inspection of London children at eight years of age shows an error of about 50 per cent., due to mental or psychical causes. This is another reason why it is important to avoid the careless visual working habits referred to on a previous page, produced by beginning education with small objects to which young eyes are so badly adapted. There is no particular reason why testing of visual acuity should not be done regularly by teachers. Dr. Miles Standish, of Boston, has advocated

this as likely to bring to light many cases which are not often seen by the school doctors in America. In any case the teacher of a myope class should know all about this testing, and record vision of particular children from time to time.

### Visual Defect.

Failure to get good visual acuity may be due to many causes. If vision becomes better on looking through a pin-hole in a thin black card the cause of the poor vision is probably due to some error of refraction of the eye. If there is no improvement by using the *stenopaic disc* (pinhole), some defect in the media of the eye itself is suspected. This may be corneal haziness or opacity; opacities in the lens of varying degree form the different kinds of cataract; or retinal troubles, of which perhaps the commonest is due to disseminated choroiditis.

To detect corneal defect the eye should be inspected by *oblique illumination*—light thrown on it sideways, focused on the cornea with a two and a half inch lens of 13 D. strength, the large lens in the retinoscope case. Any haze or opacity capable of interfering with vision will then show up clearly.

To investigate the lens or deeper media and retina, or measure the power of *refraction*, the child must be examined in the dark room, and, except for experienced workers, the pupils should be fully dilated. For this a mydriatic is necessary. Many surgeons prefer to use atropine. It is cheaper, its effects are thorough, but they persist many days. Where small numbers only have to be dealt with, a small lamella of gelatine

containing *homatropine* and cocaine is the handiest and most elegant in use, as one merely has to be laid in the conjunctival sac of each eye half an hour before the examination. A drop of castor-oil solution with 2 per cent. cocaine and 1 per cent. homatropine placed in the conjunctival sac acts equally well in about a half-hour, by which time the pupils should be widely dilated. After the examination, as the effects would otherwise last many hours, and if atropine is used this is days, it is usual to apply a drop of castor-oil solution with 1 per cent. of eserine to contract the pupil again. Eserine is a drug which paralyses the radial fibres of the ciliary muscle, causing the circular constrictor fibres to contract the pupil. This action is called *myosis*, and the agent a *myotic*.

### Refraction of the Eye.

In discussing the refraction of the eye the younger the child the greater the range of accommodation, causing the variable or dynamic element of refraction. In all growing people it is the refraction of the eye in a state of rest, the static refraction, that is required.

The only way to examine or discuss this refraction for growing children is to eliminate the variable factor due to the accommodative effects of action of the ciliary muscles. This is done by paralysing the muscles temporarily, with a mydriatic as already described.

The accommodation being paralysed, the ideal eye would be able to focus distant objects clearly on the retina. This is the standard, reference, or *normal eye*, spoken of as *emmetropic*, in which parallel rays are

brought to a focus on the retina. In the infant any young child with the eye not fully grown, and in many persons in whom it has not completely developed, the ocular axis is short of the normal length of 23 milli-

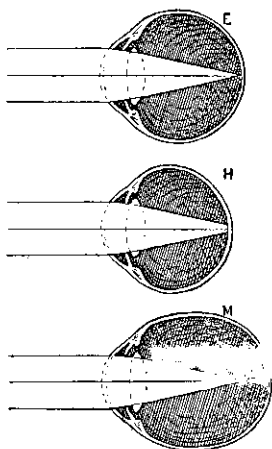


FIG. 15.—Refractive conditions of the eye.

- E. The condition of emmetropia with parallel rays focused on retina.
- H. Hypermetropic rays focused would fall at the same distance as above, but the eyeball is short, so they are not focused on retina.
- M. Focused as before, but eye axis is lengthened, so the focus falls in front of retina.

metres, and there is normally only sufficient refractive power to bring distant rays to a focus at this 23 millimetres, so with a shorter axis the focus falls behind the retina. This *short eyeball* is the condition named

*hypermetropia*. But in a few children and in many adults the eyeball is overgrown—the axis may be stretched out to 24, 25, or more millimetres behind the cornea ; parallel rays in this case focus correspondingly in front of the retina. This *stretched eye* is the condition of *myopia*.

Light which passes along any path in one direction follows the same path if reversed. If parallel rays are converged by the eye to the retina, then rays diverging from the retina are parallel when they emerge from the eye.

This explains why the retina cannot be seen by merely looking into the eye, and why the pupillary space looks black. The observer's head gets into the way and cuts off the light, so that as none is entering there is none to emerge in that direction. In the human being the nerves in the retina are transparent ; the black pigment cells of the choroid prevent much irregular reflection and the pupil is dark. In some animals, as the cat, the retinal nerves are medullated and cause a good deal of irregular reflection, so that light comes out by different paths from that by which it entered. If one sees a cat in a corner or darkly lighted place, and there is a good light behind the observer, the cat's eyes appear to gleam with this irregularly reflected light.

To illuminate the interior of the eye and be able to see it, light has to be thrown in, in the same direction as the observer looks. This was done by Helmholtz by using a small oblique mirror, and looking through a tiny hole scraped in the centre of the silvering. This is the principle of the *ophthalmoscope*.

If the eye observed were emmetropic the parallel light rays thrown into it illuminated the retina and then passed back diverging from the retina, and issuing from the cornea as parallel rays again could be focused by the observer's eye to form a picture of the patient's retina.

If the eye were one with a *short axis, under-developed and hypermetropic*, then the retinal rays issuing from it would be divergent, and a convex lens required to make them parallel enough to form a picture in the normal observer's eye. The strength of this lens in dioptries measures the amount of hypermetropia in dioptries.

With the *long, stretched myopic* eye the rays from the retina are converging as they leave the corneal surface. To get a clear image a concave lens is needed of sufficient strength to make them parallel, and the strength of this lens in dioptries gives the measure of the myopia.

In Morton's and other good ophthalmoscopes, a set of these lenses, both convex and concave, can be rotated in an endless band behind the little mirror through which the observer looks. This measurement of the refraction by the interposition of lenses appears simple. It is known as the direct method, but is only accurate in the most experienced hands.

Another way would be to make the patient with paralysed accommodation read distant types. The emmetrope could do this, but the myope would require a concave lens and the hypermetrope a convex one to make the parallel rays diverge or converge enough to be focused on the retina. Here, again, the strength of the lens gives the measure of the refraction.

### Retinoscopy.

In practice, the reading of types depends on the patient's judgment; but with children it is better to judge for oneself, so an objective method is used known as *skiascopy*, or the *shadow test*. One judges whether the image falls on the retina or not by the way the shadow of the iris edge thrown by a beam of light from a retinoscopy mirror apparently moves on the retina. An ophthalmic mirror is used about a metre from the eye to throw light into the eye. On rotating it a little about a transverse axis the shadow of the edge of the iris thrown on the retina is seen to move across the pupil like a black or grey band or spot. If the eye is hypermetropic the band appears to move with the mirror; if the direction is not clear the eye is probably emmetropic; if myopic, the shadow seems to move contrary to the mirror. By adding, in a spectacle frame, a *convex* lens to the observed eye, one is at last got which corrects the hypermetropia so that the spot no longer moves with the mirror. This lens then measures the refraction; if the eye was myopic, *concave* lenses of increasing strength are used till the one is found which corrects.

The shadow is seen as a rule to move at a slight angle with the horizontal, and then it is found that in this direction correction is attained before it is obtained in the direction at right angles. There is *astigmatism*, and these two directions give the axes of the astigmatism.

The record of such an examination might read as in Fig. 16, which shows the record of an examination where the right eye presented hypermetropia equal to

2.5 dioptries; but in a direction up and out at about 120 degrees measuring downwards from the extreme right of the horizontal line, the hypermetropia amounted to 4 dioptries, corresponding to 1.5 dioptries of astigmatism in that direction. In the left eye there was 3 dioptries of myopia in a vertical direction and emmetropia in the horizontal, thus showing simple myopic astigmatism with the axis horizontal.

Astigmatism complicates matters. The term was

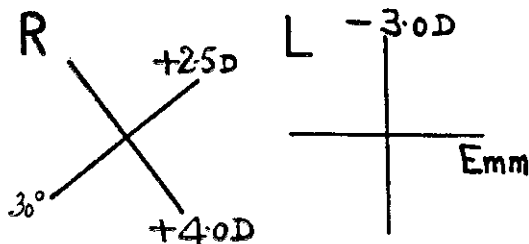


FIG. 16.—Retinoscopy Record.

invented by Whewell as indicating that a point of light is not anywhere focused to a point, but to two lines in directions corresponding to the two axes of greatest and least refraction.

By using a cylinder, that is, a glass ground only in one direction, either convex or concave as the case may be (p. 97), the error may be corrected. In the case of the above right eye a cylinder of + 1.5 D. with the axis down and out at an angle of about 30 degrees should correct the astigmatism, and if this is combined with a convex spherical glass of 2.5 D. the optical



error would be fully compensated. The prescription would read Rt. = + 2.5 D. sph. + 1.5 D. cyl. axis 30°.

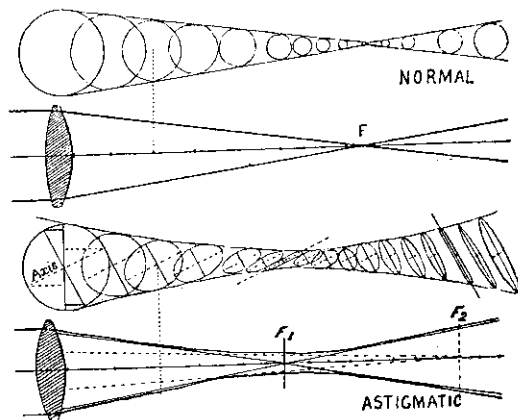


FIG. 17.—Astigmatism.

To show the course of parallel rays after passing through a lens with spherically curved faces, which bring the rays to a definite point at focus  $F$ , and also below after passing through a lens with astigmatism, no point focus is formed, but at some distance apart two focal lines,  $F_1$  and  $F_2$ , at right angles, are the nearest approach to this. Above each are sections of the beam corresponding to the various spots marked on the axis of the beam below.

In the other eye the prescription would be much simpler, reading Left = - 3 D. cyl. axis horizontal.

The sign + indicating convex, and - concave lenses.

Hypermetropia is not likely to come into consideration for one of the sight-saving classes. It is not

school produced, but racial or familial, and some consider that rickets conduces to the want of development. Its worst results are headaches, giddiness, or inability to do eye-work for long. The treatment is the wearing of proper correcting glasses. Sometimes their full benefit is not seen till they have been worn for some weeks. It is a safe rule in hypermetropia to wear the strongest glasses which can be borne comfortably.

After removal of lenses for congenital cataract, a child wearing very convex lenses as a substitute for its own lens may be deemed suitable to attend a myope school, on account of opacities remaining after the operation. These cases are rare in the classes.

Convergent squint is more commonly found associated with hypermetropia than with any other condition. The squinting eye may have very poor vision even with correcting glasses, and with no other defect sufficient to account for it. This condition is called *amblyopia*; and as there are various kinds of amblyopia this variety, supposed to be produced by want of use in the years of development, is termed *amblyopia ex anopsia*.

### Functional Failure.

Functional amblyopia is a condition occurring in nervous, overwrought children. Girls of about eleven or twelve years of age seem the most frequent; but little Jewish boys are not exempt, for it is commonest among Jews and some foreign races. A child who says it cannot see the blackboard, but sees easily close

at hand and has no apparent trouble in the eyes, is perhaps growing quickly and often physiologically exhausted, especially about adolescence. They will see better with the weakest concave glass, may also do so with the weakest convex, then finally with both together, the equivalent of plain glass. Although the Report of a Medical Officer of Health recently notes these as malingerers, they are not so in any sense. The amblyopia is the result of autosuggestion. It may come on suddenly. At first near work causes no trouble; later it is held near and done with effort, following this there may be complaint of glare or avoidance of light, and frowning or headaches. Attention to the eyes tends to aggravate; on the other hand, suggestion that vision is improving, especially with the eyes closed in the dark room, sometimes effects rapid recovery.

In the same variety of children *monocular polyopia* may be detected. A pin being held up six inches from one eye, they are asked what do you see, and will answer two pins, three pins, or a row of pins. There may be actual complaint of intermittent *micropsia*—things look as if seen through the wrong end of a telescope—this suggests relaxation of the ciliary muscle. With growth or return to a healthier condition the difficulty may disappear. Suggestion in some form is often useful, or atropine and exclusion from school. These children are more likely to be met in the first year or so of a girls' secondary school. The important thing is that there must be no treatment with concave glasses, for although they sharpen up the vision they soon aggravate the condition, setting

up the next variety of amblyopia, that due to chronic *ciliary spasm*. Formerly one saw a good many children wearing wrong glasses, coloured or otherwise, not merely the result of opticians' efforts, but sometimes prescribed by doctors. The one protection from error is that the child or young person should be examined when under a sufficient mydriatic; without this glasses should not be worn.

*Spasm, or Cramp of the Accommodation*, is sometimes called by foreign writers spurious myopia, lens myopia, or accommodation myopia. The involuntary muscle fibres in the ciliary body easily pass into a state of tonic contraction if chronically overworked in children convalescent from illness, and other delicate, anæmic or neurotic ones when growing rapidly. The length of the axis of the eye may be normal, but the spasm of the ciliary muscle causes the lens capsule to be relaxed, and the lens becomes more convex, so that the image which should fall on the retina is formed in front of it. The eye then appears as if myopic, but there is no real lengthening of the axis as in true myopia. Attempts by opticians to correct vision by using trial lenses without mydriatics will also lead to these cases having concave glasses, which, as already stated, leave the eyes worse after a short time. There must be thousands of people wearing glasses unnecessarily to whom a little suggestion, if their troubles were known, would give relief. The writer remembers a boy who would have been qualified for a myope class on the glasses he was wearing—Rt. and L. = - 8 D. sph.—had retinoscopy not shown his refraction nearly normal. In another case, a little girl wearing Rt. = - 6 D.

sph. and L. = - 5 D. sph. was actually admitted, and spent some time in a myope class, till at the school clinic, after retinoscopy under atropine, she was found to require + 1 D. sph. for her hypermetropia.

### III

## MYOPIA

THE optical condition of myopia is due to lengthening of the axis of the eye. Each three dioptries of myopia roughly means a lengthening of about a millimetre. It is doubtful if any children are born myopic. Hypermetropia, with perhaps some unchanged astigmatism, passes through emmetropia to myopia. Whilst in the child the hypermetropic eye does not get worse, but may improve, in myopia all change may be taken for the worse optically. There may be very rare cases of congenital myopia which do not alter, but no one can be sure of such a case until some years of observation have elapsed.

Rare cases of myopia, supposed to improve, are probably functional.

The cause of myopia is quite unknown. Children on entrance to school are sometimes found highly myopic, and they are likely to get worse. Somewhere about 10 per cent. of children are myopic before leaving the primary school. When students are taken in the later years of educational life, double the proportion are affected, but they are a selected group. Probably not 10 per cent. of all myopes are ever in any serious danger of their eyes going wrong. Probably 20 per cent. of students in training colleges are myopic.

This has been misnamed school myopia. It should be called developmental myopia. There is a small number of these—or perhaps at early ages indistinguishable from these, less than 10 per cent. of the myopes—whose myopia goes on increasing; and in later life there may be grave occurrences, such as *hæmorrhages* into the vitreous or under the retina,

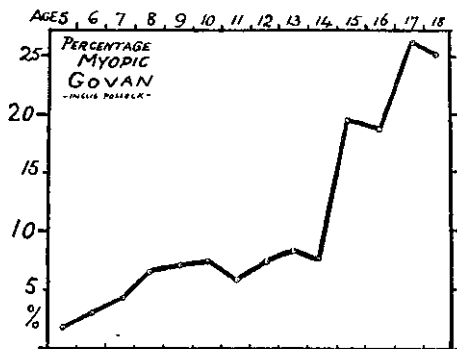


FIG. 18.—Diagram to show myopia age distribution in Govan schools.

especially damaging about the macula, or *detachment of the retina* from the choroid, with serious damage to sight and sometimes blindness, so that all myopia is at first to be suspect. The younger the child and the greater the amount of myopia, the more is it to be regarded as serious in respect of good working vision in middle life.

The medical inspection of school children ought to have added enormously to our knowledge, if it had

been scientifically organized. Unfortunately, as the Medical Officer of Health is not a success in school hygiene or ophthalmology, there is very little work of value to advance knowledge. Dr. Inglis Pollock, an ophthalmic surgeon in Glasgow, has given the best account of myopia, as distributed among the children in Govan.

Fifty or sixty years ago a panic was raised in Germany by the work of Hermann Cohn, of Breslau. He examined schools and school children, and was the great pioneer of school hygiene, but he overstated the case in attributing myopia entirely to excessive strain on the eyes from too close and too near eye-work in poor light.

Where the tendency to myopia exists these things may be contributory or accelerating factors, but still somewhere near 90 per cent. of the children who go through our primary schools suffer in no respect as regards myopia. Ten per cent. do suffer, but there seems to be a kind of constitutional build of eye liable to myopia. It runs in families. Most slight cases are developmental. All eyes tend to lengthen their axis; the majority stop before the 23 millimetres, which constitutes emmetropia, is exceeded. Somewhere about 10 per cent. of English children exceed it. Donders recorded a case where the optic axis was 37 millimetres. The growth, especially when excessive, goes in irregular spurts of development or stretching, particularly during convalescence from illness and during early adolescence. Most have the stretching arrested by twenty or twenty-two years of age, and in the next five or ten years do not increase a dioptré.



The minority, not much less than 1 per cent. of all elementary school children, do not have this arrest, but continue still to have increase; the eye goes on stretching, the so-called malignant myopia, and then becomes liable to many disasters, the least of which is inability to stand much eye-work, and the worst is loss of useful vision, due to various causes already mentioned.

### The Myopic Crescent and Annulus.

As the myopic eye stretches back, its coats become thinned. On examining the optic nerve head with the ophthalmoscope in a series of eyes the disc appears round or oval, the last in astigmatic cases, but in many myopic cases there is a thinning like a crescent moon around the outer side of the disc. This is known as the *myopic crescent*, and in advanced cases the crescent extends till in high myopia one finds an *annulus* of thinning with the white sclerotic shining through, extending completely round the disc. In cases of very high myopia the disc may appear a small object about the middle of a large white patch of an irregularly oval shape, where thinning and absorption has gone on to form the so-called *posterior staphyloma*. The bigger the staphyloma the worse the outlook.

Later in life there is a tendency for changes to extend to the vitreous; it often becomes fluid, and specks and sometimes masses of tissue float in it. There may be circumscribed degeneration also about the macula, or the atrophic changes beginning at the disc may extend till they embrace the macula, and with atrophy the central vision is lost. Hæmorrhages are also liable to occur. These are dangers familiar

in the ophthalmic out-patient room, but much commoner on the Continent than in England. There the work of Cohn and others who saw much of such cases made many take extremely serious views of myopia. Even here some 4 or 5 per cent. of our blind school children are put down to results of myopia, and it runs to about 14 per cent. of the blind. These accidents are commonest after about thirty years of age, so that it is prudent to look on high myopia in a child as an ominous portent for visual failure in middle life. At any age the outlook for a patient with 10 D. of myopia is bad.

Where glasses have to be worn by children the simpler the better. Where cylinders have to be worn, they should be worn constantly. Children may suffer less, but older patients wearing cylinders intermittently may have a good deal of headache and discomfort, either when wearing the glasses or after leaving them off.

Floater, or *muscæ volitantes*, the little spidery, filmy particles sometimes seen in the eye, are not related to myopia, but mean that something is interfering with the nervous tone or nutrition in the retina, so that the shadows of those little particles, which should not produce any effect, have an excessive effect on the retina and are noticed. They are neurasthenic or debility symptoms, and generally indicate a need for a rest.

### General School Treatment of Myopia.

Myopia usually increases during the growing period. This accounts for much of the influence assigned to

school-work. Bearing in mind that school-work does not make 90 per cent. of the children passing through it myopic, the primary cause is evidently in the child itself.

As far back as 1864 Donder's book on Refraction gives a clear story of myopia, setting it out in three classes: the stationary, the temporarily progressive, and the permanently progressive.

Two types of school myopes one notices to emerge from the crowd. The first is a small delicate child of nine or ten years old, who probably already has decided that she wants to be a teacher, and is of the *type cérébral* of some French anthropologists. There is also the big, fat, heavy type, suggesting *endocrine* faults, who often has high myopia at a comparatively early age, rapidly progressing.

The average myopic child of low degree has a well-developed brain, which perhaps is associated with an over-developed eye. Definite myopia, which appears by ten or eleven years of age, may be noted then as up to a couple of dioptries. This can be expected to double by sixteen years of age, and add an equal amount ere full growth is attained, when it probably becomes quiescent from the age of twenty to twenty-five.

It is quite impossible to say how much school-work contributes quantitatively to the aggravation of the condition of myopia. Possibly 50 or 60 per cent. would be a full estimate, but these eyes are not originally made myopic by school. Some of the German writers deplore that school palaces have done nothing to diminish the prevalence of myopia.

Whatever be the story, at the age of eleven children have to be chosen for scholarships or secondary education. A serious question now arises in connection with certain scholarship candidates just over eleven years of age. These are the children who with glasses can get fair or excellent vision, and who consequently often have not been detected at school as suffering from myopia of considerable amount. Myopia at early ages, if it changes at all, changes for the worse, and as there is generally a great increase at puberty and during the remainder of growth, it is important to preserve such eyes as well as possible till growth is accomplished. The claim put forward in the *Board of Education Report* (1917, p. 60), that a child unfit with myopia can have it rendered stationary by open-air treatment so that in a year or two it may return to the elementary school is an improbability which right criticism should have condemned. Any child of eleven to twelve years of age, with myopia equal to four dioptries or more, is likely to be harmed by further academic work in the sense of reading or writing, or fine work like drawing or sewing. These particular candidates are often precocious intellectually. They have gained a scholarship, their ages average eleven and a half years, and they must stay at school till fourteen at the earliest; they have probably attained standard seven, hence to remain at the primary school is merely marking time. On the other hand, they cannot be regarded as blind or semi-blind, and the myope schools are probably below their standard of scholarship. These children are of incomparably more value to the community than

mentally defective, crippled, or tuberculous children, and special education should be adapted to them. There are about two thousand children in London requiring education in the present myope classes, but there are at least ten times that number who would benefit visually by a simpler sight-saving education than is afforded by any arrangements in the elementary school. This foreshadows another type of sight-saving school, apart from the myope school.

As an immediate measure of protection, every child with two dioptries of myopia by the age of eleven should be put under half-yearly reports, partly for safety and partly for parental education, and with — 3 D. or more should be rejected for scholarships.

Bishop Harman (*Lancet*, October 28, 1922) compared two sets of working myopes. Those of — 3 D. to — 5 D., engaged in continuous close employment, showed "failure in work" in 33 per cent.; from — 5 D. to — 10 D. showed 60 per cent. failure; and over — 10 D. had 77 per cent. failures. The whole of these myopes who engaged in near-working occupations showed a failure of 53 per cent., whereas myopes of the same order who did not engage in near work failed only to the extent of 9·4 per cent. Apart from this there must be a limit beyond which public money should not be expended in education of the individual likely to suffer or to fail.

Candidates for the teaching profession, when seen as bursars, should be rejected if found with refraction needing more than — 4 D. for correction. In practice these people are aged about fifteen or sixteen when seen, and if myopic, may be expected to increase

at least a couple of dioptries. For candidates for admission to training colleges, generally over eighteen years old, the same rules should apply, but  $-5$  D. might now be accepted, full acuity being required with the glasses. These are values which have been adopted by the British Council of Ophthalmologists, although for many years  $-3$  D. and  $-4$  D. respectively had been the limits acceptable for bursars and training college admissions in London. The writer's rule was to allow astigmatism up to  $-3$  D., but the rule now is that where in addition to myopia there is astigmatism, 2 D. of astigmatism may justly be considered a ground for rejection. There is much opposition to these rejections by parents, teachers, and often even doctors, who should know better.

On the day on which this was written one indignant mother objected to her boy being put under restriction, as at the age of thirteen he had already  $-4.5$  D. of myopia with 2 D. of astigmatism, she had the same amount of astigmatism herself, but myopia amounting to 12 D. in the right and 16 D. in the left, with some detachment of one retina, yet had failed to profit by her own experience.

### Hygienic Treatment of the Eyes.

Modern school hygiene may be said to have almost originated in the efforts of Hermann Cohn to trace out the factors of myopia which he thought he had reduced to prolonged near work in poor light.

There ought to be educational provision for good hygiene—

1. Of the normal and weak eye.
2. Of eyes with diminished acuity or tendencies to disorder.
3. Of the educationally blind.

### Glare.

Hygienic treatment of the eye in school means the avoidance of *eye-strain*. Eye-strain is essentially due to maintained efforts at accurate compensation for poor retinal images. Where the strain is moderate, discomfort is often not felt for some time, but where the strain is great, *glare* is felt almost at once. Glare is extremely difficult to define. One associates it in the mind with the acute discomfort of bright light on the dark adapted eye, as when the headlights of a motor-car are suddenly caught full blaze on a dark night, or the holiday memory of emerging from some ancient Norman dungeon into the summer sun of an August noon. Glare is subjective, and can be felt acutely in poor light. Try to watch a tiny intermittent movement, like the jerk forward of the hand of an electric clock, from some distance, and the feeling of glare asserts itself in the space of a minute or so. Usually very accurate detail is not wanted in most visual affairs; the merest hint is sufficient to enable the mind to build up a picture from its previous experience, although subconsciously the mechanisms of the eye are always endeavouring to get a clear image on the retina. So long as extreme effort to get an exact image has not to be made, either from poor light or from watching a small object, no glare may be evident.

The glare from very bright lights, compared with what the eye is adapted to, falling on the retina is often further distinguished as *dazzle*. It may be serious in connection with incandescent mantles or filaments, which should never be exposed unshaded to the eye in school, and must be regarded as almost criminal if unshaded in a myope school. Opalescent shades through which the form of the mantle or filament cannot be made out will give a large bright surface, which can be looked at directly without any sense of glare. The average brightness of the sky is as much as the eye can tolerate continuously; it is about three candles per square inch, and no source of light in school or house should exceed this if it is to be visible. Only the sprayed or opalescent bulbs should be allowed for electric lamps. In the case of those with sensitive eyes, the so-called daylight, green-tinted lamps, although wasteful of electricity, have an unirritating effect on the user. Clear glass electric bulbs must not be permitted in a myope class. A good rule for the myope classes is to do no eye-work whatever by artificial light. Intrinsic brightness of sources of light may cause after-images, which are very irritating to myopes, especially during the stage when myopia is progressing. Many points of light are better than one or two powerful sources.

There is irritating glare caused from shiny surfaces which reflect ill-defined vague images of the source of light and which the eye subconsciously keeps up an effort to focus. Where this condition exists, and in addition the light is not very good, a chronic condition of eye-strain may come on in children attempting



any fine eye-work. After the twelfth year, as accommodation becomes reduced, the strain is increasingly obvious, and especially so in girls.

In rooms, particularly if not well lighted, the moderately adapted eye resents the shiny surfaces of walls or desk-tops, and if there are few bright sources of light in the room the reflections from polished objects may exert a kind of distracting effect, more easily if attention is beginning to flag.

Important, and probably part of a vicious circle, is the effect on the young student who is using the eyes in an intensive way, far beyond what any generations before have done. The spasm of overworked ciliary muscles, and fatigue of their nerve centres, and possibly allied conditions of structural irritation with nutritive changes, especially in early myopia, have made the eye sensitive of glare in any effort of exact work. It is reading, writing, and figuring that demand accurate images, although even here the scholar works without the proof-reader's eye for detail. In these tasks especially is glare evident; it becomes insistent and is distracting to attention, seriously hindering the efficiency of educational aims.

Artificial lights may be very troublesome, and as the shiny reflection glares proportionately to the intrinsic brilliancy of the source of light, it is again a reason for insisting that no naked flame, mantle, or filament should be permitted, nor any visible source of light with greater intrinsic brilliancy than three candle-power per square inch, the brightness of a summer sky.

**Eye-strain.**

The eye-strain already mentioned from defective lighting results from either glare or poor lighting, and is due to the attempts at steady fixation. It is scarcely realizable what microscopic minuteness of adjustment is possible—of course, at great nervous expense—in maintaining the exact co-ordination of the dozen different muscles of the eyeballs.

Dr. W. B. Lancaster, of New York, in regard to the usual resolving power of the one eye taken for two black lines on white as an angle of one minute, states that by stereoscopic tests with both eyes it may be reduced to 3 seconds, certainly under 12 seconds, and is one-fifth to one twenty-fourth the normal acuity standard, so that, making all allowances, we can fix to within a few thousandths of a millimetre. Usually with sufficient lighting there is no exactness in work ; a glance at one or two prominent indications, and the picture is filled in mentally—with, it is true, many mistakes—up to 30 per cent., the kinema psychologists say, in the apperception of things seen. Where the light falls off or is dim, the above finer adjustments are possible, but can only be maintained at great physiological expense and with the risk of hyperæmia and eye-strain. It is the requirement for this kind of work from which the early myope stands in such need of protection, and continuous fine work and bad lighting, either in quantity or distribution, is the chief school cause of the strain.

The next noticeable source of glare in teaching is the blackboard. Glare from this is almost certain to affect a considerable percentage of the students from

their relative position in the class. A matt and dull surface is worth maintaining, and in the myope schools the blackboard should have a weekly overhaul. Its importance is so great as an indirect lesson in eye hygiene that this is a suitable occupation for part of the scholar's work, and ought to be marked on the time-table as an occupation in the myope classes.

### Hygienic Lighting.

A good position of the blackboard in any school avoids reflection of lamps, windows, or bright walls in the faces of the pupils. By suitable tilting these images can be thrown harmlessly in other directions. With artificial lighting in ordinary schools the yellow colour requires good contrast to be maintained between the colour of the chalks and the board. The written figures should be brightly lighted from above, so that any regular reflections fall towards the floor. A high accessory lamp near the board, shaded completely from the pupils, aids illumination and lessens glare. It must be an absolute rule that no eye-work, blackboard or otherwise, should be done in myope schools by artificial light.

For school purposes of reading and writing all the contrast possible between the black of the letters and the white of the paper is required. The surface brightness of the paper should be about a hundred times that of the ink. Only the irregularly reflected light, which shows up the texture of the paper and the colour of the ink, is wanted by the eye. The eye is accommodated to the focus of this paper surface and the ink. The amount of regular or specular reflection,

if any, from the surface tends to form a vague image of the source of light which appears to be behind the surface, and for which the eye is not accommodated, so that diffusion circles of unfocused light are formed on the retina, blurring and interfering, veiling and reducing contrast in the focused image of the paper and print, and causing glare from the maintained subconscious efforts to compensate or correct the faults in the image.

The proportion of this regular reflection must be kept as low as possible. By pressure of hard types it is possible for the black printed letters to have a smoother surface than the white paper, so that beyond a certain angle of incidence they are invisible. The shiny surface even of Indian ink is therefore bad, dull engraving "process" black being the best material for school use. The conditions of glare in low degrees are accentuated by ocular sensitiveness, due to malnutrition of the nervous elements of the retina, as in early myopia, spasm, migraine, neurasthenia, and chronic fatigue from excessive eye-work. Beyond this the position of the eye must not fall within the position of regular reflection from the source of light, for which reason, commonly in olden times, as still in churches, reading was done standing at a desk, looking down at the book placed at such an angle that any regular reflection tends to fall below the chest.

When light, book, and eye are not approximately in the same plane, glare does not predominate, as, for instance, with light coming over the shoulder. It is not only actual lights *en face*, as when a student sits at home at a centre table with a light in the middle

of the room, but also bright reflected images which act as equal to sources of light.

Glare has been treated in detail, for, important as it is in ordinary school-work, it is ten times as important in the myope school.

## IV

### SPECIAL EDUCATION FOR SUBNORMAL VISION CASES

THE cases which require special educational treatment beyond the ordinary school routine, purely on account of their visual defects, may be classified as follows :

1. Those who can continue in the ordinary school, with certain restrictions. They amount to some 7 or 8 per cent. of all.
2. Those who should be educated with totally different ideals to the ordinary school curriculum in sight-saving classes, including high myopes. This group is at least 1 per cent. of all.
3. Those considered educationally blind. They run to about 1·5 per thousand of the roll.

There are children with slight defects that may diminish visual acuity, or may get worse with even ordinary school strain. In these ought really to be included cases of spasm and slight myopia, which would raise the numbers to 10 per cent. of all children. In practice not half this number are ever considered, and not one-tenth placed under restrictions. The children considered are only about the worst tenth who have been examined for other visual treatment, and not deemed bad enough, or there has not been sufficient

provision. The doctor's conscience will not allow them to return to the ordinary school, so a salve is applied by a proviso for special treatment. Too often from ignorance on the part of both teacher and taught no further notice is taken. The action of many secondary school teachers is more than stupid: it is reprehensible, even refusing admission to such pupils. School is for individual education, not for the mere passing of percentages at examinations. What particular standard in the curriculum a pupil attains does not matter in the slightest so long as education goes on reasonably, and to the full limits of the pupil. There are many pupils in every secondary school below the mental average of these eye cases, even allowing for their handicap, but whom there would be no idea of refusing. In this matter many teachers require to be taught, and no teacher should be permitted to refuse a child on account of such visual restrictions. Secondary head mistresses, thirsting for numerical successes, have been the worst offenders.

The instructions regarding these children, to whom the educational wind has to be tempered, should be printed for general use as "children for easy treatment," and severer cases as "children for oral instruction only."

### **Children recommended for Easy Treatment.**

These children usually suffer from a defect of one eye only, or they have defective vision in both eyes of a moderate degree. With care school-work should not cause strain of the eyes or entail the risk of exaggeration of their visual defect. They should sit

in the front row of the class, sit upright, and not be allowed to stoop over any literary work allowed them. Girls may learn knitting, providing it be taught by touch and not by sight, but are to be exempt from sewing. Boys and girls should be prohibited books with small print or writing of any sort other than a bold, large letter hand, and be exempt from reading or writing of masses of numerals or geometrical figures. They may read or write in large letters, preferably for periods not exceeding a quarter of an hour to twenty minutes without a break. They should not stoop over their work, and if possible the writing should be free-arm on a blackboard, or even a millboard set up on the desk. All the object lessons, demonstrations, and oral lessons that are given at the school are to be allowed. Drill, dancing, games of all kinds may be freely encouraged. Home-lessons of any sort should be prohibited.

### **Children recommended for Oral Teaching only.**

These children suffer from some serious defect of vision, such as gradually increasing short sight. When no place can be found for them in a special class they are admitted to the elementary school, with a view to their gaining the educational advantage of school discipline and such general knowledge as can be given them in the oral lessons of the classes.

The use of books, pens, paper, pencils, and slates of any kind and for any purpose in the ordinary school is to be prohibited, and the child should be reminded at intervals by the teacher in a friendly chat that the prohibition is for his or her own benefit, and that



they must continue at home what they are trained to do at school. They may be allowed to write or draw on the blackboard in large characters free-arm fashion.

If a girl shows aptitude for hand-work she may learn knitting by touch, but not by sight. Similarly a boy may do the larger kinds of carpentry, but he must not use the rule for fine measurements or draw carefully scaled plans on paper.

For the most part these children may drill and dance, but in the case of high myopia they should be warned against using gymnastic apparatus or dumb-bells—for example, in connection with the Children's Happy Evenings Association. They should be cautious in the playground games.

### **The Ideal of the Myope School or Sight-saving Class.**

This is quite different from the academic ideal of most school-work. For the majority of these children it would possibly be an advantage that they should not learn to read or write beyond the merest rudiments. They should learn the minimum of reading from wall sheets, and be instructed that, until they are full grown, for them reading is a vice. Those who have to do with these classes, particularly Americans, can be given the dictum of the great educational administrator, Horace Mann, in 1843: "Reading and writing are not education." On the other hand, the children should be fully instructed in all that they can learn about ocular hygiene and good practices. The Socratic method, by question and answer and reasoning on

the answer, is the soundest method of education in academic subjects in these schools.

Owing to difficulties in getting parents, teachers, and others to aid with their support, a sheet of advice is useful for their information, briefly stating that to save children with short sight from eye-strain these classes have been instituted. The conditions of the class have been set out that—

1. For all lessons that can be learned by listening to the teacher the children in the myope class go into the ordinary school.

2. Lessons that need reading or writing are given in the myope class. Instead of using books, pens, and paper, each child has a large blackboard, on which it writes with chalk just as the teacher does.

3. In the myope class a speciality is made of handicraft, various forms of carpentry, bent-iron work, model-making, printing from blocks, and drawing. The children enjoy the work immensely, and the instruction is most profitable.

4. The children learn to dance and drill, and for these lessons most of them are able to join in with the ordinary children.

“ . . . You are particularly asked to take your share in carrying out the scheme for the protection of your children's eyes. Get the little one interested in games and outdoor play. Do not let it read or write. . . . ”

These circulars should be amplified and illustrated, not only to give information, but also to appeal to

reason, as, in spite of what has been done, there is continual trouble.

As an instance, this summer a girl of eleven is seen as a scholarship candidate, with rapidly advancing myopia of seven dioptries. Recommended for the sight-saving class, her father "most emphatically declines to allow it." He objects to the class of children, says the education is practically nil, and that her chances of a secondary education and the future will be spoiled. He has already had another girl there.

The girl's head mistress of the secondary school writes that a fee-paying girl has never had to be withdrawn for defective sight, and presumably she objects to this one going.

It is obvious that the doctor who certifies these cases must be prepared to adhere to his decision, in accord with the not very strict rules set out on page 76, as approved by the Council of Ophthalmologists.

### Cases admitted.

About two-thirds of the number admitted to the sight-saving classes in London are myopes, and perhaps a quarter have superficial or interstitial keratitis, the remainder being chiefly affected with various congenital defects. In thirteen such classes gone over individually there were 226 high myopes, 73 with keratitis of different forms, and 58 with various congenital and rare conditions. It might be possible to lighten the teachers' burden if they classified the children into two sections.

I. The progressive and acute cases, including all high myopes and cases of active keratitis. The majority of myope cases admitted are from 6 to 12 D. of

myopia, in approximately equal numbers. A few cases exceed 12 D., most of whom should probably be regarded as educationally blind.

II. Non-progressive cases, such as old cases of ophthalmia neonatorum, old corneal opacities, cataracts, defects like dislocated lenses, colobomata, aniridia, albinos, and some with nystagmus or old choroiditis.

Four-fifths at least will belong to the first category, whose eyes with active disease must be protected in the strictest way during the whole of the growing period. They have to follow the full regime, doing no continuous, accurate, or fine eye-work, and the avoidance of all such work in or out of school should be inculcated until it becomes a regular habit of their lives. The principles of education for the four-fifths being so different to those for the other fifth, two separate kinds of sight-saving schools are a possible future development.

At Cleveland, U.S.A., where R. B. Irwin, who has done so much for blind education, has recently interested himself in conservation of vision, the conditions are somewhat different to ours in England.

The standards for admission are: Myopes of more than  $-8$  D.; children having maculæ or leucomata of the cornea, reducing vision to  $\frac{6}{15}$ ; hypermetropes over  $+8$  D. having asthenopia; congenital cataract cases which have been operated on and have vision of  $\frac{6}{15}$  or less, with glasses; children whose vision cannot be improved over  $\frac{6}{30}$ ; children with interstitial keratitis, uveal or corneal disease who are under treatment and have been temporarily withdrawn from the ordinary school.

Obviously, and quite properly, they have many children who would be included in our previous categories. They have ten children to a leader, and use books printed in clear-faced, heavy 36-point type, on buff unglazed paper. There are special precautions for good lighting and prevention of glare.

One hears a great deal of the dangers of high myope cases from hæmorrhage or detachment. These risks are mostly after the period of growth. The writer excluded a brilliant nineteen-year-old girl in the middle of her training for the teaching profession. She was taken into the office of one of the members of the local education authority. Within four months after exclusion she had become practically blind through hæmorrhage, first at one macula, then at the other. This is the only case he has met in so young a person, although it is a catastrophe occasionally heard of in one or other parent of a myopic child. Football and violent games are likewise forbidden, from fear of detachment, although again he has only twice known detachment attributed to this cause in a young myope. Evidently during school age the risks of detachment are not great. Swimming is a doubtful exercise for moderate, and forbidden for high myopes, but in no case is diving or swimming under water to be permitted.

### Guides.

For either blind or partially blind, including the pupils of the sight-saving classes, it may be expedient to recommend, and the local education authorities have power to provide, guides or conveyances to and

from school. The duty of attendance, however, is imposed upon the parents by the Education Act, and the local education authorities are not compelled to make such provisions, nor are they in any way liable or responsible for accident or damage to children on their way to or from school without guides.

### **Other General Conditions related to the Eyes.**

Before leaving the subject of the eye itself certain related conditions should be mentioned, as they require notice by an observant teacher; indeed, each child should have been surveyed by the teacher, and mentally, at least, catalogued under the following heads:

General nutrition.

Posture.

Condition of throat, nose, and ears.

Mouth and teeth.

Cervical glands.

For details of these conditions, to which the teacher should give considerable attention, the author's little work on general school hygiene should be consulted.

The general nutrition is of enormous importance in many of the chronic eye diseases for which children are sent to convalescent or seaside homes. Phlyctenulæ, corneal ulcers, blepharitis, and various forms of chronic conjunctivitis are largely matters of ill-nutrition. Nutrition is judged on the age, height, and weight of a child, or rather on its weight-height index. Probably of better value is an estimate of the child's vitality, as shown by general school activity and

behaviour ; its complexion, as showing good blood from the colour of the lips, gums, and nail-beds of the fingers ; also the firmness and plumpness of its tissues, in absence of flabbiness ; in good solid muscles, and no boniness being obvious. Diet is important. Practically all children show improvement, if additional green vegetables are added to their diet. The absolute need of at least a pint of fresh, unboiled milk daily for every growing child has now become an article of faith with all scientific workers on children's diets.

### Posture.

The posture of the child in considerable measure determines efficiency in later life. It may seem an absurdity, but it is a truth, that posture materially influences mentality. The writer always has been of opinion that the success of a blind school can be assessed at a glance by the posture of the children. In like measure the myope school needs little further inquiry as to its value if the children are seen to have good postures. More than this, the doubting, timorous, diffident mental attitude in later life, which becomes characteristic of many myopes, can be largely obviated by training to good attitudes. There is a tendency to stooping in those with poor vision, and in the case of myopes this is held to be an aggravating cause. Just before the war one writer (Levinsohn) declared it the most important factor in rapidly increasing myopic cases. It is held of importance that myopes should not bend the head over to congest the blood-vessels of the head. Stooping means other faults as compensations. The back is rounded, the chest com-

pressed, and then the abdominal walls yield, and there is a likelihood of visceroptosis in later life, with its feeble health, almost amounting to semi-invalidism. A child should stand straight up about a vertical axis. It should not stand in a miserable way, with head sloped forward, chest at a backward slope, and, again, a forward slope of the lower spine with protruding stomach, and hip- and knee-joints a little bent as well. The slouch is a feeble attitude, as well as mentally and physically unwholesome. The stooping attitude of the head materially enfeebles muscular tone generally.

A good test which children can apply for themselves is the ear test. If the head is carried properly all the rest is likely to follow. The front edge of the ears should lie behind the centre line of the shoulders. If the flat hand is held in a vertical plane, with the little finger edge touching the centre line of the shoulders, the ear should be wholly behind the plane of the hand. This gives a safe test of posture, which, if complied with, means all kinds of other adjustments automatically made to keep head, spine, hip, knees, and feet in balance. Here children might be taught to correct each other.

### **Throat, Nose, and Ears.**

The throat, nose, and ears form structures bound up to some extent with the eyes, as all share a common lymphatic system; indeed, treatment of some of these organs may be a pre-requisite to improvement in eye conditions. The child with recurrent phlyctenulæ who has enlarged tonsils and adenoids is not



likely to remain with healthy eyes until the other conditions are also treated. The same may be said of a large number of cases of chronic blepharitis. Discharging ears are not likely to clear up until the throat is treated. The condition of chronic conjunctivitis, blepharitis, *rhinitis*, and ear discharge often co-exists, and requires the *rhinitis* first clearing up if any lasting result is to be attained. Teachers in myope schools must be very much alive to the removal of these defects in their charges. Some teachers manage to get such conditions cleared up rapidly.

### Oral Sepsis.

There is no field of public endeavour which has been followed by so great immediate success, and from which so much benefit yet remains to be reaped, as the introduction of dental care among children. For the magnitude of the result the cost has been almost negligible. The occasional association of caries of the teeth with troublesome eye conditions is perfectly definite. The writer himself suffered for months many years ago from variable subjective *scotomata* in one eye. Careful elimination of one possible cause after another at last left an apparent innocuous dental root as an unlikely cause, but on its removal the alarming symptom immediately vanished. Some cases of troublesome iritis have been similarly arrested by removal of dental sepsis. In any case no school child should have septic foci untreated in the mouth or elsewhere. As many teachers know, septic foci are often the cause of all kinds of pains and aches, so-called neuritis and chronic rheumatism.

### Glands.

Shotty cervical lymphatic glands, or glands feeling like haricot beans or even larger, are less frequent than formerly, but yet too common. They will be palpable on sweeping the flat of the fingers from the ears round the sides of the neck and under the jaws towards the front. They may indicate general conditions of poor nutrition, but are often, especially when a few are definitely enlarged, dependent on conditions of inflammation, or centres of septic poisoning, existing in throat, nose, or ears.

The conditions of health leading to a general slight enlargement of these glands are the unwholesome conditions of children who do not get sufficient exercise. It is a condition to avoid which requires special care in institution children. Although not very marked in the children of the average school, and commoner among the girls, the tendency exists there as well. Among the blind it is very common, and must be specially watched in the myope schools, where, as indeed in all schools, frequent changes of posture and position are desirable and almost necessary. No lessons should mean continuous sitting at desks for long periods. Anything over twenty minutes will be a long period in the myope school. Desk lessons should alternate with others, and even then the desk lessons ought to be broken up as much as possible by intervals of standing up, or walking to, or working at the blackboard, moving about handling objects, and so on. The promotion of lymph circulation by muscular movements is of the greatest importance to growing children, and possibly more so if softening of tissues is the cause, in the case of myopia.

## Spectacles.

Spectacle lenses are described according to the curvature of their surfaces. Usually they are curved on both surfaces. In the figure sections of the various lenses are shown: (1) plano-convex; (2) double convex;

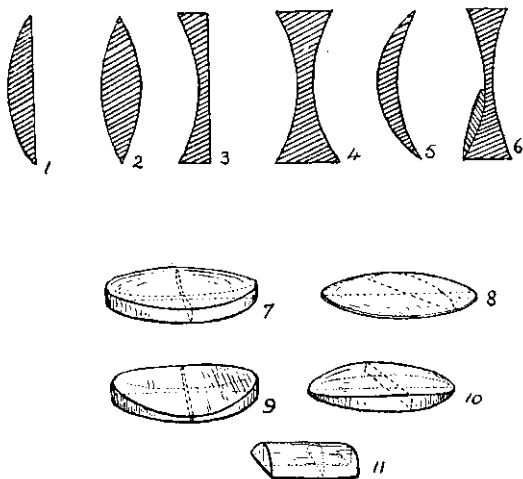


FIG. 19.

(3) plano-concave; (4) double concave; (5) concavo-convex; the so-called periscopic; and (6) a bifocal, consisting of a double concave; with a small double convex cemented on to the lower part: these would be for a myope who required to have a glass suitable for distance and for reading.

Cylindrical lenses will be understood from the other figures, which show in dotted lines the section in two directions at right angles. The plano-concave spherical lens is 7, a plano-convex spherical 8. Both of these show the regular curvature in both directions. A plano-concave cylinder 9, and plano-convex cylinder 10, show curvature in the section paralld to the paper, but no curvature in the section perpendicular to this, to which the axis is parallel. The little magnifying cursor (11) of the slide-rule is a plano-convex cylinder, with its axis parallel to the plane of the paper.

Where glasses are worn the teacher should try to keep a record. The prescription for the glasses is generally in the parents' possession and available for the asking, and should be copied on the child's card. The child's record should have stated any alteration of glasses, with the date and the strength of the glasses and the visual acuity of each eye, with and without the glass. It may be very instructive, and useful later.

The values would be entered, stating the visual acuity, as in a typical example :

Right, V.A. =  $\frac{6}{38}$ .

With glass - 2 D. sph. + 0.5 D. cyl. axis  $10^\circ = \frac{6}{9}$ .

Left, V.A. =  $\frac{6}{18}$ . With glass - 1.5 D. sph. =  $\frac{6}{6}$ .

Where the prescription is not available the values of the curvature are most readily obtained by using the Geneva lens measurer, a small spherometer which has been empirically graduated to show dioptres when used for flint glass of which spectacles are generally made. Pebbles used in former times, as they did

not scratch easily, should never be looked for nowadays as material for lenses. Suspect quackery if they are mentioned.

The strength of the spherical glass is expressed in dioptries. + D. for convex and - D. for concave, the algebraical sum of both surfaces giving the values of the glass. Thus a glass might give + 1 D. sph. on one side and + 1 D. sph. on the other. Its total value would be + 2 D. sph. On the other hand, it might read + 3 D. sph. on one and - 1 D. sph. on the other side, and again its value would be + 2 D. sph. as before. Where strongly convex in front and concave behind they are sometimes called *perisopic*. When a cylinder is prescribed to correct astigmatism the value of this is given in dioptries as above, and its axis marked in degrees beginning with zero at the left end of the horizontal axis of the eye, as looked at from the front, and going downwards, against the clock, round to 180°.

Occasionally *toric* lenses are suggested. They are practically equal to a form of crossed cylinders combined with a spherical curvature. They have theoretical advantages optically, but none in practice, and should always be declined. They are unnecessarily expensive, have no advantages for children, and are very unsightly especially for women, on account of the shiny reflex from the curvature of the fronts. Their measurement when it has to be made is a case of careful algebraical summation of the different axes. Another optician's glass is the *bifocal*, very useful for elderly people at times, but a nuisance in the case of children.

Where glasses are to be worn by children, spectacles should always be obtained, steel frames with curled sides. The bridge should not be brittle, and if cylinders are worn the frames should often be inspected to see that they have not got bent, as the optical effect may

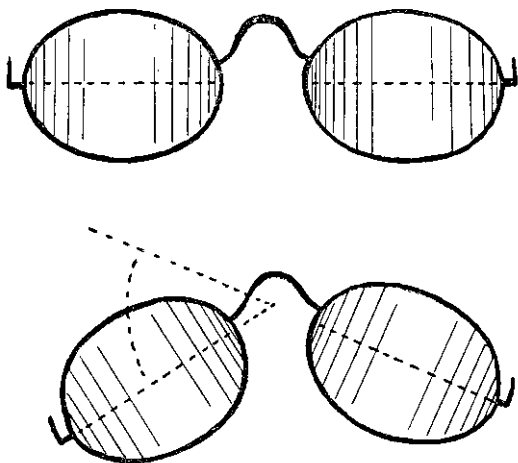


FIG. 20.—Cylindrical glasses showing alteration of optical effect by angular displacement of cylinder axis through bending of bridge of spectacle frame.

be very bad. The long axes of the "eyes" should be in the same straight line, or the glasses may even be doing harm. In any case the child should look cleanly through the centre of the glass. The writer has seldom gone into a school where, with a little manipulation of several children's glasses, he could

not improve the power to read the test type by one or two lines. Another useful service is to inspect the screws occasionally as they often work loose and are lost by the child. Often one comes across a pair of spectacles held together by a twist of wire or even a knot of thread, for want of a little oversight in this respect.

Children used to be seen quite commonly in school wearing blue-tinted or "London smoke" glasses. The first order the writer made in respect to school hygiene was, thirty years ago, to forbid attendance with such glasses. Coloured glasses are sometimes justified in cases of photophobia, or blepharospasm, but such children should not be in school. Children should not wear Crookes glasses, as they are unnecessary in school.

### The Use of the Eye in the Myope School.

From previous chapters it follows that all actions requiring continuous fine eye adjustments should be avoided, and that anything which tends to congestion of the eyeball or to cause a feeling of strain should be eliminated in school-work. These may be grouped as :

*Illumination.*—Glare from excess of contrast in lighting, or from strained efforts to see accurately in poor light. This can be avoided by even lighting of about three- to five-foot candles, according to the class of school and work.

*Congestion of Eyes.*—Directly from prolonged convergence of axes on near objects. Indirectly from

attitude of head, bent over near work. Avoidance necessitates a good eye-work distance, of twelve to fourteen inches, and correct attitudes. Indirectly from sustained efforts as lifting weights, tug-of-war. *Overuse of the Eyes* by prolonged and continuous eye-work, in school lessons, not being sufficiently broken up, and by written homework. The only remedy is a radical recasting of values in school-work with reduction of eye-work by substitution of other work for it.

If the eye gate is not to be much used, the ear gate must take more of the traffic. This is attempted in the borderland cases which are marked "For oral teaching only," but the care devised for these extends to all in the sight-saving classes.

### **The Kinæsthetic Sense.**

Another large class of memories is built into every concept of our minds, not vision alone, or hearing alone, but also the sense of relationship of the body and parts of the body in all actions: the kinæsthetic sense or feeling of movements. It is through this in great measure that the sense of space is attained, and this sense is as equally valuable for education as either vision or hearing. Teaching Braille would be an interesting education in the discrimination by fingers. Blind children read books under the bedclothes at night, and a writer in *The Times* (November 20, 1924) advocates learning Braille, and reading in bed for those disposed to insomnia as an agreeable hypnotic.

Many years ago in some of the Bradford infant



schools it was attempted to develop this sense by using free-arm work, standing at the blackboard and using both hands simultaneously. The eye cannot watch both hands at once. The movements of the large muscles are better appreciated at these ages than the finer finger movements, and the children subconsciously gained a good feeling of space and soon learned to draw and letter. For the same reason the Chicago open-air children, with large woolly mittens, learn to write better than if they were in the ordinary class-room with bare hands and free fingers. My test of teaching letters to any infant thirty years ago was that it should be able to write its name on the blackboard in letters as big as its hand with its eyes shut (p. 129).

The aim of the teacher in the sight-saving class should be the same. Within a month of entry every child should be able to write words well on the blackboard in letters as big as its hand and with its eyes blindfolded.

Handwriting is an essential. Whilst a large part of ordinary school-work could be beneficially scrapped for things of much greater importance, and as regards myope schools it will be later suggested much yet thought important should be discounted by low assessment in examinations, we still adhere to actual handwriting instead of adopting any shorter phonography or using machines, it is therefore a necessity, and it is also a valuable kinæsthetic training for the fingers and arm.

The only handwriting which should be used or taught in sight-saving classes is the print or manuscript writing of single letters in their elemental forms

(p. 119). All other kinds of cursive writing should be given bad marks. With script writing the eye need scarcely be used. A shield of at least two centimetres radius should be attached round the penholder about a centimetre above the point so that the child could not see the point itself when in use. This arrangement can be recommended for all young children to aid good letter formation.

The simple letter forms, straight and curved strokes and circles, without loops or connecting hair lines, having been learned, first in the method of stick-laying, bending bits of pliable telegraph wire, or using pieces of plasticine to mould them ; further, handling wooden letters, or the Montessori method of letters cut in sandpaper, all the various means serve to develop a kinæsthetic memory of the letters. The script letters can now be chalked by the children on the blackboard, and finally there will be little difficulty when they begin with the shielded pen and are still using the muscular memories instead of depending on comparison of ocular images. It is important that at no time are any guide lines to be used or permitted. Probably it will be hard for the teacher to reconcile this with their earlier custom, but guide lines are merely spurious result props, relics of the dame school, and in connection with myopia cannot be permitted. The final result anywhere with them is probably worse than without. The report of the Sheffield myope school in 1912 was marred by illustrations showing extensive use of lined boards. Guiding lines mean fine adjustment of the eyes at every stroke that touches the line, and therefore are hygienically bad. The trained hand

can do just as well, and do it for much longer if it is given time to learn. Here, again, the teacher must readjust ideals of work, and realize that letters are symbols to be read, and that it is a matter of supreme indifference whether letters are in exact alignment or not. So long as writing can be easily read no marks or praise need be given for exact or neat writing, anything else is mere examination pedantry. The examiner who refers to this in criticism does not understand the purpose of the myope school. This matter of writing will be treated in more detail later (p. 127).

Similar reasons make the written work of arithmetic beyond any commendation. Where rows of figures have to be arranged in a certain spatial distribution, as in multiplication or practice, only blackboard work should be done, and very little of this. We must get away from the idea that the lumber which fills up the second half of arithmetic books has any value for the majority of people. We have given up teaching children, as they did a century ago, how to gauge barrels, or how many cannon-balls could be stacked in a pyramid in the back garden. The purposes of life for the majority can be well met by mental arithmetic, and in the myopic it is the only form that should have any value attached. No marks should be given for big multiplication sums or long division if these are written.

## READING, WRITING, AND DRAWING

**Reading.**

READING nowadays is a widespread dissipation, much of it is almost waste of time. There is excess of reading and writing in all schools. Reading should be learned as a tool for educational use. Oral reading, "reading with expression," is a mere pedagogical exercise, a bad habit to form, one of the spurious results of education, of the scantiest use in practice. In the myope schools reading should be excluded as far as practicable ; in many it is excessive.

According to such reliable writers as Dearborn and Huey, the careful dwelling upon each word and phrase which is the daily method of the classical student through many years of study, helps not a little in fixing a habit of slow assimilation. Silent reading, rapidly to grip the meaning of the word, is the valuable process. Mere verbalism, whether in writing or speech, is almost pathological. A passage may be read dramatically and with expression, yet the whole substance hardly apperceived. There are beautifully written reports published year by year, which on analysis are full of mistakes, almost empty of real first-hand information, although in their elegant phrases and all-embracing, if platitudinous, generalizations, a joy to read. They are mostly verbalism.

With the enormous amount of reading being done, the hygiene of these performances becomes of the first importance, and when understood the necessity of myopes avoiding either reading or writing or like work will be a guiding principle in their school management. Even where class-rooms are small, or two

17. *Greek*.—Greek type is troublesome to beginners by reason of its unfamiliarity and of the difficulty of synthetising accents and letters into word-wholes. The correct Porson type has a line of uniform thickness. Such type affords easy discrimination of individual letters, and is legible in mathematical formulæ, even when small sizes are used. For reading, it is recommended that no type smaller than twelve-point be used for beginners, or eleven-point for experienced readers. The variety of Greek type which employs fine hair-lines should be entirely abandoned. Uncial Greek may be re-

FIG. 21.—Actual size of print shows area of distinct vision for letters within dotted circle when viewed with one eye from 12 inches. The eye was centred on the dot of "i" in "legible." The area in the white oval marks the blind spot as taken at the same time.

classes in the same room, reading is to be avoided as routine work.

The first task here is to understand how the work affects the eye. If an eye were fixed in one position, owing to the rapid decrease in retinal acuity extending from the macula, only about fifteen or twenty letters could be seen in a newspaper held a foot off.

The task of the learner in reading is different from that of the accomplished scholar: the first has to

discriminate carefully each part of each word, the other apperceives a word from the merest glimpse of its form.

### Eye Movements in Reading.

Facing a person looking out of the window of an express train the eyes are seen to be continually jerking through perhaps ten or twenty degrees horizontally as they successively fix outside objects. Here the relative angular movement of the objects and the axes of the eyes is considerable and easily seen.

In reading, the axes of the eyes still move, but the book is at rest and movement is smaller and less noticeable.

One means of subjective observation is sometimes rarely available. The writer has a small corpuscle in the vitreous of one of his eyes, only noticeable under special circumstances. Its shadow can be seen if a very brightly lighted page is looked at, and in reading in a brilliant light it moves along the lines like a small faint comma, moving just above the line, marking the movements and pauses of the eye.

Much ingenuity has been spent in working out the physics of the eye movements in reading. Javal, the French ophthalmologist, who himself went blind, first noted in 1877 the small springing movements of the eye in reading, how it jumped by steps along the line and then swung back in one long sweep to begin the next. The farther off the book the smaller the springs made. He studied the movements either directly or by observing them in a mirror, and thought the eyes were centred on the upper half of the letters.

The upper half of a line of print is the more easily decipherable, as one may easily see by cutting a line horizontally. Landolt, another French worker, confirmed this work, and showed that the smallest movements were very fatiguing, so that he thought this might be one reason for children holding their books so close to their noses in learning to read.

This type may be used for books to be read by children from seven to eight years old. The letters are larger than the minimum given in the typographical table. This type may be used for books to be read by children from seven to eight years old. The letters are larger than the minimum given in the typographical table.

FIG. 22.—To illustrate the importance of the upper part of the letters.

By means of kinetoscopic records the eye movements have now been completely investigated.

### Fixation Points of Eye.

The eye movements of an average reader are very variable, and the fixation points of the eye not co-extensive with the line read. The eye is never at rest; there are fine movements even during fixation, so that one should speak of a fixation area in which the axis

of the eye is kept balanced rather than on a point. The range of these fixation movements increases with fatigue.

During the springing movements of the eye, which last about twenty-three thousandths of a second, the duration of stimuli appear to be below the threshold necessary for a distinct visual impression. The fixation periods last twelve to twenty times as long. The eye, in reading a line of 90 millimetres, will pause from six to eight or more times, then sweeps back to begin the next line, this last movement taking about forty-one thousandths of a second. Little supplementary movements are found on examining the photographic records, as if the eye were seeking a suitable halt. The proportion of records showing these movements increases with the length of line. Dearborn found 58 per cent. with these when the line was 107 mm. long, and only 16 per cent. when it was 56.5 mm. If the line is too long, fatigue is markedly increased by the difficulty of backward movement and of locating the next line.

The fixation points may be anywhere, in a word or between words. It is the form, rather than the letters, of a word which is fundamental. Just as the upper parts of letters are most important, certain parts of words are important. Huey pointed out that there are determining letters. *C*, *ntr*, *m*, are determining for *centrum*, but *ent* and *um* are indifferent. The first letter of a word is almost always determining. The breadth of the letters is less significant than the height, and the height of long letters helps to build up the word form. The long letters up or down must preserve the correct relative proportion to the short.



**Span of Distinct Vision.**

The span of distinct vision as tested with 10-point Roman old style letters, that is letters 3·5 mm. high, at 35 cm. distance, was found by Dockery (*Journ. of Educ. Psych.*, 1910, p. 123) to be 20 to 22 mm. on either side of the fixation point. The distance between fixations being ordinarily 10 to 20 mm. apart, all letters come into distinct vision. One can, if careful enough and with a little practice, test for themselves that by using one eye and fixing it on one spot, with newspaper print, the letters being 1·3 to 1·4 mm. in height, the span of legibility is not more than 7 or 8 mm. as represented in the figures. Legibility appears to increase with the "leading," that is, space between the lines; probably it is decreased as soon as one line above or below comes within the small fixation area of distinct vision, spoken of on the previous page.

The whole psychology of reading cannot be gone into here. The history of the Alphabet shows that at first pictorial signs connoted definite objects, then ultimately mere sounds, whilst the original picture signs altered to the symbols of sounds. Their first meaning was lost, and only the sound indicated remained. Now the letters are built into words, and do not always indicate the same sound.

**Word Form Important.**

In English the word and the word form has become the unit. The logogram too, as it may be called, does not necessarily evoke the same sound; it represents an idea. Children made to read as fast as they can, as mistakes use synonyms, which have no form

resemblance to the words seen. For instance, monarch was read as king, stock as stick, in several instances "cut out its tongue" was read "cut out its tonsils," and so on.

The difficulty of controlling the eye in small movements is shown by the fixation area increasing in fatigue. There is rapid onset of fatigue when accurate fixation is attempted to eliminate glaring conditions, or in poor light. The small movements when reading at a distance were also noted by Landolt as very fatiguing; probably more and finer muscular adjustments are necessary.

The determination of the optimum size of letters of print is educationally valuable, but again the beginner has to be distinguished from the well-accomplished scholar. To the learner, on looking at a large letter the eye may be fixed on different parts, and muscular sensations remembered; or the large-size letter, throwing a larger image on the retina, causes a more voluminous nervous impression to go through to the visual centres. Anyhow, young children with normal visual acuity will stick at the smaller distant test types, which they can see perfectly, and will only read them when exhorted or persuaded to the uttermost, but they do read them correctly if sufficiently induced.

For learners and young children, therefore, letters of print should be larger than for ordinary use, but not so large that they exceed the span of distinct vision, which may be taken as 20 mm. at 33 cm., or roughly an angle of about 20 minutes equivalent at 33 cm. to about the letters of Snellen's test type-for reading at 12 metres.

The fundamental work in regard to print from the modern standpoint is that of Cohn. His last book on the subject of *How should Books and Journals be Printed* is, strange to say, printed in a tall compressed and comparatively illegible type.

The *Report on the Influence of School-books upon Eyesight* of the Committee of the British Association in 1913 is, perhaps, too minutely detailed to be adopted for practical school use. A publication of interest to educational workers illustrating the enormous amount of thought which has gone to the making of satisfactory type is *A Note on the Legibility of Printed Matter* by L. A. Legros (H.M. Stationery Office, 1s. 6d.).

For the avoidance of glare the paper must be without gloss, so hard as to take a clean impression and not to be easily dirtied. It must be thick, and opaque enough to prevent any shining through, and not allow the pressure of types on the reverse side to mar the smoothness of the surface.

### Sizes of Type.

English and American printers measure type by points, of which seventy-two go to the inch. This determines the body of the type, which is much larger than the small letter, as provision has to be made on it for the up or down strokes of the long letters.

The *face* of the letters on the type, on which depends the size of the printed letter, is not necessarily fixed by determining on type of so many points. The 24-point type has a vertical edge of the body equal to  $\frac{2}{7}\frac{4}{7}$  inch, that is  $24 \times 0.353 = 8.4$  mm., whilst the usual small letter set on it is only 2.8 mm.

The 14-point type has a body of 4.95 mm., and letter size about 1.65 mm., and the 11-point body is 3.88 mm., with a letter 1.3 mm.

For ordinary school purposes, after experimental tests and inquiries, the writer suggested the allowable minima as: Infants below seven, 24-point type with small letters 2.8 mm., or 8 points; child seven to nine years old, 14-point type with letter 1.75 mm., or about 5 points; children over nine years, 11-point

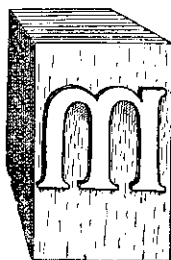


FIG. 23.—Type body and letter face.

type and small letter 1.5 mm., or about 4 points. For school, Cohn's square centimetre test is the readiest. Through an opening of a square centimetre not more than two lines of the print should be visible. This was improved later in the Russian Regulation, that through the opening not more than fifteen letters should be visible. This rule should be followed without exception in school material for children under twelve years of age. The letters which the children print from india-rubber types in the myope schools are aligned by a wooden frame, and the capitals

are 20 mm. and small letters 15 mm. high and 13 mm. wide ; that is, between the sizes of the  $\frac{6}{9}$  and  $\frac{6}{12}$  type on the test cards, which are 13 mm. and 17 mm. high respectively.

The British Association Committee tabulated their recommendations as to type in a standard typographical table.

Age of reader, years	Minimum height of face of short letter	Minimum length of alphabet small letter	Minimum interlinear space	Minimum No. of lines per vertical 100 mm.	Minimum length of line
Under 7 ..	mm. 3.5	mm. 96	mm. 6.5	10	—
7-8 .. .. .	2.5	72	4.0	15	100
8-9 .. .. .	2.0	55	2.9	20	93
9-12 .. ..	1.8	50	2.4	22	93
Over 12 ..	1.58	47	2.2	24	93

There are about fifty varieties of founts in common use, and it is important that the face shall be as simple as possible and free from any peculiarity. The unornamented simple outline letters, known as *sans serif*, or Gothic or grotesque, and in Germany as *Steindruck*, would seem the best, but owing to irradiation they are not as legible as letters with thicker ends.

The old manuscript work showed thickenings due to the broad quill points used in writing, and these were imitated in the serif endings. These thickenings are best if quite slight and nearly terminal. Modern faces for numerals are all the same size, and to be preferred for tabulations. Where letters are printed as symbols in mathematical work, the types, being themselves logograms and expressing more than letters of the text, should be larger and markedly

different, with this exception, one type and one spacing are to be used as uniformly as possible in educational work, so that word forms as logograms may be quickly learned and remembered. In some cases with the letters used for beginners a specially thick down stroke and thin cross strokes give what Bishop Harman calls a palisade effect. Compressed faces may thus be more difficult to astigmatic persons ; whilst expanded faces destroy the word form to some extent. Letters must be thick and thin, but even the thin should not be in the form of hair strokes, but good clear decipherable marks.

Much has had to be done to make optical and printing requirements agree. In the case of such letters as B, for instance, the white circular spaces, or "counters," have to be maintained so that the actual shape of small letters of the same fount, but different point size, is very different, and would show if they were all magnified up to an inch height. The smaller the letter the larger relatively the white counters in the letter have to be.

Printing from actual types is sharper than from stereotype plates. When magnified up, the one has a sharp black edge, whilst the other is crenate and indistinct in the margins of the letters.

### Letters and Words.

Infants learn their letters by combining many memories, especially muscular sensations, kinæsthetic memories, either of arms or hand or of eye movements. Experimenting on this a quarter of a century ago, it was found that infants learned visually quite quickly,

but forgot the letters learned in a few minutes. By using colours, by drawing the letters large, by kinæsthetic feelings, describing the letter in the air with the finger, by stick-laying, or writing with the finger in a sand tray, or by feeling cardboard letters, the symbols came to be memorized, then written forms followed by chalk on the blackboard. Montessori has since given this a large place in her scheme.

The importance of letters before the age of seven is exaggerated by teachers. It would be better if they were not permitted to be formally taught in school before this age, especially as for probably 10 per cent. of children they never have much practical use in after life, being mostly forgotten. "Five successive witnesses in the Bow Police Court were unable to read," October 1924.

W. S. Cornell observed that without definite standards the examiner in reading tends to grade the child higher than its capacity, as a child reads easy words, which are the majority. He used sample tests with fifty test words in each, and neglected the context of easy words. If the child reads thirty-five out of fifty test words correctly it is credited with 70 marks per cent. His experience that many children coming to the Philadelphia House of Detention over fourteen years of age possessing employment certificates based on a recorded ability to read and write, nevertheless prove to be illiterate, agrees with the writer's observations of young factory hands, many of whom between the ages of twenty and twenty-five were unable to read the ophthalmic test cards because, although they had spent seven or eight years at school, they

had forgotten the letters. No doubt many have learned a few simple words, but have never had intelligent power of reading, and lack of subsequent exercise in the task leads to complete forgetting of the process. In one case where a boy, who was specially weak in this respect, had worked long division correctly in his presence, and where he had preserved the papers, five years later the lad had forgotten all except the addition of simple integers, although he was now an intelligent worker earning excellent wages. Therefore on such experiences the conclusion was reached that reading is a much over-rated element in elementary education and of scanty practical use to probably 10 per cent. of school children, who, indeed, fall two or more years behind in school-work.

For writing on the blackboard to be legible at the maximum distance of about thirty feet in the ordinary class-room, remember that a considerable proportion of the children for some part, if not all the day, have visual acuity which is not more than half normal. Under these circumstances for comfortable reading the blackboard would require thick chalk letters about two inches high. For myopes who have fully corrected eyes with glasses this would also do. There are, however, many in a myope class who fall short of full correction, and it would be advisable in using the chalk to have letters still larger. Thin-lined letters which are occasionally seen on blackboards are to be warned against for the myope classes.

So far it has been assumed that simplified Roman letters are the best for reading, but on the Continent the German type or Gothic print, like the black-letter



Old English, which is an ornamented degenerate ecclesiastical production from the Roman, is still largely used, and discussion goes on as to whether Latin or Fraktur, as they call the German type, is the best. The Latin letters are acknowledged as the most legible, but from the point of view of logograms several German writers claim that the Gothic print is the most readable. Probably this is because they have been trained to that print, and one reliable worker, an Alsatian trained to French, got very different results from his fellow-workers in the same German laboratory. The great improvement in myopia in Sweden in the past generation has been put down partly to increased activities and partly to the abandonment of the Gothic for Latin types. The simpler the letter forms the better for the young child who has to learn them. It learns quicker with one alphabet, and the Roman block capitals seem easiest to pick up, if one may judge from spontaneous infant work.

The German child has eight alphabets to learn, and Lehmensick proposed to reduce this and use the Roman letters in their simplest form to teach reading (Rein's *Enc. Handb. d Paedagogik*), and later J. Speiser, an Alsatian teacher, reduced this to a simple form for either print or writing. His "Fibelschrift" is the easiest to learn and remember. It was practically the form into which children learned to bend their telegraph wires in the Bradford experiments half a dozen years earlier.

When writing has to be considered, it has been further simplified in the last ten years in English schools by the adoption of the so-called manuscript writing or script alphabet.

The all-important matter in saving the eye in educational work is that each word, whether printed or written, shall have exactly the same form relation in respect to heights and widths of letters and the spaces between letters, words, and lines.

In learning to read, young children tend to hold the book too close, as they do all fine work. The reading distance should be as far off as possible, to save both the accommodation and the convergence of the eyes, at the same time remember that the smaller eye movements appear disproportionately fatiguing in



FIG. 24.—Elements of simple letters (Speiser's "Fibelschrift").

running along the lines. An optimum distance for the youngest is ten to fourteen inches, too far off to hold a book with infant arms. The position with the head bent over the book is bad as causing some congestion and tending to produce myopia in those with this disposition. The bad posture with bent back and stooping shoulders giving small play to the chest movements is part cause of the notoriously bad health of the bookworm in later life.

### Writing and Drawing.

Writing and drawing are really two forms of one subject, that of graphic expression, which in its earliest

and spontaneous form is drawing. Used for signs, this soon becomes conventionalized, as in Chinese, or the early cuneiform or hieroglyphics. In these last, however, the sign ultimately developed to represent a sound and became alphabetic, as in our own language descended from them.

Spontaneous drawing is the earliest mode, it seems almost instinctive, and enormous educational value can be got out of it. Drawings can be further explained by lettering when the child acquires some of this knowledge. Writing should be delayed as long as possible.

The four main reasons for excluding teaching of writing as a formal exercise from the education of children below seven years of age are :

(i) Each hour of desk-work before seven is deprivation of more important general muscular activities, so necessary for development and nutrition.

(ii) The child's undeveloped eye makes near work an excessive strain, and leads to bad educational habits.

(iii) The nervous effort required in both eye- and finger-work with fine objects is so great that children do not make the effort without strong inducements; they are mentally readily fatigued, and it is quite probable that such efforts have bad effects on later nervous development.

(iv) The easy fatigue of young children leads to attitudes, which in many cases result in contracted or undeveloped chests or aggravate spinal curvatures.

Even the earliest drawings of children are conventional, as they also were in history. The old Egyptians

drew their figures in profile, but with one eye in full front view on the face. So with children, a hand drawn has all its fingers spread out. The front of a house is shown with the window usually stuck up in the corner like a postage stamp on an envelope, and often the gable end is also shown in full front view. The natural method of drawing by a child is first the formation of a mental image, then its transfer to the board or paper. Draw a tilted crescent moon on the blackboard. Show it to the baby class for a couple of minutes, then remove it and ask them to draw it. The variety of results shows the mental process by which drawing is accomplished. So, too, test the next class, with copying of some English letters and one or two Greek or Russian letters unlike any English. Some of the children will probably mirror one or two English letters, but this will not occur with any of the other letters of which they have no fixed memories. Object drawing seems the real way of teaching. The old-fashioned freehand copies of outlines drawn by the quarter-inch with much use of india-rubber and trial and error till a good result obtained, were destructive of all spontaneity and artistic expression. As an educational method for youngsters this seems to have been wholly bad, forcing the child to a premature use of the undeveloped fine muscles of the fingers and straining the eyes.

It does not matter how bad early efforts at drawing may be, if rapid rather than exact work is asked for, the subconscious adjustments will be made and a constant improvement follow.

The earliest drawings should not be small, or

restrained by paper or narrow boards. They should be scrawled on the wall or wall-boards at arm's length ; although too much of this is rather fatiguing. If any formal education for the six-year-old is attempted, it should be long strokes, vertical or horizontal, then sloped right and left. After this come long ellipses, then broadening out till the circle is reached ; all one size at first, then big and little, and as much of pictorial attempts as they like to make in addition. Attempts at exact work of any kind slowly done at early ages merely make demands on fine adjustments for which the child is not suited, and at the best attain educationally spurious results. So long as a child expresses an idea intelligibly at this age it does not much matter how it is done, and the quicker it is done the more likely is it that true education is being accomplished by subconscious effort and adjustment. Hence an exhibition of beautiful work by young children may connote bad education. At an exhibition of school-work in Yorkshire about 1900, the writer once selected as the text of an address on spurious results a sample of a beautiful patch said to be done by a child of four and a half, in which he counted fifty-six stitches to the inch.

### Free-arm Work.

In rapid free-arm work at the blackboard the use of both hands in an attempt at bi-manual work is useful as training to rely on the muscular sense rather than the eye, as obviously one cannot see both hands at once. These simultaneous arm movements give a good realization of proportion and develop a kin-

æsthetic sense of space, which is valuable. It is probably the only instance in which support can be given to the training of the left hand as a special educational process.

Working at the blackboard with a thin line and small-scale movement of the fingers is not free-arm work, such as the small child requires. This work cannot be done to any advantage in desks with mill-boards. That is a mere camouflage for the real educational work that should be provided. This free-arm work cannot be done in English class-rooms whilst they remain the smallest in the world, on the nine square feet per head basis for infants. With this restricted space a large part of the all-important hand and eye training in the pre-standard child is thereby excluded. No elementary class-room should be less than 600 square feet.

### Written Letters.

In making their first letters, English children seem to incline to the Latin capital forms, probably on account of seeing them so prominently on signboards, or of seeing them larger on pages of print, and also that perhaps their simpler form is easier to remember. A letter represents a shape and sound; it must be felt and heard as well as seen. Spelling merely by ear is bad, printing letters are needed to round off the word image.

Our children have several alphabets to remember, but get off easily compared to the young Germans. The beginner's alphabets should be reduced to one. It must be the simplest form possible, combinations

of straight strokes and hooks. Both printed and written letters should be in the same simple alphabet (p. 120). The script writing printwise, by single letters, is the only writing which should be taught or used in the primary school. Its qualities will be discussed later, as it is easier to learn, neater to produce, speedier to write, and more legible than any other form. It eliminates problems over which European ophthalmologists and orthopædic surgeons have striven for a generation.

The simplest writing stroke when writing at a desk is not a vertical line, but one at a tangent to the circle of which the writing elbow is the centre; roughly it is the direction from the pen-point to the centre of the breastbone. This normal writing tends to slope downwards to the left. Teaching children vertical script when standing at the blackboard is the easiest and most correct form, but allowing any natural slope they take up in writing at a desk is also most reasonable for that position. The first writing will probably be vertical, later tending to a slope as it becomes more speedy and automatic, and finally gets cursive.

Mediæval writing of a formal nature was vertical, printwise. Writing was taught as vertical. A copper-plate by Holbein (1516), showing the room of a writing master, represents vertical writing. Cursive script, written in a hurry, sloped. Printed italics were got from a fount of type to imitate this. Sir Isaac Newton was the first prominent Englishman to slope his writing. In France writing was vertical till the beginning of the nineteenth century, when the quill was supplanted by the steel pen, and to-day throughout

France and Italy a sloped hand is known as "English writing."

Teaching letters and then written symbols by free-arm work entails no undue strain on the child.

Again, the teaching of handwriting to children by copy usually is a pure eye task for any accurate result. There should be no network of lines thick and thin and dotted. Fortunately they are passing. It was systems of this kind with various types of guide lines which caused the demand for the abolition of sloping writing.

### **The Muscular Strains of Writing.**

English and American observers have paid most regard to writing as a muscular effort. Dr. Drever, in Edinburgh, by isolating separate movements, found the finer movements due to the fingers, and the faster the writing the more it becomes hand, then arm, work. In children hand movement is commonest. The pressure, too, has to be carefully adjusted. The cheirograph shows that the adult probably writes from a whole word image, whereas the child has separate strokes and separate letters. In America, Bryan testing tapping rates found that rapidity increased with age. When speed is decreased the accuracy due to vision increases, but with increasing speed it is muscle control that comes in. Woodworth concluded that the eyes of a practised writer do not follow the letters, but only general alignment, and in forming letters we depend mostly on muscular and tactile sensibility.

Freeman in his study of the movements in hand-



writing by the kinematograph demonstrates that all loops and turns take up much time. Support of the hand on the third and fourth finger seems preferable to the side of the hand. In training children the spasmodic grasp of the penholder is gradually eliminated, and the finger should be lower on the penholder than the thumb.

In some of the myope schools the children do unseen writing standing at the blackboard, but looking away from it. Some do cursive writing, some excellent print scrip, written at a great rate and with well-formed letters. This is the way in which all children should preferably learn to write.

It is also possible to write quite well without seeing the pen-point. A paper shield two inches across is used, having the pen thrust through it. A broad blue guiding line may be used on the shield to help the sense of direction. The blue is to distinguish it from the black ink of the writing.

### The Written Product.

There have been empirical scales of goodness of writing, and in the earlier years of the war much written in the *Journal of Educational Psychology* by educators such as Thorndike, Ayres, Graves, Starch, Gray, and others. Graves's paper in 1916, p. 483, sums the subject well, testing speed, legibility, and other qualities by statistical methods; slant, classified by the angle, spacing, and arrangement. Little useful material for the myope comes out of their work. On the other hand, Grailey Hewitt in *Handwriting* (1915), by detailed criticism of the instruments, materials, and

development, from Roman capitals to the modern Civil Service style, provides suggestive stuff for the teacher.

Writing can be enormously simplified if one gets clear of the idea that the old sloped copper-plate of the writing master is desirable. It is undesirable, if only on the score of illegibility.

The student of writing will soon be able to analyse the requirements with which teaching must comply.

(i) It must not make severe demands on vision.

(ii) It must not cramp the fine finger muscles, by requiring small accurate forms, or extreme variations of pressure.

(iii) It must in the written word and sentence preserve the same spatial relations as in the standard printed forms. This means the maximum legibility.

(iv) It must be able to be written rapidly, have individuality, be an artistic expression, and look well.

A common complaint against the writing of all children who are taught well is that it is lacking in any character. This hyper-criticism is probably made in ignorance of adolescence being the time when individuality in this respect declares itself. Even then in the extraordinary parodies on vertical writing common in the early years of the century, where letters six or seven times their proper relative height were joined by long slanting hair strokes almost invisible, although almost illegible and all very much the same, yet a considerable individuality showed itself.

The earliest beginning, then, should be with the kinæsthetic memory of letters ; afterwards the printed word and its spatial relations. From the earliest



FIG. 25.—Myopes' unseen writing exercise



stage, spacing is the most important factor in legibility. Here is the 100 per cent. mark sample of a scale for measuring freehand lettering published by Rugg; but in regard to legibility it is a failure as a standard, many of the letters are too wide compared with printed letters, and the approach between other letters too small, detracting from legibility.

Many excellent school exercises fail in this matter of spacing. Some of the beautiful work reproduced in the pamphlet on script writing, edited by the author for the Child Study Society in 1918, had doubtful spacing.

The simple forms gain in legibility and speed if

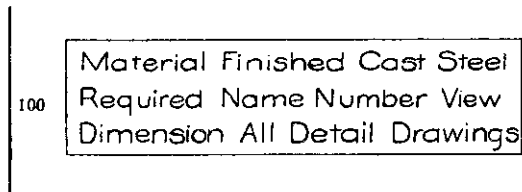


FIG. 26.—Illustrates 100 per cent. standard lettering held to be defective.

connecting strokes are wholly omitted for children. So far as the eyes are concerned the work is nearly halved, and it is also eye-work that slows the writing. There is, therefore, everything to gain educationally from this script-print writing, which abolishes the useless and time-consuming loops and turns.

The size of learner's letters should be as large as possible (p. 118). One would prefer for the learner of letter forms my old infant class formula, "as large as your hand." When copybooks are to be used in the primary schools they should be at least half text,

and whatever age the child no formal writing lesson should be permitted with letters less than about five millimetres in height. In the case of the myope all formal writing lessons, except on the wall-board or with a concealed pen-nib, are forbidden.

### **The Pen-point for Learning Writing.**

It is worth modifying the pen-point to suit the simple script forms. For all children a broadish point is an advantage; not the fine point which requires watching with much manipulation and variation of pressure to give a good result, but a broad, square point to save finger strain of the fine muscle movements. An average width of three-quarters of a millimetre, but not more than the millimetre, will give a down stroke even, thick, and legible; its curves will thin and thicken mechanically, and in the right places without effort and without variations in pressure. Good writing, as the author found after much experiment, can only be done easily, and becomes beautiful with what Grailey Hewitt calls a "quill cut broad"; that is, a millimetre breadth of point. Loops and flourishes which are marks of degeneration in writing, and possibly also in character, are almost impossible with the broad-pointed pen. It also holds a good attitude in the worker.

Children tend to a spasmodic, cramp-like work with the fine finger muscles, and are most easily exhausted if using delicately pointed pens. Almost any young child, instead of holding the pen with its index finger below the thumb, pulls this finger up level, or possibly above, the thumb, and bends the second finger-joint.

at an acute angle in its efforts, a practice which is a common forerunner of writer's cramp.

The crow-quill or mapping pen should not be allowed in a primary school.

C. W. Kimmins, who studied writing as Chief Inspector in the London schools, found that the omission of a guiding line, as formerly advocated by

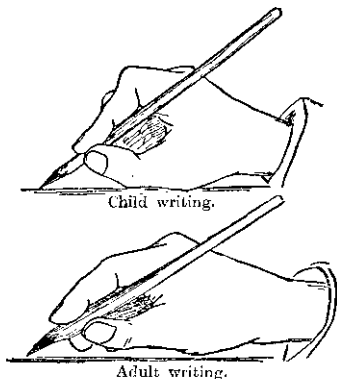


FIG. 27.—Upper figure shows strained position of child's hand, compared with lower figure, the adult writing position.

the writer, was disappointing in results. He thought a couple of lines were useful for the actual beginners, but should never go beyond the infant school. Probably with teachers, as educated at present, some orientation is a necessity and time-saving in the earlier lessons; but if the teacher has faith in the child learning by muscular sense instead of vision, he will get better results in the long run without guiding lines. This is not a matter for dogmatizing, but for

help by practical experience. A definite attempt in all schools to replace visual writing by muscular is worth while. It will result in greater rapidity, better mechanical formation of letters, greater legibility, and be an aid in the campaign for the preservation of good vision in our scholars, especially the 10 per cent. of whom on leaving the primary school are now found myopic.

### Unusual Writings.

The capacity for writing is very varied. As a general statement a considerable number of children are incapable of acquiring more than the merest rudiments. Many of these children have marked mental feebleness, others seem scarcely amiss in many respects. The want of literary ability is probably more general than is supposed; and these cases throw a very suggestive light on the comparative value of an academic or classical training as the chief part of a general education, and the school failures who have been distinguished in after life. Failure to read or write to such a degree that it is not generally useful, or useful in after life, seems inseparable from about 10 per cent. of the elementary school population (*L.C.C. Report M.O. Educ.*, 1904, p. 30). Although in this direction teachers' efforts are but wasted, little further notice has been taken of the fact by educational administrators. It was one of the writer's chief reasons for pressing for a residential school for educational and psychological observation and diagnosis about 1905-6. It is not among the myopes that one expects to find this class of case, but among the other children with visual defects who find their way to these classes.



## VI

### THE MYOPE CLASS AND ITS WORK

THE accommodation for myope schools has hitherto been generally of a makeshift or experimental nature. Some spare room at a school has been allotted as available without any very special provision.

The two chief considerations with regard to the class-room are space and good lighting. In the first place, as the ear has to come in so much, under no circumstances should two classes be in the same room. Next, the space should be based on a minimum of 20 square feet per head, in view of the activities and necessity of other than desk-work as the main part of education. A class should not exceed twenty scholars, for which a 400 square feet room is not too large.

There is no reason why such a class should be isolated. Any segregation of these children is a mistake. It is better that the class should always be in the same building group as the primary school departments, in which indeed much of the time will be spent by both boys and girls.

The lighting of the rooms has to be given much attention. Windows ought to approximate to a quarter of the floor space; but as this is unusual in most school buildings already existing, the best effect

can generally be got out of the windows by light colouring of the walls, ceiling, and all woodwork and furniture. As the extensive area of wall-boards will cause much absorption of light, the lightest paint elsewhere is a necessity. The wall-boards should be continuous, so that a child may not feel cramped for room in working at them. A space of at least three feet must be kept clear all round the room as a working space for the children at the wall. Continuous cloth roller arrangements with American cloth have been tried instead of wall-boards, but are unsatisfactory as substitutes, although used in addition to wall-boards by the teachers they afford increased space in London. Light-coloured covers have been suggested to be pulled down when the wall-boards are not in use. They have been tried in America and Vienna; and although they improve the illumination as much as 50 per cent., the use of the boards should be so frequent in the myope school that covers would be more trouble than they are worth. In England they have not been tried, but might be utilized if lighting were poor. The lighting has to be abundant and well distributed to avoid violent contrasts and glare. The minimum place illumination should be 5-foot candles, double that prescribed for the ordinary primary school. With artificial lighting this is especially necessary, but when it is necessary there should be no writing or blackboard lessons, nothing but oral or aural work. The sources of light must be many, rather than a few powerful ones. In every case a source must be well screened to diffuse the light, no filaments or mantle being visible. Electric lamps with clear glass are

not permissible, only sprayed or opal bulbs being used and large diffusing shades. No visible source should have a greater surface brilliance than three candles per square inch. This is the usual school precaution recommended for all schools, and to be regarded as an indispensable requirement in a myope class, or school, where these children are taken to work. Wholly indirect illumination is costly, and in work unsatisfactory here.

As to furniture, probably plain tables are as good as any kind of desks. Writing being kept at the lowest possible, slopes are quite unnecessary. A desk which can be utilized as a level table or reversed to form a slight slope with the vertical is one of the best special forms of desk for myope schools; but if the teachers have caught the true spirit of education in the myope school, it will be unnecessary—that spirit being never to read and never to write if it can be avoided.

### Development of the Educational Ideal.

When first started, after some discussion with the selected teachers, the scheme was formulated as :

- (1) Prohibition from reading school books.
- (2) Writing to be done on large-scale materials, and reading only from letterpress prepared by the children with large india-rubber types, each letter being at first 2 inches high, and later, when well known, 1 inch high.
- (3) The class-room was fitted with continuous black boards.

- (4) Special desks were devised by Mr. Bishop Harman, which tipped up to a slope to show a black writing surface underneath, acting thus either as an ordinary table or as a black-board at about  $30^{\circ}$  with vertical.
- (5) To widen the circle of the child's experiences, oral lessons were arranged in the ordinary school.

If the first experiment at Boundary Lane School in 1908 had not succeeded, the whole movement might have been postponed indefinitely. It was so well worked by the co-ordinate efforts of Mrs. Buckley, the head mistress of the class, and Miss Holmes, the head of the blind school, that success was immediate.

Little details of technique were soon improved; for instance, the extensive use of ordinary chalk was embarrassing, and dustless chalk was adopted, a little more expensive, but much more efficient and cleanly. There are now a couple of dozen such centres in London, and over forty teachers working in them and co-ordinating their work with the ordinary school classes.

It is necessary for the staff of an ordinary school to be well acquainted with the hygiene of vision, which is applicable to all children, although it may not be so pressing as in the case of the myopes. All teachers have to do with myopes at some time, and all should be aware of the precautions needed in school-work.

The partially blind child should not be segregated, the herd instinct has to be developed as *esprit de corps* in all school children, and these myopes must be regarded as part of the ordinary school when they are

there; but care has to be taken, for instance, that they are not set on one side with such tasks as silent reading. The superintendent's experience has been that the visually defective child coming into the classes seems at first educationally backward and indifferent. Where visual acuity is defective this is almost an obvious result, as the continued strain of the effort to keep up with the other scholars of an ordinary school is not maintained for long, and the child also loses the attention of the teacher in considerable degree.

In the myope class this changes rapidly, and the child may turn out to have ability and understanding.

The routine followed for admission is that the child, either having been found at medical inspection with much reduced visual acuity, or being noted by the teacher as obviously poor in this respect, is specially reported, and after examination by the medical officer certified as either (i) fit for the ordinary school, possibly with restrictions as regards easy treatment (p. 85), or oral instructions only; (ii) suitable for a myope class; or (iii) for instruction as blind.

Arrangements are then made for its attendance at a myope school, and, if required, a guide may be provided and travelling expenses paid by the authority. In many cases a midday meal is provided for those unable to go home, and the charge is usually the cost of food alone.

The children in the myope school are periodically reviewed; for this the school doctor should have specialist knowledge, indeed for the myope classes a specialist is advisable. The care committee attempts

to carry out any medical advice. This part of the work would undoubtedly benefit the myopes if it were wholly confided to a school nurse, who would understand the requirements better, and whose advice would be received with much greater confidence by the family. Indeed, the whole following up should be by school nurses, or the care committee organizers should have had twelve months' out-patient hospital experience. At fourteen years of age these children leave the school, and where possible situations are found for them by the care committees.

When initiating this special branch of education, a beginning had to be made with teachers who had still to acquire the particular qualifications and experience necessary. Their whole educational outlook and aim has to be considerably modified. Tasks have all to be revalued; and just as the special schools for the mentally defective led to the psychological appreciation of educative measures being enormously changed, and indeed to the whole revaluation and standardization of intelligence by the Binet Simon scale and other such means, so here in the myope schools there appears a hope of beginning the revaluation which will enable us to discard 50 per cent. of the present "standard" work as of scanty permanent life value.

The teachers in London had to be aided by constant personal talks about their work in the schools, from the superintendent and doctors. Circulars of advice were prepared for the benefit both of teachers and parents. Dr. Margaret Hogarth and the author volunteered a series of winter lectures to teachers concerned with myope schools, and the need then

became apparent for a book concerned with the physiological requirements to be met, and has resulted in the present little work.

### Teaching Points as seen by the School Doctor.

The teachers actually in the myope schools should be recognized as specialist teachers, for to some extent they have to give up opportunities of advancement open to the ordinary teachers, and they have to acquire a considerable body of special knowledge and take much greater part personally in the technique of their work; their financial outlook ought not to suffer in the end, or it reacts on the schools.

It is a good part of the educational policy that the children should share in all that is possible in the normal school. This requires considerable tact on the part of both sets of teachers, as the fitting in of the children may interrupt the ordinary school class and vice versa.

Physical exercises are an advantage taken in the ordinary school. Except a few cases of very high myopes, withheld as a precautionary measure, these activities are better with the masses of children of the ordinary school. The cases noted as "with care" are chiefly high myopes, whom the doctor has judged as unfit for strenuous efforts. In London they are seen weekly by a specially qualified instructor for corrective and special exercises at their own centres. In some places they are badged, red-button children, but it is unsound to label any individual as different.

The first lessons are mainly in eliciting the points of each individual, correct breathing and good posture

being aimed at. All exercises likely to cause any congestion of the head are eliminated. These are the typical exercises of endurance or strain, and also games like "tug-o'-war," jumping, and the movements of downward bending. Oral teaching in such subjects as history as a narrative, geography, science, and singing are all as usefully done in the ordinary school.

English, literature, and composition, so far as they concern printed or written work, should be written down to a very small part, but English as a spoken language, good articulation, clear enunciation, and the proper voicing of a sentence are all of the utmost importance. Literature from books, and all concerned with a knowledge of books, and private reading is taboo.

In one school, where considerable attention has been paid to English, it has been found that oral training is helped by :

- (i) Individual recapitulation of the lesson.
- (ii) Description elicited from the children of some current school event, like a football match.
- (iii) Practice of allowing the children to question the class in certain subjects.
- (iv) The literal repetition of a paragraph read.
- (v) Giving the contents of a paragraph in their own words.

The holding of a mock parliament in the class-room, or discussion among the children according to established rules, makes for readiness and intelligent appreciation.

Teachers find that in the correlation of work myopes



have some advantage over the ordinary child. They may not get the opportunity to read and mark, but they inwardly digest what they hear in lesson.

The composition can be done with blackboard work; but here, again, the good teacher will eliminate reading and writing and any exaggerated appreciation of literature as literature in this respect. The adult's appreciation of literature is not the child's, and if they are taught to recite a few masterpieces of prose or poetry from the large-print charts, all that can be reasonably or profitably required will be done.

The point to remember in this work is that reading and writing and figuring on paper are ophthalmologically bad, but educationally to some extent required, and the actual practice has to be a compromise in which as much good as possible is to be got at the cost of as little damage as can be incurred.

There has to be give and take all through in the matter, and rigid school standards of educational attainment here are worthless, so long as the child is sent into the world able to play a useful part.

Occasional staff meetings of the centre and all who work in conjunction with it—handicraft instructors, nurse, and doctor—might be very useful in effecting further co-ordination of efforts.

Arithmetic is generally reputed to be a splendid discipline, but for the majority of pupils it is immensely overvalued and overdone in the primary school. The first four rules can be taught by oral means and concrete measures. They may be regarded as a necessary part of the knowledge required in civilized life to be taught to all, but further exercises and

advance should only be for those who show distinct abilities in this direction.

Children are now admitted to the myope schools at comparatively early ages. They know their integers, and can learn numbers from domino cards, coloured counters, sticks, strings of good-sized beads, and such objects. There is an opening for games of the domino type for young children where addition or subtraction is brought in. It would brighten life in the afternoon school, teach composition of numbers, and make the youngsters ready reckoners. Weighing and measuring, finding areas or cubical contents are actually done as simple experimental demonstrations by children, others checking the results. Children also do black-board arithmetic, the only worked form of figuring which should be seen in these classes. Reckoning in money should here always be by mental arithmetic, or actual handling of counters.

### **Occupational Work.**

The original idea of abolishing pens, pencils, and papers, whilst hygienically sound, is educationally disadvantageous. The pencils permissible are the large soft carpenter's pencils. The broad-pointed pen, "quill cut broad," has been stated already to have advantages mechanically for the production of good writing without great visual tax, but except in the last year of school life should not be used in the myope class without the shielded point already described. Brushwork like the Japanese method of writing is a kinæsthetic task which might be profitably tried with a fairly coarse brush. Handicrafts of all kinds requiring

dexterity of the fingers rather than accurate eye judgments have advantages which should be thoroughly examined. As one of the difficulties in these schools is finding work for the older boys and girls, whose outlook is poor as regards future eye occupation, any handwork is to be encouraged. Cardboard and folded paper work can be utilized from the earliest ; all gradations of paper work and then on to cardboard models can be worked, giving plenty of variety in form and colour. Modelling in clay is useful, and can be worked with desk boards.

Bookbinding has been utilized at some centres for the older children. It permits of alternate demonstration by the teacher and then practice by the children, and requires cleanliness and patience, with some skill and care in touch and handling. There is a variety of processes, all of considerable educational value and scarcely involving any strain. The usual woodwork centres can also be used for the older boys, provided they have not to make measured drawings beyond the rough plans, elevations, and sketches on the blackboard.

The whole school-work has to be looked at from a new standpoint, which is its utility as a preparation for citizenship and its harmlessness to vision. Hitherto the routine of the ordinary school has been followed more or less as far as this could be pursued in face of the doctor's demands. In the future, teachers knowing the principles on which they have to work, should be able to reason out the solution of their own problems and probably eliminate at least half the present school-work for other tasks and lessons of greater essential value in life.

It lies with teachers of myope schools to begin an elimination of non-essentials wherever the eye is concerned; and, as already indicated, their work will soon result in a revolution in the work of the primary school, a pruning and discarding of useless branches.

The main concern in combating the majority of eye troubles seen in these classes is good nutrition, and each child ought to be definitely assessed at intervals in this regard, and if subnormal should not be permitted to remain so. Care Committees have much to answer for in their penny-wise policy in this matter.

School journeys should be a regular part of the work of these classes. There should be a school visit or day outing frequently, and a definite journey two or three times a year. This is, of course, a matter of educational arrangement, of which only the desirability can be indicated. It is, however, one of the most available methods for general education of the myope, usually disinclined to activity.

### Secondary Education.

Secondary schools for myopes do not yet exist, but they are required wherever pupils can be brought together by train, tram, or tube. Education could be carried much further without books or much written work, by lectures, discussion, and objective teaching on concrete objects. Physiology and hygiene would be important. The cost should not be unreasonably greater than the ordinary school. The aim, the acquirement of practical knowledge instead of educa-



FIG. 28.—Modelling in clay in myopic school



tional lumber. The necessity for such education is very obvious, for it has to be confessed that the primary myope schools at present fail in their high aim, in that many of their best pupils are almost marking time for the last two or three years of school life.

The ordinary inspectorial standards and examination methods are here out of place unless specially adapted to these schools. They may, indeed, be a cause of much dissatisfaction and possibly injustice to both the teacher and children. Some means of standardizing or assessing the work done is necessary.

In London, so far as purely academic and educational work is concerned, a progress book is kept of each child, under three main headings :

- A. General attainments.
- B. Manual attainments.
- C. Character and habits.
  - Response.
  - Will power.
  - Memory.
  - Perseverance.
  - Discipline.
  - Health.

The medical record card generally affords useful information as to ophthalmic conditions.

A method might be suggested by the use of score cards, although the time is not yet ripe for exact quantitative statement.

*School Assessment.*

- (I) Teacher. Teacher's room. Age of building.  
 Condition of school-rooms.  
 Class-room area per head.  
 Lighting, natural and artificial.  
 Heating and ventilation.  
 School cleanliness, baths, and washing apparatus.
- (II) School meals.  
 Physical exercises provision.  
 Out-of-doors work and games and school visits.
- (III) Educational provisions.  
 Time spent in desks.  
 Time spent in reading and writing.  
 Time spent in manual occupations.  
 Time spent in oral work and Socratic teaching.

For each of the above divisions about equal marks possible. The total marks attained give a school assessment.

In assessing the child the academic status should not weigh for more than a third, other conditions being more important in the final make up of the citizen. Indeed all children should be assessed in this wise if real values are to be obtained.

My suggestion to develop such a scheme would also be the use of a score card for each child.

*Child's Assessment.*

- (I) School assessment. Height. Weight. Age.  
 (Vaccination ?) Eye defect. Visual acuity.  
 Hearing. Dental condition. Posture.



(II) Nutrition. Physical exercise. Cleanliness.  
 Social status. Good conduct. Attendance.  
 (Intelligence quotient ?)

(III) Educational attainments in respect to age, viz. :  
 Oral arithmetic. Oral English. Hand-work.  
 Position in class. General academic rating  
 as estimated by teacher.  
 (Intelligence quotient ?)

For each of these three divisions about equal marks should also be awarded, and the child's assessment based on this. The sum of the children's assessments divided by the number of children would give the rough school status of any class.

These score cards would be well worth working out, and possibly an intelligence quotient might be added on the child's card, but whether under (II) or (III) would require careful consideration. The education-  
 alist would probably prefer it under (II).

It is obvious that if myope schools are properly handled and the possibilities to which they lead are well explored, the workers in them will find themselves presently opening a new chapter in the general history of primary education. The work will be worthy of their best efforts, for at present myopia has become an incubus on mental and physical growth, and seems to become daily more apparent.

## GLOSSARY

- Accommodation.**—Used for the adjustments by which the lens is altered in focus to accommodate it to focus the various distances from the eye accurately on the retina.
- Adaptation.**—An alteration in the distribution of pigment granules in the retina making it less sensitive in bright light, and enormously more sensitive in the dark.
- Albino.**—The term applied to an individual in whom there is a want of development of the pigments of the body. The hair appears white, the iris not being coloured shows the pink of the blood, and the want of pigment in the choroidal layer of the retina causes dazzling and poor vision. There is generally also nystagmus.
- Amblyopia.**—Poor vision as a rule without any definite structural change being visible to account for it. Often found in old squinting eyes.
- Aniridia.**—A condition in which the development of the iris has been so defective that vision is seriously interfered with.
- Annulus.**—The myopic annulus is a region often seen by retinoscopy around the disc, when the retina has stretched and become atrophied.
- Aqueous.**—The fluid in the anterior chamber of the eye between the lens and cornea.
- Astigmatism.**—The optical condition where an eyeball has not developed regularly. It has the same result as a lens whose surfaces are not spherical and cannot focus a beam of light to a point. There is no exact focus.
- Atropin.**—The chief alkaloid of belladonna, the deadly nightshade. A dilute solution dropped in the eye dilates the pupil, the effect lasting for several days.
- Bifocal.**—Term applied to glasses where the upper part looked through for a distance is of different refractive power to the lower part for near work. They are most serviceable in presbyopia.

- Blepharitis.**—Inflammation of the edges of the eyelids, usually very chronic, and if neglected leading to loss of the eyelashes and raw sore lid edges.
- Blepharospasm.**—A condition of tightly closed lids, often with inflammation and great sensitiveness to light, most commonly due to a small ulcer of the cornea.
- Buphthalmos.**—A condition in young children in which the drainage of the interior of the eye is unsatisfactory and the globe gradually distends, till often it has to be removed to save pain.
- Canthus.**—Inner and outer, applied to the angles formed by the meeting of the ends of the two eyelids.
- Cataract.**—Consists in opacities in or just behind the lens. It may be congenital, present at birth, or appear a little later as lamellar cataract, or may be a little spot of opaque embryonic remains on the centre of the back surface of the lens capsule posterior polar cataract.
- Chiasma.**—The Greek word for the optic commissure.
- Choroid.**—The coat of the eyeball carrying most of the blood-vessels, and lying between the retina and sclerotic.
- Choroiditis.**—Inflammation of the choroid and overlying retina leading on recovery to atrophy and loss of vision over those spots. The commonest form is scattered about the inner surface of the eye in patches as *choroiditis disseminata*.
- Ciliary body.**—The thick collar containing muscle fibres and some glandular cells, which lies between the iris and the front edge of the retina.
- Cohn's hooks or Cohn's E's** are a series of letter E's turned in various positions, useful for testing children and illiterate persons.
- Coloboma.**—The term applied to a gap in tissues due to want of development. Coloboma of the iris is as though a small portion had been snipped out. Coloboma of the choroid also occurs, but can only be seen by retinoscopy; it may seriously affect vision.
- Concave lenses** are thinner in the centre than at the edges.
- Conjunctiva.**—The delicate membrane covering the inner surfaces of the eyelids and reflected from them on to the sclerotic, covering the visible white of the eye. It does not extend over the cornea.
- Convergence.**—The automatic adjustment of the two eyes, when an object is attended to, which rotates the eyeballs so that their optic axes coincide in the object, whose image then falls on the macula in each eye.
- Convex lenses** are thicker in the middle than at the edge.

- ✓ **Cornea.**—The clear portion in the front of the eyeball, forming about a sixth of its surface.
- Cramp.**—A term usually applied to the ciliary muscle when from over-use or through nervous irritability it passes into a long-continued contraction, which affects the accommodation so that the eye may appear myopic.
- Crescent or myopic crescent** is an early stage in the formation of the myopic annulus, when only a small area on one side has undergone atrophic change.
- Cylinder.**—A term applied to lenses when one surface is curved in one direction, and in a direction at right angles to this is free from curvature.
- Dazzle.**—Applied to glare produced by sudden excess of light.
- Detachment** is loosely applied, meaning a separation of some part of the retina from the choroid, leading to loss of vision or distorted vision in the affected part. It is one of the serious risks of later life in any case of considerable myopia.
- Dioptre.**—A unit of refractive power. It expresses the power of a lens of one metre focus. A lens of double this power or two dioptres, written 2 D., would have a focus of half a metre. The focal length in metres expressed as a vulgar fraction is the reciprocal of the number of dioptres of refractive power of the lens.
- Disseminated choroiditis.**—See Choroiditis above.
- Ectopia lentis** is congenital defect of the lens usually present on both sides, and generally shown by the lenses being dislocated from their usual position. Vision is often seriously affected.
- Emmetroopia.**—The refractive condition of the resting eye which focuses rays from distant objects accurately on the retina.
- Endocrine.**—The term applied to ductless glands, which secrete material circulated in the blood, and having specific qualities of stimulation for certain tissues or structures.
- Epicanthus.**—A small fold of skin stretched round and possibly a little over the inner angle between the two eyelids. It is supposed to be one of the stigmata of degeneration.
- Eserin.**—A myotic used to neutralize the dilatation of the pupil after retinoscopy.
- Fixation.**—The power of keeping the optical axes of the eyes so centred on an object that its image is held steadily on the macula, giving the clearest possible vision.
- Foot-candle.**—The original unit of illumination equal to the illumination a foot away from a spermaceti candle burning 120 grains of wax in an hour in a still atmosphere.

- Fovea.**—The small pit or depression at the optical centre of the retina, where form vision is most accurate.
- Glare.**—The sense of discomfort and inability to observe details of objects looked at, either from excess in amount or variation in distribution of light.
- Granular layer** is the old term applied to the layers in the retina where the fine nerve fibrils ramify, bringing the light sensitive rods and cones into relation with the nerve cells of the ganglionic layer.
- Hemeralopia.**—From two Greek words signifying day sight. The condition of seeing badly when the light becomes reduced, as at twilight. It is common in certain retinal diseases, such as *retinitis pigmentosa*.
- Homatropin.**—An expensive derivative of atropin, but less powerful and persistent in its mydriatic effect. Most useful for temporary dilatation in scholars. Used either as a 1 or 2 per cent. solution in water or castor oil, and sometimes with an equal quantity of cocaine.
- Hyperæmia.**—A condition of active congestion of the blood-vessels. The earliest stage of inflammation, which may not go beyond this.
- Hypermetropia.**—Relative defect of refractive power in the eye, generally due to want of full development resulting in a short axis. It is commonest in young children, and tends to lessen with growth.
- Interstitial keratitis.**—A form of chronic inflammation often persisting for many months, in the deep layers of the cornea, and causing haziness of vision. Generally the result of inherited disease, and requiring good nutrition to combat it.
- Iridectomy.**—An operation in which a small sector of the iris is snipped out.
- Iris.**—The fine annular diaphragm in the anterior chamber in front of the lens. It should look clear and distinct, and react smartly to light, contracting in bright light and dilating when shaded.
- Iritis.**—Inflammation of the iris is a serious condition, there is usually pain, and the iris looks muddy and indistinct in its texture. It requires urgent medical treatment.
- Keratitis.**—Inflammation either superficial or deep in the cornea.
- Kinaesthetic.**—Applied to memories of the sense or feeling of movements and positions.
- Leucoma.**—A cicatricial patch on the cornea, sometimes of a porcellaneous whiteness, usually the result of ulceration in early life.

- Logogram.**—The graphic form of a word. It may be the letters of the word, or a single sign. Chinese writing is a series of logograms. Word-blind persons who cannot spell words can generally use their own names, which in this case are logograms. The Arabic numerals are also logograms, and can generally be correctly used by the word-blind.
- Macula lutea.**—The yellow spot around the fovea, the most sensitive part at the optical centre, the posterior pole of the retina.
- Matt.**—Applied to optical roughness of a surface so that it does not shine or glisten.
- Meibomian.**—The name applied to the row of little lubricating glands along the inner surface of each eyelid, which discharge by fine ducts on the margin of the lid. Acute inflammation of one is a sty.
- Microphthalmos.**—A congenital defect due to mal-development of the eye; it is generally small, shrunken, and almost, if not totally, blind.
- Micropsia.**—A nervous condition in which the actual size of objects appears unduly small, "as if looked at through the wrong end of a telescope."
- Mongol.**—A Mongolian facies accompanied by a peculiar type of mentally defect, with oblique slit-like openings of the eyes, and often epicanthus.
- Mydriasis.**—The condition of widely dilated pupil; owing to contraction of the radial fibres of the ciliary muscle, as in fright, or to weakness of the constrictor fibres as in debility, or from the effects of drugs like atropine.
- Mydriatic.**—Possessing properties of dilating the pupil.
- Myopia.**—The opposite condition to hypermetropia. The refractive power of the eye forms an image in front of the retina, chiefly due to lengthening of the optical axis of the eyeball. The attempt to see better, by bringing the edges of the eyelids nearer, gives origin to the name myopia, from two Greek words meaning closed eyes.
- Myotic.**—Having the power of producing contraction of the pupil (myosis).
- Nebula.**—A cloud-like haziness of the cornea varying from an almost invisible haze, only seen with difficulty, to a streaky-looking patch interfering with vision. Generally due to keratitis in the past.
- Nuclear layer.**—The old name applied to the layer of the retina where the first set of nerve cells connected with the rods and cones are situated.

- Nyctalopia.**—The condition of seeing better in diminished light. It is most commonly seen in the bad vision due to excessive tobacco smoking, when faces and bright objects appear hazed and indistinct in bright daylight.
- Nystagmus.**—A condition of involuntary tremorous movement of the eyeballs. Sometimes more evident when the individual attempts to look sideways or upwards. In children it occurs chiefly with congenital defects, and in albinos.
- Ophthalmia neonatorum.**—The inflammation of the eyes from infection during birth. It is a fruitful cause of damage to vision, and in some cases of blindness.
- Ophthalmoscope.**—An instrument invented by Helmholtz for viewing the interior of the eye. It is practically a small mirror about the size of a half-crown to throw light into the eye, and a small hole in the centre through which to look into the eye, with focusing lenses attached.
- Optic commissure.**—The junction between the optic nerves through which the fibrils from the inner half of each retina cross to the hemisphere of the opposite side of the brain.
- Optic disc.**—The position to which the nerve fibres from all parts of the retina converge before passing down the optic nerve. It is also called the nerve head. It can be seen by retinoscopy, when it looks like a white pearl button with a few fine blood-vessels radiating from it.
- Optic nerve.**—The nerve through which the visual impulses leave the eye. It runs from a little below and to the inner side of the posterior pole of the eye to the optic commissure, where it divides. The half with fibres from the outer half of the retina passes to the optic tract on the same side of the brain, the other half with fibres from the inner half of the retina through the optic commissure joins the optic tract of the opposite side of the brain.
- Orbicularis.**—The name applied to the series of tangential muscle fibres around the eyelids and orbit which help to close the eyelid.
- Panophthalmitis.**—General inflammation of the eyeball, due as a rule to septic causes. A wound, or an ulcer from a dirty piece of grit, or an ulcer which perforates the cornea during one of the acute fevers may be the cause of such trouble. The eye either has to be removed, or if it recovers is shrunken and blind.
- Pannus.**—The name given to a condition mostly of the upper half of the cornea, where it becomes covered with a thick organized inflammatory layer, chiefly in neglected trachoma. It is now comparatively rare in this country.

- Pebbles.**—Costly spectacles for old people were formerly sometimes made of quartz, as this did not scratch easily. There is now no advantage in them, and their mention is suspicious of quackery.
- Periscope.** Applied to spectacles so ground that the axis of vision will always be nearly normal to the surface of the glass. They have no special advantages for children.
- Retinoscopy.**—Really the examination of the retina by the ophthalmoscope, but applied to the testing of the refraction by finding the strength of glass required to neutralize movement of the iris shadow on the retina.
- Rhinitis.**—Inflammatory conditions of the mucous membrane of the nose.
- Sclerotic.**—The hard, thick coat of the eyeball which shows through the conjunctive as the white of the eye.
- Scotoma.**—A blurred spot appearing in the field of vision, and due to some condition in the eye. The best known form is the temporary blurring of the exact thing looked at which occasionally occurs in sick headache, and as it has little spots of bright colours appearing and disappearing around its margin it is called a scintillating scotoma. Much tobacco smoking may also cause a scotoma for red and green. In this case, if only one eye is used it may be impossible to pick out red and green beads successfully as the little spot of colour looked at disappears.
- Skiascopy.**—The shadow test also called retinoscopy.
- Spasm.**—Another term for cramp of the accommodation, which may cause a false appearance of myopia.
- Specular.**—Applied to the reflection of a bright light from a smooth surface approximating in regularity to that from a mirror, and the opposite of irregular reflection from a matt surface.
- Staphyloma.**—A bulging out, applied to a yielding of the tissues of the eye, as, for instance, the cornea where it has been thinned by old ulceration, or to the posterior wall in myopia, where there is a myopic crescent or annulus.
- Toric.**—Lenses ground with a double curvature, forming surfaces like part of the edge of a Dutch cheese. They are costly, and very unsightly to wear, especially for women. They have no advantages to make them worth using for children.
- Trochlearis.**—The name applied to the superior oblique muscle.
- Uvea** is used with reference to the layer of pigmented secretory tissue on the posterior surface of the iris and ciliary body.



**Verbalism.**—Using abundance of words and phrases, either spoken or written, often elegantly expressed and beautifully phrased, but containing little but platitudes and self-evident statements.

**Visceroptosis.**—Probably a congenital condition aggravated by slack attitudes, where the viscera tend to protrude down and forward, and seem to cause all kinds of sluggish function, and even affect the background of mental health.

**Xerosis.**—The dryness of the cornea and conjunctiva seen in some forms of ill nutrition from improper diet. The ever-present xerosis bacillus multiplies, forming little white frothy masses. Good nutrition, milk, and cod-liver oil are needed.

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