I must again remark that this plan of finding the range of accommodation is not mathematically exact. It is, however, sufficiently accurate for all practical purposes.

In high degrees of hypermetropia we almost always find that the acuteness of vision is more or less diminished. According to Donders this is partly due to the peculiar structure of the hypermetropic eye. The retinal images are smaller than in the emmetropic eye, because the nodal point is situated closer to the retina, hence the sight is improved by convex glasses, which move the nodal point more forward. The amblyopia may also be due to astigmatism, and to the lesser number of nerve fibres of the optic nerve and retina.

Hypermetropia is very frequently the cause of asthenopia. This affection has received a great variety of names—asthenopia, hebetudo visus, impaired vision, muscular amaurosis, &c. It is distinguished by the following symptoms: The patient cannot continue to regard near objects for any length of time, as in reading, writing, &c., without the eyes becoming fatigued. The print becomes confused and indistinct, the letters run into each other; there is a feeling of tension and pain about the eye and over the eyebrow, which, if the work is persisted in, soon becomes more intense, and

sometimes even assumes the character of headache, (which is often mistaken for nervous headache, or migraine); the eye at the same time perhaps becomes watery, red, and feels hot and uncomfortable. Yet there is nothing in the appearance of the eye to warrant this state of things. It looks perfectly normal, the refracting media are clear, vision is good, the convergence of the optic axes perfect, the mobility of the eye unimpaired. Neither does the ophthalmoscope reveal anything abnormal, except perhaps a slight state of congestion and hyperæmia of the retina and choroid. And yet the eye is perfectly useless for continued work at near objects, for reading, writing, sewing, engraving, &c.; for symptoms of asthenopia soon show themselves, and the work has to be laid aside. Then these symptoms quickly vanish, and the occupation can be resumed until their re-appearance again necessitates an interval of rest, the longer this is, the longer will the person be able to re-continue his employment.

All ophthalmologists know from experience how wearisome such cases mostly prove in the treatment, and how unsatisfactory the result generally is after the whole routine of remedies has been gone through. Purgatives, sedatives, tonics, counter-irritants, alteratives, their name is legion!

But yet how futile do they not almost always prove in curing this affection. But why do they prove futile? Because in the great majority of cases the asthenopia is not dependent upon any overwork of the eyes, or upon general debility, but either upon hypermetropia or upon an insufficiency of the internal recti muscles of the eye.

It was, indeed, a great boon when Donders discovered that most of these cases of asthenopia depended upon hypermetropia, and might, therefore, be permanently cured by the proper use of convex glasses. Since he first called the attention of the Profession to this important fact, I have examined a great number of persons suffering from asthenopia, and have found that in the great majority the latter depended upon hypermetropia.

In these cases of asthenopia dependent upon hypermetropia we sometimes find, with the ophthalmoscope, that the choroid and retina are somewhat congested. And I have known patients in whom this was the case strongly advised to abstain from all work, and particularly to avoid the use of spectacles. If there is much congestion it would be as well to rest the eyes for a short time, to use the eye-douche, &c.; but generally the congestion is but very slight, and is to be removed

and prevented by the use of convex glasses. The congestion is, in fact, owing to the overstraining of the accommodative apparatus, and will disappear as soon as the necessity for this over-exertion is removed by the neutralisation of the hypermetropia through convex glasses.

It has been thought that asthenopia might be cured by gradually accustoming the eye to weaker and weaker glasses, so as finally to render their use altogether superfluous. But the reader will now understand how just the contrary proceeding is necessary in hypermetropia. If we wish permanently to cure the patient, we must prevent all undue straining of his accommodation, and this can only be done by the proper use of convex glasses.

I would particularly call the attention of the profession to the important fact that asthenopia is, in the great majority of cases, due to hypermetropia, and that these patients, who under any other course of treatment haunt our out-patient rooms for months and years without relief, may be speedily and permanently cured by the proper treatment of their hypermetropia. Let us but consider the crowd of sempstresses, watchmakers, engravers, &c., who are rendered incapable of following their employment, whose future is starvation, if this fact is not attended to.

It does not, however, follow that all cases of hypermetropia must of necessity be accompanied by symptoms of asthenopia. They may be wanting if the power of accommodation is good, and the degree of hypermetropia but slight. When it is very considerable, asthenopia is never absent. The existence of the hypermetropia may be overlooked if the glasses are only momentarily held before the eyes, as the patient cannot suddenly relax his accommodation sufficiently. We should, therefore, in such cases, always paralyse the power of accommodation by the instillation of a strong solution of atropine, and then ascertain the degree of hypermetropia.

This form of asthenopia, which is dependent upon fatigue of the muscular system of the accommodation, may be termed *accommodative* asthenopia, in contradistinction to the *muscular*, which is due to insufficiency of the internal recti muscles, and to the *retinal* asthenopia.

Another form of accommodative asthenopia, dependent upon debility and want of energy in the muscular apparatus of accommodation, such as is often met with after severe illnesses, diphtheria, &c., will be more fully treated of in the chapter upon Paralysis of Accommodation.

Retinal asthenopia is distinguished by the absence of hypermetropia and insufficiency of the

internal recti muscles, and by the presence of symptoms of irritation and hyperæsthesia of the retina. The patients complain that the eyes become painful, red, and watery on an attempt to use them for near work, the acuteness of vision is, however, generally perfect, and the patients are not obliged to desist from work because the letters, &c., become indistinct, but from the pain and irritation in the eye. Such symptoms may also continue long after the work has been laid aside. The feeling of tension above the eyebrows, which is so characteristic of the accommodative form, is absent, but there is often considerable photophobia and chromopsia. In severe cases, all these symptoms are very marked, and are more or less persistent, and the state of irritation and hyperæsthesia may extend from the eye to more distant branches of the fifth nerve. With the ophthalmoscope, we generally find hyperæmia of the optic nerve and retina. The treatment consists chiefly in prescribing tonics, good diet, cold bathing, more particularly in the sea, and great attention to the general health, together with the use of the eye-douche, blue glasses, and complete and prolonged rest of the eyes. Lowering treatment, irritation by continued blisters, &c., often greatly aggravate the affection.

Let us now consider how hypermetropic persons are to be suited with glasses.

Theoretically, it would appear right to neutralize the hypermetropia by a convex lens, and thus to change the eye into an emmetropic one ; this lens forming, so to speak, an integral part of the eye. But in practice we find that this does not answer.

In facultative hypermetropia there will be no occasion to prescribe glasses for distance, as the patient can see well without them. Moreover, there is the disadvantage, that after convex spectacles have been worn for some time for distance, the power of seeing distinctly without them is lost, which is of course very inconvenient. For this reason they should never be ordered, except in cases of absolute or relative hypermetropia of a considerable degree. If there are symptoms of asthenopia, glasses should be given for reading, etc., which are somewhat stronger than those which correct the manifest hypermetropia. If these are found too strong and trying to the eye, they must be exchanged for weaker ones, and the strength be gradually increased until the asthenopia has disappeared.

In relative and absolute hypermetropia spectacles should also be worn for distance, as we find that in such instances distant vision is not distinct.

In such cases, I generally commence with the glasses which neutralize the manifest hypermetropia, and in young persons order them to be worn both for near and distant objects. If they prove too strong for distance, a weaker pair must be prescribed, and their strength gradually increased. If they do not relieve the asthenopia, or if presbyopia co-exists, a stronger pair must be given for reading, writing, and sewing.

In using the spectacles for reading, sewing, etc., it is always advisable to interrupt the work for a few minutes at the end of half an hour or an hour. This rests the eye, which is then able to resume the employment with renewed vigour and ease. If the asthenopia does not quite disappear under the use of glasses, we must examine the power of convergence, for together with the hypermetropia there may exist insufficiency of the internal recti muscles, and the asthenopia be partly due to this. If the accommodation has been greatly fatigued by prolonged work at near objects without the aid of glasses, or if there is spasm of the ciliary muscle, the accommodation should be placed in a condition of complete rest, by being paralysed by a strong solution of atropine, and this paralysis should be maintained for several weeks.

Donders has shown that convergent strabismus

very frequently depends upon hypermetropia. A person suffering from the latter is always obliged to accommodate more or less, in order to see with distinctness. Even at a distance, he must already accommodate in order to neutralize the hypermetropia, and the nearer the object is approximated, the more will this tension of the accommodation increase. There exists, however, a certain relation between the accommodation and the convergence of the optic axes, for with an increase of the latter there is also an increase in the power of accommodation. This assertion is proved by the fact, that if we place a prism with its base turned outwards before a hypermetropic eye, the latter will squint inwards, in order to avoid diplopia in looking at distant objects; and this convergence will enable the eye to accommodate for parallel rays (distant objects), whereas with parallel optic axes, it before required convergent rays, *i.e.*, the rays from a distant object had to be rendered convergent by means of a convex glass, in order to be brought to a focus upon the retina. Again, if we place a concave glass before a normal eye, we change it into a hypermetropic one; parallel rays are united *behind* the retina, and it either requires an effort of accommodation, or a convex glass to bring them to a focus *on* the retina. If the concave glass is but of slight power, an increased effort of accommodation,—an increase in the convexity of the crystalline lens,—will neutralize the effect of the concave lens and overcome this artificial hypermetropia. But if the concave glass is too strong for this, the eye often overcomes its effect by squinting inwards, and thus increasing its power of accommodation. Now the same thing often occurs in hypermetropia; the eye squints inwards in order to increase its power of accommodation. This has been called periodic squinting. In the beginning, no deviation of the optic axis is observable as long as the person is not looking sharply at anything; but as soon as he looks intently at any object, near or distant, convergent squint shows itself. Sometimes this only occurs when the eye is regarding near objects, the squint disappearing as soon as the eye looks at some distant point. After a time, the squint becomes permanent, particularly in those persons who work at near objects, whether in reading, writing or sewing. We meet with it very frequently in children about the third or fourth year, when they first look attentively at things, or begin to use their eyes for any length of time for near objects. When this tendency to squint first shows itself, it may be corrected by neutralizing the hypermetropia by

means of convex glasses; but it will generally require an operation.

Since Donders first pointed out the connexion between hypermetropia and convergent strabismus, I have made a point of examining a great many cases of squint, and have found that hypermetropia was present in the great majority of convergent squints. The degree of hypermetropia is generally not very great, varying from $\frac{1}{40}$ to $\frac{1}{16}$ or $\frac{1}{12}$.

There are, of course, other causes of convergent squint, such as myopia, paralysis of the antagonist muscle, opacities of the dioptric media, &c.; but I reiterate, that of all these causes, hypermetropia is the most frequent.

I have stated that this form of squint often arises in childhood; that in order to correct the hypermetropia by a stronger action of its power of accommodation, the child involuntarily, unwittingly squints inwards when it wants to see any object distinctly. The strabismus soon becomes permanent, the image of the squinting eye is suppressed (in order to avoid diplopia), and its vision is very frequently soon irremediably destroyed, if a timely squint operation be not performed. Yet there is amongst some ophthalmologists a strong opinion that a squint should not be operated upon in childhood. But how erroneous is this advice,

how many eyes have not been sacrificed through following it!

If, for instance, a child suffers from hypermetropia, and squints inwards in order to increase its power of accommodation, this strabismus will soon become permanent. To avoid diplopia, the image of the squinting eye is suppressed by the brain; but this negation of the pseudo-image soon leads to deterioration of sight, and the vision of the squinting eye is gradually greatly impaired or even sometimes almost completely destroyed. Hence the necessity of operating on a squint as early as possible, whilst the sight is yet good. I have not the slightest hesitation in saying, that the sight of the squinting eye would thus be saved in the greater number of (if not, indeed, in all) such cases. In some of these cases of amblyopia from disuse, the sight of the amblyopic eye may be greatly improved by exercising it with strong convex lenses.

We must always warn the patient and his friends after the squint operation in eyes suffering from hypermetropia, that if the latter is not treated by the use of convex glasses, the squint may return.

But there may be in hypermetropia an *apparent* squint, the direction of which is not, however,

inwards, but outwards. There is an undoubted, well-marked, outward deviation of the optic axes, and yet both eyes are steadily fixed upon the object, neither moving in the slightest degree when the other is closed. The squint is, therefore, not real, but only apparent. Donders has called particular attention to this fact, and furnished us with the explanation. It has been shown by Helmholtz (vide p. 19) that the optic axis and the visual line (an imaginary line drawn from the yellow spot to the object point) do not correspond, but that the latter impinges upon the cornea slightly to the inner side of the centre of the cornea, forming with it an angle of about 5°. It will, therefore, be evident that if the visual lines are parallel, the optic axes must necessarily be slightly divergent, and such is in fact the case in the normal eye, but this divergence is so extremely small, and we are so accustomed to it, that it escapes observation. But, in some cases, the visual line may change its position with regard to the optic axis, and, if this deviation be at all considerable, an apparent squint will arise. In hypermetropic eyes the visual line always cuts the cornea considerably to the inner side of its axis, forming with it, according to Donders, an angle of not less than 7° 55. He has found that the

maximum may even be an angle of 11° 3, instead of one of 5°. If such eyes look at a distant object they will appear to be affected with a divergent squint; for, whilst the optic lines are fixed upon the object, the optic axes will diverge from it. In myopia the reverse obtains, for there the visual line, instead of lying to the inner side of the optic axis, may correspond to the latter, or even lie somewhat to the outer side of it; and in the latter case, there will consequently be an apparent convergent squint, for whilst the visual lines meet in the object point, the optic axes must necessarily cross on this side of it.