HYOSCYAMUS. See *Henbane*.

HYPERIDROSIS is a functional disorder of the sweat apparatus accompanied by a more or less excessive increase of the normal amount of sweat excreted. This increase may be local or general. Local forms are symmetrically confined to certain regions such as the palms of the hands, soles of the feet, axillæ, or genital regions. Cases of unilateral excessive sweating, confined to one side of the body wholly, have been observed, but they are rare; of more frequent occurrence, although still not common, are the cases of unilateral sweating limited to one side of the head or to one limb. Usually intermittent, the sweating in some cases may be continuous and is aggravated by hot weather, emotion, depression of general health, etc.; and the disturbance may be temporary or permanent, depending upon its exciting cause. Subjects of the disorder are nearly always in a lowered state of health, sometimes hysterical and often nervous. The direct causes which lead to local hyperidrosis are quite undetermined. Examinations of sections from the palms of the hand fail to show any abnormal features of either the glands or the epithelium. The disorder is to be regarded as purely functional, connected with a disturbance of the vaso-motor control, no doubt, but as yet the exact links of the chain have not been definitely placed.

In the *treatment* of hyperidrosis, whether local or general, the condition of the patient's general health is of prime importance; the various ferruginous tonics, mineral acids, arsenic, strychnine, and quinine, are all of value. Belladonna and atropine, though but of temporary benefit, are of service at the outset of treatment in most cases. Cold baths for general toning of the circulation are strongly recommended. External treatment must be resorted to and is often very efficacious. In the local form that attacks the hands much benefit will be derived from immersing the palms for a few moments only in water as hot as can be borne, dabbing dry with a soft cloth, and then dusting on boric acid powder. The same treatment for the soles of the feet may be employed. A saturated alcoholic solution of boric acid dabbed on the palms during the day will control very well the excessive sweating of the hands that is so annoying to those who do much writing. Hebra's treatment for hyperidrosis of the feet consists of enveloping the feet, the toes separately, after thorough washing and drying, in strips of cotton cloth, over which is spread, to the thickness of a knife blade, his Unguentum diachyli. The parts are well bandaged and the patient may subsequently either remain at rest or pursue his vocation, wearing shoes and stockings that have not been previously used. In twenty-four hours the feet are redressed without washing, after dry rubbing and a dusting powder. This process is repeated daily for from ten to twenty days, after which a dusting powder, preferably boric acid, may be substituted for the local dressing. There occurs a parchment-like desquamation of the skin in thick, yellowish-brown flakes, beneath which is formed a new and at first tender, but apparently normal, epidermis. When the latter has lost its tenderness, the feet are for the first time washed with water. The process is to be repeated in case of failure.

Prognosis in any case of hyperidrosis is uncertain. At times treatment may meet with brilliant success; again, it is followed by complete failure. The disorder may disappear spontaneously, only to recur and prove obstinate to all measures. *Charles Townshend Dade.*

HYPERMETROPIA—H—(from *ὑπέρμετρος*, overmeasure, and *ὤψ*, eye—less correctly hyperopia; *Uebersichtigkeit*, Ruete, 1853; incorrectly *hyperpresbyopia*, Stellwag, 1855) is the name given by Donders (1860) to the abnormal refractive condition of the eye in which its principal focus—*i.e.*, its focus for parallel or practically parallel rays, such as are received from a distant object—lies at some point beyond the actual position of the retina. In H the antero-posterior axis of the eyeball is too short relatively to the focal length of the eye as determined by the radii of curvature of its three refracting surfaces, namely, the anterior surface of the cornea and the anterior and posterior surfaces of the crystalline lens, and in typical H the axis is actually shorter than in the normal or emmetropic eye. H is ordinarily an inherited condition, and may then be regarded as a result of incomplete development of the great posterior segment of the eyeball, in consequence of which the axis remains shorter than in the normal eye.*

The essential points of difference between the emmetropic and the hypermetropic eye are shown in Fig. 2758, in which the dotted outline represents in section the normal or emmetropic eye, and the continuous outline a hypermetropic eye. It is a property of the emmetropic eye, when in a state of accommodative rest (see *Accommodation and Refraction*), that the sum of the refractions at the surface of the cornea and at the two surfaces of the crystalline lens is just sufficient to unite all the rays of a parallel pencil, *A, E, B,* in a focus upon the retina at *E*. When the retina is so misplaced as to lie within the principal focus of the dioptric media, the pencil is cut by the retina before its rays have come together, and the image of a distant point upon which the eye is directed is formed at *H* as a circular spot of appreciable diameter (circle of confusion). What is true of a pencil of rays emanating from one point of the distant object is true of pencils emanating from other points of the same object; the inverted retinal image is, therefore, more or less confused, and all the finer details of the object are lost. This confusion of distant vision is experienced by every hypermetrope whenever his accommodation is fully relaxed, and it may be evoked artificially, in any case of H, by paralyzing the accommodation by instilling a drop or two of a mydriatic solution, such as atropine, into the conjunctival sac.

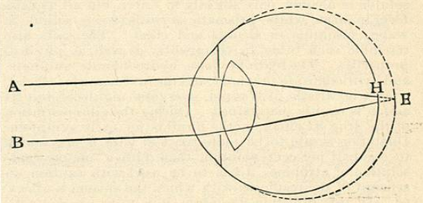

FIG. 2758.

As the emmetropic eye, when in a state of complete accommodative relaxation, is adjusted for the focussing of parallel rays upon its retina, so the hypermetropic eye is adapted for the focussing of rays of some definite degree of convergence. Fig. 2759 shows a convergent pencil, *A', H, B'*, focussed upon the retina of the hypermetropic eye at *H*, and also a pencil, *A, H, B*, of rays originally parallel, but rendered convergent by passing

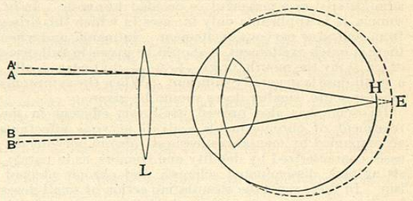

FIG. 2759.

* H is, in fact, the normal condition in the Quadrumana, and in the higher Mammalia generally.

through a convex lens, *L*. The hypermetropic eye receiving and focussing such a convergent pencil becomes practically equivalent to an emmetropic eye receiving and focussing a pencil of parallel rays, and as any required degree of convergence may be given to an originally parallel pencil by allowing it to traverse a convex lens of suitable power, so the vision of a hypermetrope may always be perfectly corrected for distance by wearing properly chosen (neutralizing) convex glasses.

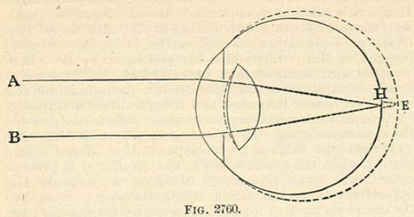

FIG. 2760.

H does not ordinarily give rise to defective vision at a distance so long as the range of accommodation (A) remains unimpaired, as in the case of young persons. The reason of this will appear from an inspection of Fig. 2760, which shows a hypermetropic eye adjusted for the focussing of a pencil of parallel rays, *A, H, B*, through the increase in the convexity of its crystalline lens incident to the act of accommodation. The focussing of the several pencils of rays which form the retinal image is here as perfect as in the case shown in Fig. 2759, but with the difference that some part of the accommodation is expended in advancing the focus from its normal position at *E* to the actual position of the retina at *H*, so that only the unexpended part is available for the further adjustment of the eye to meet the requirements of near vision.

Fig. 2761 shows a hypermetropic eye, in its condition of fullest accommodative adjustment, focussing a divergent pencil, *A, H, B*, emanating from an object situated at its nearest point of distinct vision. Fig. 2762 similarly shows an emmetropic eye focussing a more divergent pencil, *A, E, B*, emanating from a nearer object situated at its nearest point of distinct vision. Comparing these two figures, it will be seen that the near-point of distinct vision for the hypermetropic eye lies farther from the eye than the near-point of distinct vision for the emmetropic eye, so that the hypermetropic eye, as compared with the emmetropic eye, is limited in its region of adjustment for near vision (region of accommodation), and the higher the grade of H the greater the limitation.

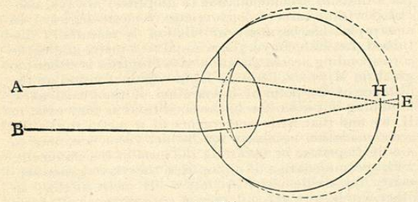

FIG. 2761.

In very high grades of H the absolute range of accommodation (A) may be insufficient, even in young persons, for the perfect focussing of parallel rays upon the retina, in which case H is said to be absolute (H *absoluta*). This condition is shown in Fig. 2763, in which the focus of the parallel pencil, *A, H, B*, which, without aid from the accommodation, would lie at *E*, is, through the full exercise of the accommodation, advanced to *H*, which, however, still lies behind the actual position of the retina at *Ha*. A point in the distant object, which in the emmetropic eye would be depicted as a point at *E*, is, therefore, actually depicted as a circular spot (circle of confusion) at *Ha*. Even under the full exercise of the accommodation this circle of confusion still remains a spot of appreciable diameter; the retinal image of the distant object is therefore made up of circles of confusion instead of points, and, although it may be improved in definition through the exercise of the accommodation, the picture remains confused in its details.

This distinction, in young persons, between H *absoluta* (H > A) and the lesser grades of H (H < A) is important. In H < A the hypermetrope is able to see at a distance by using only a part of his accommodation, and he has still a residual accommodative power sufficient to meet, in some measure, the requirements of near vision. He therefore forms the habit of using some part of his accommodation in every act of vision, and by a strong exercise of the same faculty he may even be able to read, although necessarily at the cost of excessive effort, and generally for a limited time only. Hence a hypermetropic child is apt to be judged harshly by parents or teachers, who, recognizing the fact that he is able to apply himself effectively to his books for a short time, are slow to comprehend that he becomes quickly wearied and is incapable of sustained application (see *Asthenopia*). In certain cases, however, impelled by the strong desire to see distinctly, the child learns to force his accommodation by concentrating an abnormally powerful impulse upon the two correlated functions of accommodation and convergence, and thus acquires the power of sustained application by sacrificing binocular vision and laying the foundation of a convergent squint. (See *Asthenopia* and *Strabismus*, also later in this article.) In H > A (H *absoluta*), on the other hand, distinct vision is impossible even at a distance, and, although the definition of objects may be considerably improved by a strong accommodative effort, it nevertheless falls so far short of perfect vision as not to offer a sufficient motive for continuous or prolonged exertion. In H *absoluta*, therefore, the case is apt to be regarded as one of defective vision, and glasses are perhaps tried at random until a pair of convex spectacles is found, which renders the use of the eyes comparatively easy. But even here prejudice may come in to deter a parent from permitting the child to

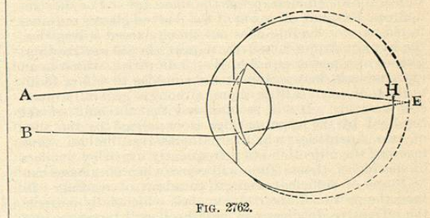

FIG. 2762.

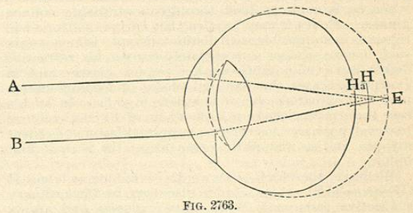

FIG. 2763.

wear spectacles "old enough for its grandfather," and efficient aid from glasses may be withheld.

H *absoluta* is but rarely met with in the first years of childhood, for the reason that at this early age the normal range of accommodation is very large; but often in youth, and still more in adult life, the progressive limitation of the range of accommodation comes into play to increase the disability of the hypermetrope, and, with advancing years, to render it complete. Thus all cases of H < A pass sooner or later through the stage H = A to H > A (H *absoluta*), and the hypermetrope suffers in turn from disabilities incident to successive stages of his refractive anomaly, to find rest and distinct vision, perhaps after the lapse of many years, in convex glasses of which he should have had the benefit in childhood.

As the emmetrope at about the age of forty-five years has generally lost so much of his power of accommodation as to require aid from convex glasses to enable him to see distinctly at the usual reading distance of about one-third of a metre (twelve to fourteen inches), so the hypermetrope finds his near-point receding beyond this limit of distance at an earlier age dependent on the grade of H. Hence he will need convex glasses for reading, comparatively early in life, and will be compelled to change them from time to time for other glasses, which must always be of greater power than those which would suffice for an emmetrope of the same age. For the emmetrope the limit of power of the convex glasses required in old age for reading does not much exceed 5 dioptries; the hypermetrope, however, requires in old age reading-glasses of a power equal to H + 5 dioptries, which in an extreme case may amount to as much as 10 + 5 = 15 dioptries, or even a little more, although generally much less than this. It will be observed that the limit of aid required by the hypermetrope is expressed by the sum of two quantities which are themselves limited, thus meeting the objection not infrequently urged by venders of spectacles, that a time will come when no glasses can be found of sufficient strength to admit of reading. In fact, the power of the convex glass which fully corrects the refractive deficiency in childhood will never require to be increased by more than four or, at most, six or eight dioptries to meet the further disability incident to loss of accommodation, to the diminution of the refractive power of the crystalline lens in old age, and to senile deterioration of the acuteness of vision. (See *Presbyopia*; also H *acquisita*, later in this article.)

We have seen (*vid.* Fig. 2760) that a hypermetrope who sees distinctly at a distance necessarily makes use of some part of his accommodation, and that he is compelled to accommodate in excess of the normal degree in order to see nearer objects distinctly. He thus forms the habit of associating some degree of accommodation with the act of directing the eyes upon any distant object, and he generally continues to accommodate to some extent even when he is made to look through neutralizing convex glasses. Hence it may happen that a hypermetrope will reject as incompatible with distinct distant vision not only such convex glasses as completely correct his refractive defect but even notably weaker convex glasses, and, in exceptional cases, this habitual tension of accommodation may be so great as even to simulate myopia. In such a case the grave mistake may be made of having recourse to concave glasses to correct a supposed but non-existent myopia, and so materially aggravating the actual disability.

We have, therefore, to recognize a hidden or latent H (H *latens*—Hl), which eludes discovery by the ordinary subjective tests made with convex glasses, and also a manifest H (H *manifesta*—Hm), which is readily detected and measured by this mode of examination. Thus we may have to do with a case of apparent emmetropia, or possibly even of apparent myopia, which, on thoroughly paralyzing the accommodation by atropine, turns out to be really a case of H; and in every case of H in a young person with normal accommodation we obtain, by tests with convex glasses alone, a measurement which falls notably short of the total refractive defect (H *totalis*—Ht) as measured by means of convex glasses after artificial paralysis of the accommodation.

Hl is then the expression of the degree of accommodative tension which persists during the fixation of a distant object, and the ratio which it bears to Hm is dependent upon the extent of the range of accommodation. Hence it is greatest in childhood, and it diminishes year by year throughout youth and adult life until, at the age of sixty, or perhaps somewhat earlier, it becomes wholly merged in Hm, which then becomes equal to Ht. Hm = Ht is also realized as a pathological condition as a result of paralysis of the third (motor communis) nerve, or of its terminal branches, and it is produced artificially by the instillation of atropine or other sufficiently powerful mydriatic drug. It is also generally true that the hypermetrope relaxes his accommodation almost completely when the eyes are not in use, so that it is practicable, in a large proportion of cases, to measure Ht objectively by means of the ophthalmoscope, either by the direct method of examination or by employing the shadow test (see *Shadow Test*). More frequently, however, we first measure Hm subjectively, by successive trials with convex glasses, until we have fixed upon the strongest glass through which a test-object, such as the appropriate selection from the test-letters of Snellen, is seen distinctly at a distance of five or six metres, and then measure Ht by the use of the same test-letters at the same distance, after having fully paralyzed the accommodation by means of atropine or of hyoscyamine; we then calculate Hl by means of the equation, Hl = Ht − Hm.*

We have thus far considered H in its relations to A mainly as if it were a question of vision with a single eye; as a fact, however, we see with the two eyes at one and the same time, so that every act of binocular vision involves two simultaneous adjustments—namely, accommodation for some particular distance, and convergence of the axes of the two eyes upon the object for which they are severally accommodated. In emmetropia these two adjustments go hand-in-hand, so that parallelism of the visual axes is associated with complete relaxation of the accommodation, and convergence upon any near object is associated with accommodation for the same distance; or, taking as units of measurement the degree of accommodation required for distinct vision at the distance of one metre (1 dioptrie), and the degree of convergence necessary for single vision at the same distance of one metre (1 metre-angle), we find in emmetropia n units of accommodation (n dioptries) always associated with n units of convergence (n metre-angles). In ametropia this harmony of relation is essentially disturbed, for with convergence equal to n metre-angles the corresponding accommodation of n dioptries is either too great (in M) or too little (in H) for distinct vision at the distance of the point of intersection of the visual axes. Confining our attention to the conditions as they exist in H, we find that with convergence of n metre-angles the accommodation necessary for distinct vision amounts to n + H dioptries; or, inverting the form of the statement, with accommodation of n dioptries, the convergence necessary for single vision is only n—H metre-angles; in other words, any given degree of convergence calls for a relatively strong effort at accommodation to meet the requirements of distinct vision, and, *vice versa*, the degree of accommodation required for distinct vision must be associated with a relatively weak effort at convergence in order to admit of single vision with the two eyes.

The maximum of accommodation (*absolute* A) is attained only when the convergence is simultaneously exerted to the utmost, and even in emmetropia this involves a very strong crossing of one of the eyes. In H, however, excessive convergence is the rule in every act of accommodation whenever the conditions are such as not to admit of binocular vision, and *absolute* A is attained only

* As a rule, Hl is less than Ht, and the latter is the arithmetical sum of Hl and Hm, but in the exceptional cases in which H simulates emmetropia Hm = 0: in the still rarer cases in which an apparent myopia gives place to H after artificial paralysis of the accommodation, Hm appears as a negative quantity, and Hl is greater than Ht.

in conjunction with even stronger crossing than in emmetropia.

H *absoluta* includes, therefore, only those cases in which, even under the condition of extreme crossing of one of the eyes, the accommodation is insufficient for distinct vision at a distance.

In convergence for any given distance the associated accommodation is found by experiment to be always less than when the convergence is for some shorter distance; in other words, every act of convergence not only compels an approximately proportional exercise of the accommodation, but inhibits, within certain limits, its greater exercise. Hence, in binocular vision, the *relative* A (A_1, *i.e.*, the range of accommodation as related to the convergence) is always less than the *absolute* A; we have, therefore, to recognize a type of H in which the *absolute* A is sufficient for distinct uniocular vision at an infinite or at some finite distance, but in which the *relative* A is insufficient for perfect binocular vision at any distance (H *relativa*).

In H *relativa* perfect uniocular vision is possible, not only for distant, but in most cases also for near objects, but only on the condition of crossing the non-participating eye.

It has been stated elsewhere that the link by which the accommodation and the convergence are tied together is not an absolutely rigid one. This is proved by the fact that, as a rule, perfect binocular vision is still possible when moderately strong concave or convex glasses, or convergent or divergent prisms, are placed before the two eyes. In the former case the convergence remains unchanged notwithstanding the altered accommodation, and in the latter case the accommodation remains unchanged notwithstanding the altered convergence; but to these adjustments of the convergence to varying states of the accommodation, and of the accommodation to varying states of the convergence, there is a limit well defined in each case, but differing in different cases. This binocular range of accommodation (A_2) may undergo considerable modification, according as it is habitually exercised in a negative or in a positive sense, and the ability to relax the binocular accommodation in M, or to force it in H, is usually considerably greater than in emmetropia, thus conserving in a measure the harmony of the two adjustments. Confining our attention to the conditions as they exist in H, we find that in moderate grades of H, with ample range of accommodation, it is often perfectly easy to accommodate accurately for a distance without convergence of the visual axes, and in many cases, at least in childhood and youth, also to accommodate and converge correctly for the ordinary reading distance, without conscious fatigue.

This type of H, in which binocular vision is perfect for a distance, and in which it may be also possible to read easily with the two eyes, is called H *facultativa*.*

As the power of convergence remains practically constant throughout life, while the range of accommodation diminishes progressively through the periods of youth and maturity until it is reduced to zero in old age, it follows that H *facultativa* is but an early, and often a quickly passing stage in the life-history of most hypermetropes, changing sooner or later to H *relativa*, and ultimately to H *absoluta*; nevertheless, the duration of each of these earlier stages is not infrequently measured by years, and may then afford abundant time to develop the characteristic disabilities and to work out the special tendencies to mischief incident to each type.

* Donders, who made the first thorough study of hypermetropia, writing for English readers ("Anomalies of Accommodation and Refraction of the Eye," London, 1864), gave the name *facultative* H to this condition. In its French and Italian forms this word has a well-recognized meaning, and from these languages it has been adopted in German. In English it can hardly be said to be fully naturalized. Its meaning, as given in the "Dictionnaire de l'Académie," is "Qui laisse la faculté de faire ou de ne pas faire une chose; dont on peut, à son gré, faire ou ne pas faire usage." The writer of this article ventured, in the first edition of this HANDBOOK, to adopt a Latinized form of the word, with a view to more perfect uniformity of notation.

These disabilities and tendencies must now be considered in detail.

(*a*) In H *facultativa* binocular vision is perfect at a distance without glasses, and also with convex glasses of any power up to that which measures the manifest hypermetropia. In the case of many young hypermetropes, convergence for some short distance is also associated with good accommodation for the same distance, so that it may be possible to use the eyes easily in near work. In other words, the sphere of the habitual exercise of the accommodation (region of accommodation) has become so adjusted to the abnormal condition of refraction as to allow the two correlated functions of convergence and accommodation to work harmoniously together. This compensatory displacement of the region of accommodation is sometimes so perfect, in childhood and youth, that, even with Ht = 3 or 4 dioptries, the prolonged use of the eyes in reading or other close work may be unattended with fatigue, and in many other cases the available binocular accommodation proves equal to all ordinary demands upon it. A young hypermetrope may thus remain for years in complete unconsciousness of his defect, but sooner or later, as a consequence of the progressive physiological limitation of A, or perhaps of a temporary impairment of this function incident to some transient illness, or in connection with the change to a new vocation which calls for an unwonted exercise of the accommodation, he finds that his eyes are no longer equal to the demands made upon them. The inability to use the eyes continuously in near work may be first discovered in connection with the increased requirements of the higher grades in school, or the assiduous employment of the eyes in fine sewing. In other cases the disability manifests itself in early childhood, as when the eyes are first exercised in the more delicate tasks of the kindergarten, or in beginning the study of geography from maps crowded with names engraved in minute letters. Small near objects are, perhaps, still seen clearly for a little while, and apparently without great effort, but the accommodation soon becomes fatigued, and fine print then appears blurred, or may become altogether illegible. Under the strong stimulus of emulation, or dread of censure, the child may perhaps persevere in his efforts, though at the cost of physical and mental strain and with increasing sense of fatigue, until at length he is compelled to desist. After a short rest he may be able to resume his work, but only for a shorter time than before, and he soon finds himself unable to read at all. Thus the familiar picture of accommodative asthenopia is developed, to give place, sooner or later, to inability to see distinctly at the distance of the point of intersection of the visual axes (see *Asthenopia*).

(*b*) H *relativa*, by its definition, implies a state of conflict between the convergence and the accommodation at all distances. Either the two eyes are habitually directed upon the object, in which case the lagging accommodation is insufficient for the perfect focussing of the retinal images, or the accommodation asserts itself in a strong effort to see clearly with a single eye, and the axis of the fellow-eye assumes a crossed direction. The conflicting impulses on the one hand to focus perfectly for the distance of the object, in order to see it distinctly, and on the other hand to direct the two eyes accurately upon it, in order to avoid seeing it doubled, thus contend for the mastery until at length one of two alternative conditions is established—namely, distinct vision with a single eye, the other eye assuming a crossed direction (periodic or confirmed convergent strabismus), or single vision with the two eyes, but with insufficient accommodation and consequent imperfect recognition of the finer details of the object.

Any condition which detracts from the perfection of binocular vision may predispose to the development of convergent strabismus in the presence of H. Prominent among such conditions is an original or acquired imperfection of one of the eyes. Thus an imperfect eye is easily thrown out of use whenever the vision of the fellow-eye may be materially improved by so doing. In

fact, we find that in by far the greater number of cases of strabismus the crossed eye is decidedly inferior to its fellow in visual acuteness, even though no structural defect is to be detected. Again, any pathological condition of one eye, attended with temporary or permanent impairment of its visual acuteness, may so detract from the importance of the part which it plays in binocular vision as to allow it to be easily excluded from participation in the act of vision. Under this category fall cases of strabismus, dating from the appearance of a corneal phlyctenula, or following the formation of a corneal scar. Again, it would appear that the faculty of perfectly controlling the convergence to meet the requirements of binocular vision is often more tardily acquired than that of perfect accommodation, so that a hypermetropic child with normal acuteness of vision in both eyes may acquire the habit of crossing one eye in order to see clearly with the other before he has become confirmed in the habit of using the two eyes together. In such cases the crossing is apt to alternate between the two eyes (strabismus alternans), and this alternation may either persist for years or may give place to the more common condition of habitual crossing of one and the same eye. A difference in the grade of H in the two eyes is often sufficient to determine the crossing of the more hypermetropic eye, and this in some cases even when this eye is in other respects somewhat the better eye.

(*c*) H *absoluta*, the ultimate stage to which every case of H necessarily tends, has been already defined as a condition in which distinct vision is impossible, even under a maximum exercise of the accommodation conjoined with the strongest convergence. With the development of this absolute disability, the hypermetrope learns to desist from unavailing efforts at accommodation, and so finds relief from his asthenopia in enforced amblyopic vision. If in the previous stage of H *relativa* the excessive convergence has been limited to the times of actual exercise of the accommodation (periodic strabismus), now that no effort suffices for distinct vision, he learns, with the cessation of all attempts at accommodation, to abandon also the habit of crossing the eyes. Very pronounced strabismus may thus become decidedly less pronounced, or may possibly even disappear.

Paresis of accommodation, from impairment of the function of the ciliary nerves, is attended, even in emmetropia, by many of the characteristic symptoms of H; and when it occurs in a hypermetropic subject it may develop special conditions, which may be temporary or permanent according to the nature of the cause which underlies the paresis. Thus, in connection with the temporary paresis of accommodation not infrequently observed as a sequel of diphtheria, H *facultativa* is converted, at least for the time being, into H *relativa* or H *absoluta*, and H *relativa* into a higher grade of the same or into H *absoluta*. If the change is limited to the state of H *relativa*, vision becomes indistinct, or, more rarely, a true convergent strabismus appears, which may even develop later into permanent squint. Complete paralysis of accommodation, or paresis occurring in connection with a very high grade of H, develops, on the other hand, the condition of H *absoluta* with attendant indistinctness of vision at all distances and immunity from all tendency to crossing of the eyes.

Artificial paresis or paralysis of accommodation, evoked by the instillation of a mydriatic solution into the conjunctival sac, may play an important part, in the presence of H, by transforming H *facultativa* into H *relativa* or H *absoluta*, or H *relativa* into H *absoluta*, thus promoting in some cases and suppressing in other cases a pre-existing tendency to strabismus. As a rule, incomplete mydriasis, when limited in its effect to the production and maintenance of the condition of H *relativa*, favors the development of strabismus, and may even evoke it in a case of H *facultativa* which might otherwise have passed gradually through the stage of H *relativa* to H *absoluta* without other symptoms than those of accommodative asthenopia with ultimate inability to see distinctly except by the aid of convex glasses. On the other hand, a condition of complete mydriasis, if long enough maintained, may, by rendering all efforts at accommodation unavailing, lead also to the abandonment of excessive exercise of the convergence, and so permit binocular vision to reassert itself even in a case of already developed crossing.

Myotics work a change in the relation of the accommodation to the convergence exactly the opposite of that produced by mydriatics. Under the influence of eserine, or of pilocarpine, H *absoluta* may be transformed, for the time being, into H *relativa*, or H *relativa* into H *facultativa*, or even into temporary emmetropia or myopia. Unfortunately, however, for the general applicability of this method to the amelioration of the condition of young hypermetropes, the known myotics are essentially transient in their effect, so that it is always difficult, and often practically impossible, to maintain a uniform degree of myosis for any lengthened period. In low grades of H in young persons the systematic instillation of very small doses of pilocarpine is often of use by assisting the accommodation for a time, and may thus be a valuable adjuvant to other measures, such as carefully regulated daily exercise of the eyes, in dealing with asthenopia when dependent in part upon temporary weakening of the accommodation. In the higher grades of H, and especially in middle and advanced life, the sphere of usefulness of myotics is extremely limited.

It has been already stated that H is ordinarily an inherited defect, the result of incomplete development of the posterior segment of the eyeball. Myopia, on the other hand, is generally an acquired condition, resulting from a pathological distention of the eyeball. It follows that a similar pathological distention, when it occurs in the hypermetropic eye, must necessarily be attended with a corresponding lessening of the grade of H. At a certain stage in this progressive distention H may thus pass into the condition of emmetropia, though with a thinned and weakened eyeball especially prone to further yielding of its coats under the continued action of the distending force. That a change from H, through emmetropia, to myopia, is of not infrequent occurrence is proved by the fact that individual cases of H in young persons, when examined at intervals of several years, often show a progressive diminution in the grade of H, or even a transformation into emmetropia or myopia. The statistics of the refractive condition of the eyes of large numbers of school children, showing a progressive decrease in the proportion of cases of H and a corresponding increase in the proportion of cases of myopia in the higher as compared with the lower classes, also the occasional occurrence in hypermetropic, emmetropic, or slightly myopic eyes of pathological changes in the fundus, such as are ordinarily found in the higher grades of myopia, point unmistakably in the same direction. The disappearance of H through its transformation into a pathological emmetropia or myopia must, therefore, be recognized as a possible, though, in most cases, an undesirable, event, and this possibility should always be kept in mind in weighing the indications for and against operative intervention in the treatment of strabismus in young children.

A form of H dependent on a physiological increase in the focal length of the crystalline lens (H *acquisita*) is a frequent incident in advanced presbyopia. In old age the myopic eye becomes, from this cause, somewhat less myopic, low grades of myopia pass into emmetropia or through emmetropia into low grades of H, emmetropia is transformed into H, and H becomes appreciably increased in grade. Inasmuch as A has now become reduced to a comparatively unimportant quantity, acquired H is nearly always absolute, and so reveals itself as a true *hyperpresbyopia*, necessitating the use of convex reading glasses of a focal length somewhat shorter than the actual reading distance, and of weaker (neutralizing) convex glasses for perfect vision at a distance.

H *acquisita* may also occur as a result of flattening of the cornea from disease, in which case it is generally complicated by irregular, or sometimes by approximately

regular astigmatism (H + Ah). In such cases the damaged eye not infrequently goes out of use, and, in the presence of H of the other eye, may become crossed. If, however, this eye happens to be the better eye, the very strong accommodative effort required for tolerably distinct vision may give rise to crossing of its fellow.

A pathological shortening of the focus of the crystalline lens is not infrequently observed in the incipient stage of cataract in old persons. H may thus pass into emmetropia, or through emmetropia into myopia, and emmetropia may be transformed into a grade of myopia sufficient to admit of reading without the aid of glasses. This seeming improvement, often called second sight, is however, only temporary, and is lost sooner or later in the progressive failure of vision incident to increasing loss of transparency of the crystalline lens.

The diagnosis of H turns on the fact that the hypermetropic eye, when in a state of accommodative rest, is able to focus only convergent rays upon its retina at or near the fovea centralis, and, conversely, that a pencil of rays given off by any point in the fundus at or near the fovea centralis must necessarily emerge from the eye as a divergent pencil (see Fig. 2764). The methods employed for the detection and measurement of H are either subjective, based upon the recognition by the patient of the strongest convex lens through which distant objects are seen with undiminished distinctness, or objective, based upon the recognition by the examiner of the degree of divergence of the efferent pencils emanating from the fundus. The subjective method is generally the more accurate, and is to be preferred whenever the patient has approximately normal acuteness of vision, together with sufficient intelligence and training to enable him accurately to define his perceptions. Objective methods are, on the other hand, invaluable in the case of young children, and also in the case of exceptionally stupid or illiterate persons of riper years. By the subjective method we first measure Hm by preliminary tests made without the use of a mydriatic and we may subsequently determine Ht by repeating the tests after having thoroughly paralyzed the accommodation by instillations of atropine or of hyoscyamine. By objective methods we obtain, in most cases, a pretty accurate measurement of Ht without having recourse to full artificial mydriasis, although it is often desirable, or even necessary, to dilate the pupil in order to secure a satisfactory view of the central portions of the fundus. Inasmuch as it is not ordinarily necessary to paralyze the accommodation, we may, with great advantage, avail ourselves of the rapid but transient mydriatic action of cocaine, which, besides sufficiently dilating the pupil for purposes of observation, has the additional effect, in many cases, of measurably controlling any existing nystagmus. A mixture of cocaine hydrochlorate with euphthalmin hydrochlorate, in a solution containing one per cent. of each, may also be used for obtaining transient dilatation of the pupil.

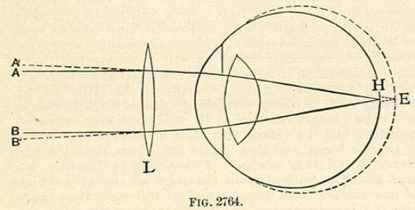

FIG. 2764.

In applying the subjective method we make use of a suitable test-object placed at the greatest convenient distance from the eye, usually the test-letters of Snellen hung upon the opposite wall of the room at a distance of say 5 metres, and direct the patient to read, with eyes well open, as many of the letters as he can. If vision is shown by this test to be of normal acuteness ($\frac{5}{5}$, or perhaps $\frac{5}{4}$), H *absoluta* and also myopia of any degree higher than 0.2 dioptrie are excluded; also any notable grade of astigmatism. H *facultativa*, or, under the condition of crossing of the visual axes, H *relativa*, may, however, be present. We next place a pair of weak convex trial glasses before the eyes, and again direct the patient to read as many of the test-letters as he can, using preferably another test-card with different letters. If through these glasses the acuteness of vision is still equal to $\frac{5}{5}$, we change the convex trial glasses for others of greater power, until we have hit upon the strongest convex glass through which the patient enjoys his maximum of visual acuteness. The value of this glass is the measure of Hm.* Having measured Hm, it is often possible to make a sufficiently accurate estimate of Ht by taking into account the degree of Hm and the age of the patient, but in other cases it is important to measure it directly. To this end we repeat the examination after having paralyzed the accommodation by the instillation of atropine or of hyoscyamine. Of these two agents the latter is the more powerful, and one or two instillations of a one-per-cent. solution are generally sufficient to produce full paralysis of accommodation in the course of an hour; if atropine is used it is generally advisable to repeat the instillation two or three times at intervals of half an hour, and to defer the examination for an hour or so longer. In many cases of H the accommodation yields more slowly to the relaxing influence of mydriatic agents, so that the full measure of Ht is obtained only after repeated instillations continued for at least twenty-four hours. Under the effective use of either of these mydriatics Hm and Hl become merged for the time in Ht, H *facultativa* and H *relativa* give place to H *absoluta*, certain cases of apparent emmetropia turn out to be actually cases of H *facultativa* in which H has been concealed by habitual tension of the accommodation, and a few cases of apparent myopia are shown to be really cases of emmetropia or of H, but simulating myopia through persistent accommodative tension.

The objective measurement of H is made with the aid of the ophthalmoscope by the direct method, using as points of observation the finest visible details of the fundus in the neighborhood of the fovea centralis. The best objects for this purpose are the smaller retinal vessels, which serve also for measuring any difference of refraction in the different ocular meridians (see *Astigmatism*), and the general texture of the fundus, which is usually distinctly granular. Under ophthalmoscopic examination, in a well-darkened room, the accommodation is generally found to be so far relaxed that the ophthalmoscopic measurement may be accepted as a very close approximation to Ht; the measure of Ht is then the strongest convex lens, placed behind the hole in the mirror, through which the details of the fundus are distinctly visible. This measure must, however, be corrected for the distance of the lens from the eye, and also for any ametropia which may be present in the eye of the observer.

Under full mydriasis an abnormally large area, both of the cornea and of the crystalline lens, is uncovered and brought into action in the formation of the retinal image, and it is not infrequently the case that, owing to a lower refractive power in the uncovered marginal zone, measurements obtained under atropine show a slight excess over Ht as it exists when the pupils are of normal diameter. It is therefore generally advisable, when glasses are to be given to correct the total hypermetropia, to prescribe them of a somewhat lower power than that indicated by tests made with dilated pupils.

The shadow test (retinoscopy, so-called; see *Shadow Test*) affords very accurate measurements. In common with the ophthalmoscopic observation of the fundus in the erect image, its results are wholly independent of the degree of vision which the patient may enjoy, and of the

* In strictness, 0.2 dioptrie should be subtracted from this measure, to allow for the finite distance of 5 metres at which the test-card is hung; and in the case of glasses of short focus a further correction must be made for the distance at which the lens is placed in front of the cornea, which is ordinarily about 15 mm. As most measurements of the refraction are made for the purpose of selecting glasses, this latter correction is generally superfluous.