For diagnostic explorations they are inferior to the needles, from the fact that with the former it is impossible to make use of the previous vacuum. The trocars are of special value in tapping the chest, or any other cavity in which there is danger of doing harm by the point of the needle.

In aspirating the cranium, pericardium, spina bifida, and intestine the smallest needle, No. 1, should be used. For the bladder, joints, strangulated hernia, and tumors, No. 2 is suitable; while for abscesses, thoracic and peritoneal effusions, the larger sizes are appropriate.

Owing to the fineness of the needle, and to the elasticity of the tissues, almost any organ or part of the body may be safely explored with the aspirator. For example, the head, chest, stomach, liver, gall bladder, spleen, intestines, uterus, tumors of various descriptions, and aneurisms have been punctured without untoward results. The principal diseases, however, in which the aspirator has been proved by experience to be of especial value are the following:

Retention of Urine.—In the severer stages of this affection, aspiration, as a temporary resource, is often of great service. It is safe, speedy, and effectual. So little pain attends the operation that, as a rule, anæsthetics are not required. If relief is not obtained in these cases from milder measures, together with a moderate trial of the catheter, it is far better to aspirate the bladder above the pubes than to irritate and perhaps lacerate the urethra by prolonged and often fruitless efforts at catheterization. The operation is best performed with Potain's apparatus. It being in readiness, the needle is entered on the median line just above the symphysis, and carried backward and downward toward the hollow of the sacrum, to such a depth that the point will not escape as the bladder contracts. When the viscus is nearly emptied the patient is apt to experience a pricking sensation, which is due to the needle's impinging on the posterior wall. It should be withdrawn a short distance, and the urine allowed to escape as long as it will without producing too much pain. The puncture in the skin may be covered with a bit of adhesive plaster. This operation can be safely repeated as often as may be necessary for two or three days, by which time the urethral irritation is generally so far subdued by appropriate measures that the power of voluntary micturition is restored, and the primary obstruction can receive the required attention.

Aspirating the bladder is preferable to the operation of tapping by the rectum, because it is safer, it is more easily performed, there is less liability to mistakes, and it is not followed by recto-vesical or other fistulæ, by extravasation of urine, or by pelvic or prostatic inflammation and suppuration, accidents which have occasionally supervened upon the rectal operation.

Affections of the Joints.—While almost any large joint containing a considerable quantity of fluid may be aspirated, the operation is chiefly confined to the knee. Large effusions in that articulation, whether of serum, blood, or pus, can be safely and quickly removed by this method. The needle is to be inserted wherever the swelling is most prominent, which is usually above or to the inside of the patella. Care should be taken not to wound the cartilages with the point of the instrument, as serious results have been known to ensue. After the operation the patient should be kept in bed, the limb should be placed upon a posterior splint, and firm pressure should be applied by means of flannel or rubber bandages. Should the fluid reaccumulate the operation may be safely repeated (under aseptic precautions) as often as is necessary. Anæsthetics are required only in children, and in nervous or timid subjects.

Strangulated Hernia.—It was thought at one time that aspiration might prove to be very beneficial in the treatment of this affection, but it has not stood the test of experience. The needle is apt to become clogged, or from various causes the tumor cannot be sufficiently reduced by this means to enable it to be returned to its proper place. It is true that many cases of successful reduction of the hernia after aspiration have been reported from time to time, but as the operation oftener fails than succeeds it is less frequently resorted to at present than it was formerly. Fatal results have followed this procedure, yet, when carefully performed with a No. 2 needle, it is attended with little danger, and it is occasionally successful.

Abscess.—Aspiration is frequently of the greatest value in determining the presence and character of fluids, but as a method of treating ordinary abscesses it is far inferior to free incisions, drainage tubes, and antiseptics. The pus usually reaccumulates after each evacuation, until finally a spontaneous opening takes place, unless it is anticipated by an artificial one. Occasionally, however, a favorable result follows repeated aspirations, as occurred in the case of an extensive pyæmic abscess over the sacrum, in the practice of a colleague. It was aspirated twenty-one times in twenty-five days, twenty ounces of pus being withdrawn at the first operation, and three ounces of serum at the last. But such cases are probably best treated by the method of incision, as above mentioned. An exception to this rule is an abscess occurring in a person the subject of the hemorrhagic diathesis. Such cases, when active interference is necessary, should be aspirated rather than incised, as the hemorrhage would be less, and probably could be more easily controlled. Hepatic, perinephritic, and some other deep collections of pus may occasionally be treated by repeated aspirations. The diagnosis is thus rendered certain, the shock of the operation is less than that which follows incision, and in a certain proportion of cases a favorable result will be obtained.

Hæmatoma.—Collections of blood in the cellular tissue resulting from contusion or other injury may often be satisfactorily treated by aspiration, one or two operations being sufficient in many cases to effect a cure. A large needle or trocar may be used to evacuate the contents, and firm pressure should be applied to prevent a return of the affection. The withdrawal of effused blood by this method is much more successful than the evacuation of pus, and seldom does harm.

Pleuritic effusions can be readily drawn off with Potain's aspirator. It is better to use a trocar than a needle in these cases, as by so doing there is less danger of injuring the lung. The puncture may be made in the eighth or ninth intercostal space, about two inches below the angle of the scapula. The operation should cease the instant pain or coughing sets in, but it may be repeated as often as necessary. Should the fluid reaccumulate less rapidly after each evacuation, and the general health improve or at least remain good, a favorable result may be expected by persisting in the treatment.

It is the opinion of many who have had a large experience with this operation, that ether should seldom, if ever, be given during its performance. A number of fatalities have resulted from this practice. The pain is neither severe nor of long duration. Children may be restrained by moderate force, and adults seldom request an anæsthetic if the danger is explained to them. Should it be thought necessary to administer ether, a few whiffs, just enough to produce primary anæsthesia, is sufficient, and is much safer than complete etherization. But the rule should be, use no anæsthetics in tapping the chest.

The *pericardium* may be safely aspirated with the smallest needle, as follows: The puncture is to be made in the fourth intercostal space, one inch (2.5 cm.) from the left border of the sternum, and the instrument carried slowly backward, upward, and a little toward the median line. The puncture may also be made in the fifth interspace, an inch and a half to the left of the sternum. To avoid wounding the heart it is important that the vacuum should extend throughout the needle at the earliest moment possible. Little danger need be apprehended, even if that organ is touched with the needle. The latter should immediately be withdrawn under these circumstances and introduced in another place. Aspirating the pericardium is an operation that will not often be required.

Should it be deemed advisable to evacuate the fluid in a case of *hydrocephalus*, it may be done with the smallest needle. The puncture should be made through the anterior fontanelle, far enough from the median line to avoid the longitudinal sinus. Experience gives slight encouragement for the performance of this operation.

Spina bifida has been cured by aspiration, either alone or followed by some stimulating injection. The smallest needle should be used, and pressure immediately applied.

Tumors may often be advantageously aspirated to determine their character or contents, but it is seldom that the operation is of any curative value. The most notable exception is probably that of a cyst of the broad ligament, cases of which have been cured by one aspiration.

Tympanites can be temporarily relieved by aspirating the intestines with a fine needle, but the method probably has no advantages over simple tapping, and, moreover, it is not entirely free from danger, as extravasation of fæces has followed and caused a fatal termination.

The principal dangers to be apprehended in performing aspiration are the wounding of large veins, arteries being seldom injured in this manner, extravasation of fæces and suppurative arthritis, as mentioned above, and peritonitis from tapping the abdomen. In conclusion it may be said that while aspiration is generally safe, yet, like every other operation, it should always be carefully performed, and with a full understanding of the possible accidents and results. *George W. Gay.*

ASPIRIN.—Acetyl salicylic acid, $C_6H_4.OCO.CH_3.CO\text{-}OH$, is prepared by acting upon salicylic acid with acetic anhydride. It crystallizes in white needles, which are soluble in about one hundred parts of water, and practically insoluble in acids. Alkaline fluids dissolve it freely, but split it up into its components.

Aspirin is a recently introduced remedy which has been used with good success in acute rheumatism. Being insoluble in the gastric juice it passes unchanged into the duodenum, and there, in the alkaline fluids of the intestine, it is broken up to form salicylates and acetates. Over sodium salicylate it possesses the advantages of not deranging the stomach and not causing cardiac depression, nervous symptoms, tinnitus aurium, deafness, etc. Aspirin may therefore be used in large dose even in cases of cardiac disease. The usual dose is ten to twenty grains two or three times a day, increased in the resistant cases to every two hours. It is administered in capsule, or suspended in syrup, or in a mixture with syrup and gaultheria water. *W. A. Bastedo.*

ASSIMILATION. See *Metabolism.*

ASTEROL.—Para-sulpho-phenol mercury and ammonium tartrate — $C_{12}H_{16}O_{12}S_2Hg.4C_4H_4O_6(NH_4)_2+8H_2O$. This is a preparation claimed by its manufacturers to contain fifteen per cent. of mercury, to have less action on metals than other mercury compounds, and to precipitate albumin to only a small degree. Steinmann's investigations have sustained these claims, and he states that one to ten per-cent. solutions of albumin are precipitated by 0.1-per-cent. solution of mercuric chloride, while they are made only slightly opalescent by a solution of asterol of the same strength. Vertun has questioned the claims of the manufacturers, stating that he found only eleven per cent. of mercury, and that it would attack surgical instruments and precipitate albumin. Asterol is a brown powder, slowly soluble in cold water, and rapidly soluble in hot water with the formation of a permanent solution. It is used as an antiseptic substitute for mercuric chloride in 0.1 to four per-cent. aqueous solution. Such a solution of 0.7-per-cent. strength is equivalent in antiseptic power to a 0.1-per-cent. solution of mercuric chloride.
W. A. Bastedo.

ASTHENOPIA (from ἀσθενής, weak, and ὤψ, eye) is the name proposed by Mackenzie (1843) to designate a complex of symptoms constituting so-called *weakness of sight.* "By asthenopia is understood that state of vision in which the eyes are unable to sustain continued exercise upon near objects, although the patient, upon first viewing such objects, generally sees them distinctly, can employ his sight for any length of time in viewing distant objects, and presents no external appearance of disease in his eyes. . . . In the open air the patient makes no complaint, being able to discern distant objects clearly and without fatigue. . . . In reading, sewing, and the like, he is obliged, partly from the confusion which seems to spread over the objects, partly from a feeling of fatigue in the eyes, to interrupt the exertion. . . . A very short period of rest is, in general, sufficient to recruit the sight, so that the power of perceiving small objects returns and the patient is in a condition to resume his employment. . . . When near objects fade away, as it were, from the asthenopic sight, some patients feel it a sufficient relief to turn their attention to remote objects, which they continue to see perfectly; others find remote objects also to appear confused, and require to shade their eyes till the attack wears off. The most complete relief is in all cases obtained by shutting the eyes. . . . Asthenopia is rarely observed to commence in those who have already reached the middle period of life, but almost exclusively takes its origin in childhood or youth. . . . Few patients, not even those who are mere children, continue to be long affected with asthenopia without making use of convex glasses. . . . A child, engaged in learning its lesson, complains that it cannot see, and repeats the complaint so frequently, especially by candlelight, that his father or grandfather at last says, 'Try my glasses.' The child now sees perfectly, and night after night the loan of the glasses is required before the task can be finished." To complete this graphic sketch, by Mackenzie, it is only necessary to add that, as a rule, the asthenope sees perfectly at a distance with the same convex glasses which make it easy for him to read, and that he needs only to wear convex glasses, of the greatest strength compatible with distinct vision at a distance, to be at once and completely relieved of his disability.

No allusion to asthenopia is to be found in the medical writings of antiquity. Taylor (1766) sketches its symptoms in a few lines under the name "debilitas visus." Scarpa (1801) mentions it as one of several forms of "incomplete amaurosis," and says of it that it is, "properly speaking, not so much an amaurosis as a weakness of sight from fatigue of the nerves, and especially of those which constitute the immediate organ of vision," *i.e.*, of the optic nerve and retina. Several later writers on the diseases of the eye have given excellent descriptions of asthenopia, but always in connection with amblyopia or amaurosis, of which it was assumed to be an early stage and, therefore, a precursor of blindness. Gradually stress came to be laid upon fatigue as the essential symptom, but as the seat of the fatigue was still thought to be in the retina, it was supposed that, if neglected, it might develop into amaurosis and end in loss of sight. Next, it was shown that asthenopia, even of many years' duration, does not result in actual impairment of vision, and so it came to be regarded as a condition of "morbid sensibility of the retina," or else as an amblyopia of a special and benignant type. Later, the fact began to be recognized that the essential phenomena of asthenopia are such as to suggest muscular fatigue, and the explanation was sought in weakness, or in overtension, of one or more of the external muscles of the eyeball. Still later, with a growing belief in the existence of a true accommodative adjustment, asthenopia was thought to be the result of weakness of this function, and so was brought into connection with so-called presbyopic vision in young persons. Finally, through the discovery of the mechanism of accommodation, and the demonstration of hypermetropia as an error of refraction, the way was opened for the recognition of the true cause of asthenopia in an overloading of the accommodation incident to the displacement of the region of accommodation in hypermetropia. Asthenopia is, therefore, not properly a dis-

ease, but a complex of symptoms dependent on an anomaly of refraction. (See *Hypermetropia.*)

Hypermetropia may be briefly defined as a structural anomaly in which the refractive power of the eye, in a state of rest, is insufficient to focus parallel rays upon the retina. In the highest grades of hypermetropia, the total accommodative power of the eye (absolute range of accommodation) may be inadequate to meet the requirements of distinct vision, even at a distance, and the condition may then bear a superficial resemblance to amblyopia; but in the medium and lower grades there is ordinarily developed a state of habitual tension of the accommodation, under which the adjustment for distance, and in many cases for the near also, may be easily and unconsciously performed. In other cases, little or no inconvenience is felt in distant vision, but the greater exercise of the accommodation required for reading or other near work is felt to involve effort, and becomes wearisome. The fatigue in accommodation for near objects does not, however, imply an actual insufficiency of the accommodation for the work imposed upon it, for the position of the absolute near point (p) in youthful hypermetropes is, in most cases, well within the distance at which the book is usually held in reading, and it is also true that in hypermetropia complicated with strabismus, in which condition the crossed eye takes no part in the visual act, reading is not ordinarily attended with especial difficulty, at least during childhood and youth. The principal determining cause of asthenopia is, in fact, to be sought in the close correlation of the two functions, accommodation and convergence, whereby any given exercise of the accommodation tends to evoke a corresponding exercise of the convergence, and, conversely, any given exercise of the convergence tends to evoke a corresponding, and no greater, exercise of the accommodation. Hence, in hypermetropia, either the accommodation required for distinct vision at any given short distance may be associated with excessive convergence, and so may lead to the development of convergent strabismus, or the convergence necessary for binocular vision at the given distance may be associated with insufficient or strained accommodation for that distance, and so may give rise to asthenopia.

Asthenopia may be defined, then, as fatigue incident to a conflict between accommodation and convergence when partially divorced through the displacement of the region of accommodation in hypermetropia.

Although, strictly speaking, asthenopia is a misnomer, for it is not a condition of weakness, nevertheless weakness (paresis) of accommodation may give rise to a train of symptoms not readily to be distinguished from true asthenopia. In paresis of accommodation following diphtheria, the simulation of asthenopia is perfect, but the history of sore throat, the accompanying affection of speech and of deglutition due to paresis of the faucial muscles, the absence of previous disturbance of the accommodation, and above all the absence of hypermetropia make the differential diagnosis easy.

Fatigue from long-continued tension of both accommodation and convergence in reading or in fine work at too short a distance, as by bad light, etc., may develop into a condition of disability in which all use of the eyes becomes wearisome or painful. Astigmatism, regular or irregular, distortion of the cornea from keratitis or corneal ulcers, dazzling of the retina by diffused light transmitted by corneal nebulæ, effusions in the field of the pupil, structural defects in the crystalline lens, etc., may thus disable the eyes for continued exertion by making it impossible to distinguish small objects except at an abnormally short distance; but these are essentially cases of imperfect vision, and the disabilities to which they give rise are not properly to be classed with asthenopia.

Astigmatism may, however, be a cause also of true asthenopia. Thus in simple hypermetropic astigmatism (Ah), or in mixed astigmatism (Amh or Ahm), if the ocular meridian of least refraction is horizontal or approximately horizontal, the hypermetropia in this meridian may give rise to a displacement of the region of accommodation just as in simple hypermetropia; and in compound hypermetropic astigmatism (H + Ah) this displacement may be equal to the sum of the displacements due to the hypermetropia (H) and to the hypermetropic astigmatism (Ah). But in astigmatism there is also impairment of the acuteness of vision, due to the asymmetrical ocular refraction, and for this reason the disability resulting from any given grade of hypermetropic astigmatism is ordinarily greater than that resulting from an equal grade of uncomplicated hypermetropia. In asthenopia complicated by hypermetropic astigmatism it is, therefore, often more important to correct the astigmatism, by means of appropriate convex cylindrical glasses, than to correct the hypermetropia, by convex spherical glasses, without regard to the astigmatism.

The name *asthenopia ex hyperopsia* was formerly used to designate a state of persistent weariness and irritability of the eyes brought on by long-continued application to fine work, especially when pursued under unfavorable physical or hygienic conditions. The frequent continuance of the disability even under prolonged rest from work, also the fact that a like train of symptoms may follow enforced disuse of the eyes as a result of injury, inflammation, etc., led similarly to the recognition of a so-called *asthenopia ex anopsia*. Many of the cases formerly included under one or the other of these two groups were, in fact, cases of true asthenopia dependent on hypermetropia or on hypermetropia with astigmatism, complicated, perhaps, by some other structural defect involving impaired acuteness of vision. In other cases, in the absence of noteworthy refractive error, the explanation of the disability must be sought in a disordered state—irritability, atony, etc., of the accommodation. Under these conditions, general hygienic measures, careful attention to any accompanying irritation of the conjunctiva, etc.; in some cases the use for a time of mydriatics, to secure complete physiological rest of the accommodation; in other cases carefully regulated and progressive use of the eyes in reading, either with or without glasses, and mild stimulation of the accommodation by the systematic use of myotics, particularly of pilocarpine in a weak solution, are often most useful.

A condition of hyperæsthesia is not infrequently developed, generally in persons of irritable temperament, which manifests itself by over-sensitiveness to light or by discomfort or pain in the eyes, headache, dizziness, nausea, or other nervous symptoms, after even moderate use of the eyes in near work. Such cases are more frequently observed in women than in men, and oftenest in women in comparatively easy circumstances, or who lead a sedentary rather than a physically active life. Such patients often suffer from impaired digestion and nutrition, constipation, menstrual derangements, etc. In general they need careful hygienic supervision, regulation of the diet, correction of constipation by daily small doses of laxatives, combined, perhaps, with belladonna or hyoscyamus, or with strychnine, iron, arsenic, etc. Refractive errors (hypermetropia, anisometropia, astigmatism, etc.), so slight as ordinarily to be negligible, may also require correction by means of very carefully adjusted glasses. The regular use of the eyes in reading should be encouraged, at first for perhaps only a few minutes at a time, increasing by very gradual additions as the patient acquires confidence and the eyes gain in capacity for exertion.* Pilocarpine, instilled daily into the eyes in very small doses, is also often of decided benefit.

Disease of the frontal sinuses or of the ethmoidal cells may be a cause of persistent headache, with inability to use the eyes in near work. Sensitiveness to pressure made against the roof and inner side of the orbit, especially in the region of the pulley of the superior oblique muscle, has been noted by Ewing as a diagnostic sign of this condition (Transactions of the American Ophthalmological Society, 1900).

*E. Dyer: Trans. Am. Ophthal. Society, 1865.

A special type of ocular hyperæsthesia has been described by Förster, and named by him *kopiopsa* hysterica*. This affection stands in close relation to parametritis, and is generally rebellious to all therapeutic measures directed to the eyes; its course is extremely tedious, but recovery generally takes place when the pelvic disease has been arrested or has run its course.

Muscular Asthenopia.—As in hypermetropia, with accurate convergence, the accommodation is forced to perform its work at a disadvantage, so in myopia the relaxation of the accommodation in near vision may give rise to conditions unfavorable to the perfect and easy exercise of the convergence. As a consequence of the close physiological connection between the two adjustments, the voluntary effort to accommodate tends to evoke a corresponding degree of convergence, and the effort to converge tends to evoke a corresponding degree of accommodation. In hypermetropia, as has been already stated, either the convergence may be accurately adjusted for single vision with the two eyes, in which case the relative accommodation may be insufficient for continuous distinct vision at the distance of the point of intersection of the visual axes, or the accommodation may be exerted to the degree necessary to admit of distinct vision, and the correlated excessive impulse to converge may lead to crossing of the eyes. So in myopia, normal convergence may be associated with useless or harmful tension of the accommodation, or the relaxation of the accommodation in near vision may be associated with insufficient tension of the recti interni muscles, thus necessitating a special voluntary effort to maintain single vision with the two eyes and so leading to muscular fatigue, or, in default of this special exertion, permitting one of the eyes to diverge (relatively or actually), with sacrifice of binocular vision.

Fatigue of the recti interni muscles is mentioned by Scarpa (1801) as an occasional cause of asthenopic symptoms, and it was at one time the fashion to invoke disordered action of the external muscles of the eyeball as the principal cause, and to extol the division of one or another of these muscles as the principal remedy in asthenopia generally. But the recognition of muscular asthenopia, as a distinct type, became possible only after correct views had come to be held regarding the nature and mechanism of accommodation; and its connection with myopia was revealed only in connection with the exhaustive study, by Donders, of the accommodation in its relation to the errors of refraction.

Muscular asthenopia is a direct result of the persistence of the physiological connection between accommodation and convergence, notwithstanding the displacement of the farthest point of distinct vision (r) in the myopic eye. If, for example, we assume a myopia of four dioptries, the far point will be only one-fourth of a metre (about ten English inches) from the eye, and this will be the greatest distance at which fine print can be distinctly seen under full relaxation of the accommodation. But full relaxation of the accommodation is, under normal conditions, associated with full relaxation of the convergence, whereas the requirements of single vision demand a convergence of four *metre angles.*† The relation normally existing between accommodation and convergence must therefore needs be materially altered in order to admit of distinct binocular vision at or near the far point; and such altered relation is, in fact, observed in the greater number of cases. But myopia is, as a rule, an acquired affection, and is often of rapid development, in which case the necessary adaptation may fail to keep pace with the change of place of the far point, and thus a state of conflict between accommodation and convergence may arise. In this conflict the convergence is oftenest the victor, for the reason that double vision, when first developed, gives rise to very great confusion of sight, while excessive accommodation may, in a young person, involve no particular inconvenience other than the necessity of holding the book or work nearer to the eyes. In other cases, however, the habit is formed of relaxing the accommodation in order to see distinctly at or near the far point, and a special effort of the will may then be required to effect the necessary convergence. The fatigue which attends this effort to maintain the convergence, simultaneously with relaxation of the accommodation, constitutes muscular asthenopia.*

Regarding the curability of asthenopia opposite views have prevailed at different times. Until the dependence of accommodative asthenopia upon hypermetropia had been demonstrated by Donders, it was generally believed to be curable, at least in certain cases, and the means adopted were such as we now recognize as tending to bring about a state of improved co-ordination between accommodation and convergence, namely, the use of convex glasses of the least power compatible with the comfortable use of the eyes, which glasses were afterward to be exchanged for progressively weaker glasses, in the hope of being able ultimately to dispense with them altogether. That this plan of treatment was not altogether irrational is evident from the experience of the very large number of young hypermetropes who are able to use their eyes freely in prolonged near work, a fact entirely in accordance with the observation of Donders, that, with parallel visual axes and also under moderate convergence, the hypermetropic eye ordinarily brings into use much more of its accommodation than does the emmetropic eye under like conditions. Moreover, it is not uncommon for asthenopic symptoms, occurring in connection with hypermetropia of moderate grade, to disappear after a few weeks or months of relief from strain afforded by the use of weak convex glasses in reading and study. In these cases the glasses give great relief when first worn, but after a time the need of them comes to be less urgently felt, so that the child begins to do without them, and at last forgets to use them at all. But these cures, however satisfactory they may be for the time being, are apt to be followed by relapses, which, again, may yield to a new course of treatment by glasses, until, with increasing age and the accompanying restriction of the range of accommodation, the habitual use of convex glasses becomes imperative.

Asthenopia may be treated also by acting directly upon the accommodation by the methodical use of myotics. In his original study of the action of Calabar bean, Donders observed that the range of accommodation is positively increased after the instillation of this drug, and that this increase, which is greatest after about two hours, diminishes rather slowly. He observed, also, a material increase in the accommodation as related to the conver-

*From κοπιάω, to become weary, and ὄψι, eye.

†*Metre angle*, a name proposed by Nagel to designate the unit of convergence corresponding to one dioptrie of accommodation. In convergence for a point 3, 2, 1, ⅓, ⅓, ¼, etc., metres distant, the convergence is said to be of ⅓, ½, 1, 2, 3, 4, etc., metre angles, and the accommodation (in emmetropia) is similarly of ⅓, ½, 1, 2, 3, 4, etc., dioptries.

*The conditions which determine the development of asthenopia may be stated in a general form as follows:

In the normal condition of the eyes (emmetropia), under an exercise of the accommodation equal to n dioptries, each eye is adjusted for distinct vision at a distance of $\frac{1}{n}$ metre, and with this accommodation of n dioptries there is associated a degree of convergence equal to n metre angles; the visual axes intersect, therefore, at the exact distance ($\frac{1}{n}$ metre) for which the two eyes are severally accommodated, and the two adjustments are performed in perfect harmony.

In hypermetropia a given exercise of the accommodation, say of h dioptries, is required for distinct vision at a distance, at the same time that the convergence is relaxed to zero (parallelism of the visual axes), so that for vision at the distance of $\frac{1}{n}$ metre a degree of convergence equal to n metre angles must be associated with an exercise of the accommodation equal to $n + h$ dioptries; the relatively excessive demand thus made upon the accommodation may be attended with fatigue from relative insufficiency of the accommodation (*accommodative asthenopia*).

In myopia, say of m dioptries, distinct vision at a distance is impossible, and for vision at a distance (within the limits of the region of accommodation) of $\frac{1}{n}$ metre from the eye, an exercise of the accommodation equal to $n - m$ dioptries must be associated with a convergence of n metre angles; the relatively excessive demand thus made upon the convergence may be attended with fatigue from relative insufficiency of the recti interni muscles (*muscular asthenopia*).