

still they can also act independently of each other to a certain extent. At the far point the accommodation can be exerted in excess of the convergence, and at the near point the convergence can be used in excess of the accommodation, so that in minor defects of the refraction the strain of employing one function in excess of the other is not felt. This will be better understood when hyperopia and myopia have been studied. That these two functions can be exerted independently can be proved in this way. Look at an object situate 20 feet away and hold in front of the eyes a pair of concave lenses, say 2D. The object will still be seen, because 2D of accommodation is brought into action, while the object is seen singly, which would not be the case if convergence were also exerted, as then double vision would be caused, and two objects seen instead of one, nor would the object be seen at all through the concave lenses unless accommodation equal to their strength were employed.

In the same way it can be proved that convergence can be exerted without accommodation, by looking at a distant object through a pair of prisms, say, 2° bases out placed in front of the eyes. To counteract the deviation caused by the prisms convergence is exerted, while accommodation is completely at rest.

Or at the near point similar tests can be employed by reading print through convex lenses which prevent the employment of accommodation, and through prisms bases in, which prevent the employment of convergence; or by looking through concave lenses which cause more accommodation to be exerted and through prisms bases out which cause more convergence to be employed.

Although these tests prove that one function can be used without the other, still it is contrary to nature, and therefore unpleasant, if not painful. When looking at a distance through concave glasses the eyes soon feel strained (if they be not myopic), but this can be relieved by using also prisms bases out. The latter cause convergence to be exerted, and then the two functions being equally employed no strain is felt. So also, when an object at the close point is looked at through convex lenses of sufficient strength to prevent the use of accommodation, the eyes shortly feel quite painful; but if prisms bases in be also used, these, preventing the use of convergence, also remove the painful symptoms.

It is of the utmost importance that the co-ordinate action of accommodation and convergence be thoroughly understood, as the proper fitting of glasses can never be achieved without it. It is the want of this harmony that is the cause of the painful symptoms in uncorrected or improperly corrected errors of refraction and accommodation, and next to the improvement of vision, and very often in preference, the most important thing is to obtain as nearly as possible harmonious working of the two sets of muscles.

The relative convergence is the amount that can be exerted with any given quantity of accommodation. It can be found by directing the eyes to a certain point, say, 20 inches. At this point 2D of accommodation is employed. Then find the strongest prisms, bases out, through which a single object is still visible. The deviation of the eyes to overcome the prismatic power can be calculated in MA.

The relative accommodation is the amount that can be exerted with any given quantity of convergence. It can be found by directing the eyes to a certain point, say, 20 inches. At this point 2MA of convergence is employed. Then find the strongest concave lenses through which the object can still be seen. The numbers of D of these lenses must be added to 2D, which is the accommodation that must anyhow be exerted to see the object at 20 inches.

The nearer the point the greater the relative convergence and the smaller the relative accommodation. The more distant the point the smaller the relative convergence, and the greater the relative accommodation.

Binocular accommodation is that of the two eyes together.

Absolute accommodation is that which each eye can exert separately.

The latter is greater than the former, as then convergence to a nearer point can be exerted, and so more accommodation. The former is, however, greater than the latter, if convergence to a nearer point be prevented.

If the two eyes be directed to an object 20 feet away the absolute accommodation can be ascertained by finding the strongest concave glass through which each eye separately can see it. The binocular accommodation will be that which can overcome the strongest concave lenses held in front of the two eyes. There will be found a difference of from one to two diopters, the absolute accommodation being greater to that extent, because when the one eye is covered over, binocular vision not being necessary, convergence is brought into play, so that more accommodation can be exerted; while, when the two eyes are together directed to the object, this being at infinity, binocular vision is necessary, and no convergence can be exerted, and, therefore, not so much accommodation.

From the foregoing it will be seen that in order to exert accommodation to its fullest extent convergence must also be used; this is a most important fact. Also if it be understood that the employment of the one function brings about the exertion of the other this will immediately explain convergent squint, and the reason why in hyperopia stronger convex lenses are accepted by the two eyes together than by each separately.

The co-ordination between accommodation and convergence is more conserved in some eyes than in others. When there is an error of refraction the link be-

tween the two must be, to a certain extent, severed. In slight defects this is fairly easily achieved, and in the deeper ones, if it be effected, there is a more painful condition than when the intimate connection is kept up.

A watchmaker who uses a 10D lens constantly for viewing objects 4 inches from the eyes sees without accommodating, and, as one eye only is employed, he also uses no convergence. He, therefore, suffers no pain or inconvenience; but, if he were to use a pair of spectacles of that same strength, as he would then be using convergence without accommodation, he would not be able to keep them on five minutes together.

As I have before stated, when there is an error of refraction, the harmony is disturbed, and in Hyperopia (symbol H) accommodation is used in excess of convergence, and in Myopia (symbol M) convergence is used in excess of accommodation.

The following table gives the quantity of accommodation and convergence employed at various distances in emmetropia, in H of 1D, and in M of 1D.

Distance Inches.	Distance Cm.	MA of Con. employed.	Diopters of Ac. employed.	H of 1D	M of 1D
∞	∞	Nil	Nil	1.00	Nil
160	400	0.25	0.25	1.25	Nil
80	200	0.50	0.50	1.50	Nil
40	100	1.00	1.00	2.00	Nil
30	75	1.50	1.50	2.50	0.50
20	50	2.00	2.00	3.00	1.00
16	40	2.50	2.50	3.50	1.50
13	33	3.00	3.00	4.00	2.00
10	25	4.00	4.00	5.00	3.00
8	20	5.00	5.00	6.00	4.00
6	15	6.50	6.50	7.50	5.50
5	12.5	8.00	8.00	9.00	7.00
4	10	10.00	10.00	11.00	9.00

Note that for every D of H one diopter more of accommodation must be employed at any certain distance, and for every D of M one diopter less.

Although acting independently there is also an intimate connection between the action of the ciliary and that of the iris. When the sphincter of the former contracts the sphincter of the latter contracts also, so that when the crystalline lens is accommodated by the contraction of the sphincter muscle of the ciliary, the pupil is made small by the contraction of the sphincter muscle of the iris.

The utility of small pupils when the eyes are adjusted for reading will be found by referring to "Spherical Aberration."

When the pupils are small defects of refraction are modified. In testing when one eye is covered over, the pupil will sometimes dilate because the light is excluded from it, and will cause a similar dilation in the uncovered eye; so that the sight is found rather more defective, which, perhaps, is not a disadvantage in testing. This seemingly contradicts what I have just stated regarding the pupil being smaller when the eye is accommodated, and as to more accommodation being exerted when the one eye is covered over. Both are true, and the former will apply in some cases and the latter in others, or perhaps the one will counteract the other, and the pupil remain stationary as to size.