Binocular astigmatism / [by H. Culbertson].

BINOCULAR ASTIGMATISM.

Reprinted from the "Journal of the American Medical Association," November 3, 1888.

I have not infrequently encountered cases of astigmatism in which, after having corrected the error in each eye separately, and on testing both eyes simultaneously, in binocular vision, have found that vision proximum was not perfect, and in order to attain normal vision near at hand, in binocular sight, the angle denoting the axis of the cylindrical glass must be changed in one or both eyes.

In correcting this binocular defect, types and the astigmatic bars were employed. If the patient looks upon the floor it will seem to incline to the right or left, and on changing the axis of one or both cylinders, the surface will appear level. But the same defect will be apparent if a board 12 x 3 inches, with parallel sides, be held in front of the patient at one metre, and on a level with the eyes.

In these cases then, the answer will be, that the right or left end of said "object-board" is wider than the other. The angle of one or both cylinders is changed until each end of the "object-board" seems equally wide, or in other words, the sides are parallel; and then it will be found that the astigmatic bars are seen normally in near or far vision, in binocular vision. All of my refraction cases are estimated, not only by the usual methods, but the test as given is applied to all

cases of astigmatism before the investigation is regarded as complete.

The use of glasses thus adapted has been successful in practice, with one or two exceptions, and in these the use of cylinders had to be dispensed with and spherical glasses employed.

This defect in binocular vision does not occur, of course, in all cases of astigmatism; but observation has taught me that such errors are far from being uncommon.

The following explanation offered of binocular astigmatism, seems more rational than any other with which I am familiar:

If a perpendicular be raised anteriorly and horizontally midway between the eyes from a base line intersecting each *fovea centralis*; then, in testing each astigmatic eye separately, the *axis of vision* will, in *vision remotum*, be parallel to said perpendicular. If the ocular muscles are normally balanced in action, the plane which cuts the visual axis in the cornea will be vertical. In the normal eye, *its fellow being covered*, during vision proximum, *still* the visual axis may be parallel to our perpendicular, and hence the angle of the axis of the cylindrical glass may often be the same in remote and near vision, *when each eye is tested singly*. In binocular vision, when astigmatism is present, the distance is so great, in remote vision, that the visual axes are each parallel to our perpendicular and to each other, and when the ocular muscles are harmonious in action, types and astigmatic bars are seen in normal form. So will vision be perfect near at hand, in astigmatism, provided this due balance is maintained in these muscles; but it is evident that, in proximal vision, the interni inferior oblique and superior and inferior recti muscles must exercise increased force and act in concert.

If these muscles do this, there can be no binocular astigmatism (in the sense cited) which requires re-correction, after each eye has been separately corrected, and *in vision near at hand.* But if these muscles are not harmonious, then the plane of the rays of light remaining the same, that is, vertical, and the *axis* of *rotation* of the eye at its upper extremity, inclining to the right or left, then it follows that the relation of the axis of the cylinder and the astigmatic meridian of the cornea has been changed, and in order to restore this relation the axis of the cylinder must be made to correspond with the modified position of the defective corneal meridian.

Let the following case illustrate: In binocular and proximal vision, suppose the left inferior oblique fails to act sufficiently to maintain the axis of rotation vertical, and that the inner fibres of the left superior rectus inclines said axis, at its upper extremity, towards the nose; then the rays of light will no longer cut the cornea in its vertical meridian, but towards the temporal side of—the should-be—vertical plane of the cornea. If the defective axis of the cylinder was at an angle of 180° in vision remotum, for proximal vision the axis of the glass will have to be turned upward towards the displaced axis of rotation of the eyeball, as many degrees as *this* axis has deviated from the normal vertical perpendicular. If to 10°, then the angle would be 10° instead of 180° for the cylinder, the scale running from the temporal side. In other words, the measure of the deviation of the axis of rotation is the number of degrees of axis-displacement of the cylinder required in order to cause both sides of our "object-board" to appear parallel.

By trial the proper degree is found and in which

2.75 ax. 75°, V. R. E.=$\frac{4}{9}$, and with + 3.5 ax. 90° V. L. E.=$\frac{4}{9}$; V. 2—$\frac{4}{9}$, and $\frac{8}{30}$. But the "object-board" was not seen parallel at one metre. On turning the left cylinder axis to 105°, binocular vision, near and far, became normal so far as glasses could accomplish, and these continued to serve him well.

Case 7.—Mr. F. G., aged 27 years, under duboisine requires R. E. + 1.25 ax. 180°, V. = $\frac{4}{4}$, and in L. E. + 0.5 ax. 180°, V.=$\frac{4}{4}$. But V. 2. while =$\frac{4}{4}$, reveals the sides of the "object-board" not parallel. On turning the axis of the right cylinder to 30° the "object-board" is seen normally and V. 2,=$\frac{4}{4}$ and $\frac{6}{30}$ D.

Case 8.—Mr. L. I., aged 19 years, without duboisine the angle for each eye was 90°, but when under this mydriatic he required in R. E.+3.5 ax. 70°, V. = $\frac{4}{2\,4}$, and the same cylinder in L. E. at 100° V. = $\frac{4}{2\,4}$. The bars and types were seen normally, V. 2, = $\frac{4}{2\,4}$ and $\frac{8}{20}$. These glasses were given and failed to give proper vision. He was given + 3.5 ax. 90° for each eye, and binocular far and near vision became normal. He was not brought under mydriatic at the second application. It is certain that this patient under the mydriatics saw in binocular vision normally, but after accommodation was fully restored vision was abnormal in each eye with the first glasses, and to secure binocular far and near vision each cylinder was changed to 90°. This result may be due to the stimulus of accommodation exciting through the filaments of the third nerve, the superior recti in each eye. It is true that with the cylinders at 90° in each eye vision remotum of the bars and types was normal. This can only be accounted for on the supposition that, *even in remote vision*, there must have been present accommodation. It is also true in this case that this ametrope devel-

oped = D. 4.5. Astigmatic hyperopia in each eye under duboisine, but accepted only a + 3.5 cylinder when the effects of the mydriatic had passed off. He, therefore, was exercising = + D. 1.0 of accommodation for distant vision, and it is probable this would stimulate the superior recti sufficiently to change the axis of rotation in binocular remote vision to 90° each eye. This man's unaided near point was 19 cm. = D., 5.3, and as he had = 4.5 D. of hyperopia, his accommodation was = + 4.5 + 5.3 = + 9.8 D., which is equal to what he should have had at 20 years of age. In correcting + 3.5 of this astigmatism he would possess an excess of accommodation = 9.8 —3.5 = 6.3 D., in proximal vision.

Case 9.—Miss M. C., aged 30 years. Without duboisine and with — 1.0 ⌒ — 0.75 ax. 25°, V. R. E. = $\frac{4}{4}$, and with — 1.25 ⌒ — 0.75 ax. 150°, V. L. E. = $\frac{4}{4}$, V. 2, = $\frac{4}{4}$. In binocular vision at one metre the right cylinder gave only normal vision when the axis was turned to 180° or 0°, or horizontally. Then the floor was also level, the bars alike, and types seen normally in far and near vision. After the effects of the mydriatic had passed off these results held good.

Case 10.—Miss A. B., aged 23 years. Without mydriatic and with — 0.5 ⌒ + 0.25 ax. 180°, V. R. E. = $\frac{4}{5}$, and with — 1.75 ⌒ — 1.75 ax. 180°, V. L. E. = $\frac{4}{6}$ and V., 2, = $\frac{4}{5}$ and $\frac{6}{30}$ D. On using duboisine the formula became—0.25 ax. 145°, and V. R. E. = $\frac{4}{5}$ and $\frac{6}{28}$; and — 1.0 ⌒ — 1.25 ax. 180°, V. L. E. = $\frac{4}{5}$ and $\frac{6}{28}$, and V., 2, = $\frac{4}{4}$ and $\frac{6}{28}$. Now the "object-board" sides were parallel, the floor level, and the bars normal; but the tests for binocular vision were not normal when the axis of the right cylinder was placed at 180°. These glasses held good subsequently.

It may be claimed that the foregoing results are

due to our not having found the correct axis in the monocular tests of each eye. This assumption would be untenable, because every care was taken in correcting each eye singly, both in far and near vision; but on attempting binocular vision, especially at one metre, or less, distance from the ametrope, the sides of the "object-board" were not seen parallel, nor the floor level. When the axis of one or both cylinders were changed, then, and then only, binocular vision-tests became normal. But in these cases the axes of the cylinders did not correspond.

The explanation given may not be the true solution, and accommodation may have a direct influence in the result, by changing the form of individual sectors of the crystalline lens, but the fact remains that there is such a phenomenon as *binocular astigmatism.*

If, in calling your attention to this subject, I shall induce any to investigate it, and possibly determine the true solution, I shall rest content with the result.

Zanesville, O., May 7, 1888.