tic arrangement of the optic nerve fibers, for the absence of any visible scleral perforations serving for the ingress of the nerve fiber bundles, and, in part, for the characteristic findings of the blind spot.

The nearest approaches to the description of the particular cleft of the nerve head treated of herein that I have found in the literature, are those of de Wecker, Stood, Nuël and Elschnig, though none of them conforms precisely to it. The nearest approximation as regards the papilla alone is the case of Nuël, but here there existed also high myopia and a plaque of bared sclera, outward, several times the size of the normal disc. Taking it all in all, Elschnig's case, which he examined anatomically as well as ophthalmoscopically, tallies most closely, though the ophthalmoscopic findings were considerably at variance with the cases here cited. Stood's second case is, to a degree, along this line, but here the temporal cleft was incomplete, as regarded the optic-nerve fibers, and a deep pit of ectasia occupied its floor and into which two retinal vessels dipped and disappeared, to emerge again on the other side.

Fuchs refers to a singular anomaly of the papilla, consisting in the presence of a small, temporal conus, and a white membrane covering the vessels over the greater part of the disc. He had seen three cases and cites another of Hirschberg.

I take it that the conditions presented by the fundi now brought to your notice have an important pathologic significance. This relates mainly to the accompanying imperfections of the choroid, as exemplified in its limited capillary system, its irregular pigmentation, diminution of the peripheral light sense, and general lack of blood supply. Its early recognition might redound to the great benefit of the possessor of such a fundus, for by one might hope for the possible prevention or amelioration of diseases arising through slow sclerosis of the choroidal vessels and other degenerative changes in the choroid, such as glaucoma simplex, true inflammatory glaucoma with high intra-ocular tension, and grave secondary degeneration of the retina. This would be accompanied, of course, by proper attention to the general physical condition, to the correction of errors of refraction, and, most important of all, to the regulation of the eye work in general.

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DISCUSSION.

DR. G. E. DE SCHWEINITZ, Philadelphia, said that when one examines the fundus of the eye with the aid of Dr. Beard's intelligent observations, one becomes familiar with appear-

ances which, while they may have been seen before, were never properly appreciated or interpreted. Dr. de Schweinitz considers that the temporal cleft of the nervehead, which Dr. Beard has called the "morning glory," should be called "Beard's nervehead." In some recent investigations Dr. de Schweinitz has been struck with the frequency of various anomalies, in the nervehead, of the retinal circulation and of the fundus of the eye generally in the so-called degenerate types. This has recently been the subject of an important series of observations in France, and the conclusion has been reached that there is nothing in the eye itself, so far as functional examination reveals, indicative of the degenerate type. Dr. de Schweinitz does not believe, however, that the end of this matter is yet at hand and thinks that the subject demands more elaborate investigation. If Dr. Beard's investigations are correct, we should all endeavor to recognize the conditions which he has described, because they may give indications for treatment which will prevent later ocular calamities.

DR. EDWARD J. BROWN, Minneapolis, said that during the past year and a half he has carefully examined all refraction cases with reference to the ophthalmoscopic appearance of the disc. Of the first 160 cases 39 presented greater or less temporal concavity of the disc, not confined to the center, and of these 3 or 4 presented the appearance described by Dr. Beard in sufficient degree to attract attention, 2 of them being decidedly pronounced. Of the 39 cases only 4 had perfect fields, the others presenting peripheral defects ranging from 10 to 30 degrees. Dr. Brown's attention was especially called to these cases by the paper published by Professor Schoen of Leipzig in the *Ophthalmic Record* of October, 1902, presenting evidence that the so-called "physiologic excavation" of the optic disc is pathologic in character. Dr. Brown's observations suggest that concavity of the disc, not confined to the center, may at least indicate that such eyes belong to a class especially liable to be the subjects of glaucoma.

DR. CHARLES H. BEARD, in replying to a question, stated that he had never found this cleft in conjunction with any fissures or openings indicative of imperfect closure of fetal clefts. With colobomata involving the nervehead one often sees microphthalmos and other deformities. The nearest he has found with these are nystagmus and strabismus. Where anisometropia exists, as Dr. de Schweinitz suggests, it is the eye that has the cleft which has the higher degrees of refractive error, i. e., where the defect is monolateral. At a joint meeting of the Chicago Ophthalmological and Chicago Medical societies, Dr. Beard in April last brought out the point in connection with the "powder grain" fundus and thin attenuated choroid; these cases are particularly liable to have wide physiologic excavations. In all those cases there is diminished peripheral light sense, and they are truly pathologic cases. Dr. Beard has found that these cases average up intellectually as well as any he has ever seen.

DEVELOPMENT OF THE FACULTY OF BINOCULAR FUSION.*

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The fusion faculty, which controls the ocular movements in the interest of binocular vision, is one of the most delicate and exact, yet one of the most constant and rigid co-ordinations that the human being acquires. That it is not commonly possessed at birth seems to be well established by the agreement of all careful observers. That it is normally developed in early childhood, and only during early childhood, is equally certain. Persistent intelligent efforts have failed to give any indication of its acquirement in adult life. I believe it is well established generally before the age of 2 years, and practically always before 6. The earlier age is that

* Read in the Section on Ophthalmology of the American Medical Association, at the Fifty-fifth Annual Session, June, 1904.

of normal development; the later is the limit of delayed or obstructed development, beyond which its appearance or development is impossible.

Although development of the fusion faculty occurs after birth, it is, I believe, determined essentially by congenital tendency. It is a race characteristic, and is not a result of the reaction of the individual to environment. It develops, as do the sex characteristics and organs, in obedience to inherited impulse; not like the power of reading or writing through conscious effort or training. There is not very much evidence on this point, yet what there is is fairly conclusive.

Take, for instance, the case reported by J. L. Minor to the American Ophthalmological Society in 1898, of a man operated on for congenital cataract at the age of 40. After one cataract had been removed the patient was still able to judge distance better with both eyes shut than he could by the sight of one eye. The other cataract was removed, and ten days later, when he was first allowed to use the two eyes together, tests with prisms and stereoscopic figures showed complete binocular vision. Two days after that when his eyes were again unbandaged he could judge distance accurately with both eyes open, but he usually missed when either was closed. His power of overcoming prisms was still comparatively feeble.

The very rapid acquirement of the power of binocular fusion from a few brief lessons with the amblyoscope reported by Worth and others, and which I also have witnessed, seems inexplicable except on the supposition that the fusion faculty has spontaneously become well-developed, although the patient, on account of some obstacle, has never learned to control or use it. Thus in the first of Worth's illustrative cases "fusion training" was given on five different days within a period of two weeks. On the fourth occasion it is noted: "The child has considerable amplitude of fusion." After the fifth seance, the eyes remain straight with glasses. Where the fusion sense has been established and the squint continues, Worth speaks of the repetition of fusion training once a month as being quite sufficient to keep up the fusion faculty until operation is permitted.

Evidently our most advanced treatment of squint today simply removes obstacles such as inequality of vision in the two eyes, or errors of refraction and the abnormal innervation they entail, or demonstrates to the child the existence of the fusion faculty that has already developed. But there are rare cases in which, without any apparent obstacle, no trace of binocular fusion seems to develop. In these cases without any serious error in refraction, with perfect vision in each eye, and no deviation of the visual axes, there still exists independence of function in the two eyes. They have no power of stereoscopic vision and no binocular diplopia can be provoked. There are also cases of alternating squint which are precisely similar to the above, except that the movements of the two eyes are co-ordinated to excessive convergence or divergence.

In a still larger class of cases a feeble faculty of binocular fusion or some rudiment of such a faculty is discernible; but it is not capable of overcoming even slight obstacles. The bulk of uncured convergent, like the neuropathic divergent squints of Worth, belong to this class. In the management of those cases must lie our chief opportunity for added future success in the treatment of squint. We now have instruments, the amblyoscope, the fusion tubes, and the stereoscope, with which we can in ten minute exercises demonstrate to the child

the existence of the fusion faculty when it has already developed, but which he has heretofore left unused. These instruments, however, are not adapted to help in the continuous exercise of a fusion faculty which beside being unused, is really undeveloped.

In seeking an instrument that would aid us in the actual development of the fusion faculty, I have worked out one by which the patient can employ his binocular vision, such as he may possess, not only on a few specially prepared objects or slides, but on all objects that he looks at and continuously, even while there remains actual squint of any degree. The matter can be best presented by an explanation of the instrument.

In viewing the reflection of objects in a mirror there appears a lateral reversal of relative positions. If this reflection is reflected from another mirror the second reversal gives the objects their normal relative position. If the two mirrors are parallel, each object seen is seen after double reflection in its true direction. By inclining the surfaces of the mirrors to a certain angle each object seen through them appears displaced to double that angle. When, as in squint, the visual axis of the fixing eye is directed toward one point, that of the deviating eye is directed toward another. But by causing one or both eyes to look at such double reflections as are furnished by plane mirrors inclined to the proper angle

it is easy to present the same object to the visual axis of both the squinting and the fixing eye. The accompanying diagram illustrates the effect of changing the direction of one of the mirrors.

The solid lines represent the mirrors M and N as parallel and the eye as receiving the ray L parallel to its original direction. The broken lines represent M inclined as for a convergent squint, the altered direction of the ray after its second reflection, and the way it would be received by the converging eye. By varying the angle of the mirror M, the reflected ray can be given any direction required for even the highest degree of squint.

The instrument can be used for the same purposes as the amblyoscope or an adjustable stereoscope, with slides prepared as for the stereoscope. But it can also be used in looking at any object near or distant, to produce any modification of direction required in the interest of binocular fusion. If there be present a rudiment of this faculty, even with a high degree of squint, the mirror can be set at such an angle as to constantly stimulate the exercise of fusion. By varying the inclination of the mirror M, the patient can be induced to increase or diminish his convergence, and thus exercise his power of maintaining fusion.

For an instrument not to be worn by the patient the greatest simplicity is attained by arranging it to be used

before one eye only, the other being left free as in ordinary vision. The instrument swings either way on the upright that supports it so, that it can be used equally well for the right or the left eye. The arc can be graduated to show just how much convergence and divergence the position of the mirror represents. The reflection from two mirrors somewhat lessens the visibility of objects viewed by means of them; hence, the mirrors should ordinarily be placed before the non-deviating eye. To bring down the vision to an equality with that of the deviating eye, a series of smoked glasses of different shades are also furnished. These can be slipped in front of the opening, in the clip for this purpose.

With the width between the eyes, the degree of squint, and the difference in visual acuteness exactly known we can, in any given case, construct a binocular instrument very much smaller than this, which can be attached to a head band and worn continuously. With such an apparatus all the child's seeing for hours, or throughout the day, should be done under conditions that bring the two images of a given point on corresponding points of the two retinas.

I believe that with such an application of this principle of double reflection we will be able to bring about the development of fusion faculty in some cases in which such development would not otherwise occur. With the fusion faculty once fairly developed the complete cure of comitant squint becomes possible.

DISCUSSION.

DR. WENDELL REBER, Philadelphia, declared that there are three essentially different methods of regarding the eye: First, as an optical instrument contrived to form a perfect image, every focal point of which shall correspond with a radiant point in the object viewed; second, the retinal structure, and especially its bacillary layer; third, the still more wonderful correspondence of the two retinas, point for point, and of their representatives in space, point for point. Dr. Reber said that in the study of methods for the training of the fusion faculty, the question of the evolution of binocular vision is the primary consideration. It is a bewildering complex co-ordination, gradually acquired like walking or talking. The most rational method of studying this subject would seem to be in adults who, because of complete congenital cataract, have grown to maturity without seeing, and then had both eyes successfully operated on. Several such cases have been reported from time to time. One case recorded by Trombetta four or five years ago was that of a girl of 10 years, who had both eyes successfully operated on by Guaita, the eminent Italian ophthalmologist. Trombetta took charge of the young girl and in 45 lessons he succeeded not only in teaching the child to see without the sense of touch, but in obtaining satisfactory binocular vision. Before the twenty-fifth lesson, when the child's attention was directed to a nearly bright object, one eye would fix and the other wander up and out and oscillate. In the course of this lesson it was discovered that the child's vision had become stereoscopic. Dr. Reber said that in the case of the 40-year-old man quoted by Dr. Jackson, the question arises whether some sort of crude binocular vision did not develop and flourish before the man became entirely blind from the congenital cataract. If so, it would, of course, be a relatively easy matter for him to regain the faculty of stereoscopic vision when both retinas had been restored to their functions. This rousing of the faculty of attention and its close relation to the act of convergence, Dr. Reber considers, is closely bound up with the development of binocular vision. Le Conte shows that perception of the third dimension proceeds largely from an almost imperceptibly rapid exercise of the faculty of convergence. This fact, along with the psychologist's "mental faculty of attention," seems to form the basis for correct visual judgments. Whether the complex array of acts in binocular vision are or are not represented in the

cerebral cortex by a special center is still *sub judice*. That a fusion faculty exists is beyond all doubt. Functional strabismus shows that the higher centers have abandoned the task of making the retinas correspond point for point, and must, therefore, be viewed as a species of atavism. The small globes and short interocular base line in little children, assisted by the excessive accommodation, will account for the turning in of the eyes rather than the turning out as would be expected. In constructing mechanical devices for the training of the fusion faculty one thing is axiomatic: that is, they should be simple and, if possible, so devised that they may be used several hours each day. The instrument here offered by Dr. Jackson is beautifully simple and if, as he states, it can be made small enough to be worn with a headband for several hours a day, it would seem to approach very closely to the ideal device for the development or restoration of stereoscopic vision. Priestley Smith's fusion tubes, one of which the child would take in each hand, represents the acme of simplicity. But as the child's visual axes are crossed, the tubes got in each other's way, and Mr. Worth happily thought of the reflecting tube and built his amblyoscope which has proved so efficient in selected cases. At no time should apparent parallelism of the visual axis be accepted as proof positive that the patient has been restored to stereoscopic vision. Some test for stereoscopic vision should invariably be resorted to as a final test, such as Hering's box, which is easily made and is quite as reliable as any.

DR. EDWARD JACKSON stated that the case cited by Dr. Reber is certainly nearer the experience of most cases of the sort that have been reported than is Minor's case. His case is a very exceptional one in the rapidity with which binocular vision was demonstrated after the second eye had been operated on. It was a remarkable patient; a patient who had remarkable powers of co-ordination for an absolutely blind person. The best illustration we have that binocular vision is developed sufficiently to go right into use after some obstacle is removed is the vision that children often get after the correction of a high error of refraction. Many of them will quickly or in a few days respond to the tests of full binocular vision. That is the basis for the assumption that binocular vision may develop to a high degree without having been exercised. The obstacle being removed binocular vision becomes possible. While the child undoubtedly acquires something in this short time, it does not acquire the complete nerve connections necessary for binocular vision. There is something there ready to be used as soon as the child acquires the knack.

DAIRY HYGIENE.

WITH SPECIAL REFERENCE TO THE LIMITATION OF BOVINE TUBERCULOSIS.*

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While perhaps it is impossible to be absolutely sure of the truth of any general statement, of which from its nature complete proof is unobtainable, we are justified, I think, in assuming that the statement that wild cattle are entirely free from tuberculosis is true. We are told that the native (Criollo) cattle of the Argentine are now and always have been free from tuberculosis. The appearance of the disease dates from the time when pure-blooded cattle were introduced into that country for breeding purposes. So it has been asserted that the native cattle of the Jura mountains and other places are, and always have been free from tuberculosis. So far as known, no animal running wild and eating the food that nature intended, has ever been tuberculous; and yet the disease is to-day the most common and most

* Read in the Section on Hygiene and Sanitary Science of the American Medical Association, at the Fifty-fifth Annual Session, June, 1904.