acquisition of knowledge of the past and new arrangements and adaptations to meet the requirements of a more exacting environment. The latent cells become functional, and new associational paths are formed which become, or may become, by the law of habit, just as fixed and, ontogenetically considered, as reflex, and organic as the most definite inherited reflex action and instinct.

Some such theory as the above seems to be necessary to explain the wonderful advance of modern civilization. It is certainly not explained by any one or all of the three processes mentioned above, namely, those of organic, intra-organic and germinal selection. It may however be considered as a continuation of the same fundamental process. If the organism were forced to evolve within itself, by the slow process of organic selection, all the adaptations necessary for such a civilization as we have to-day, it is obvious that after millions of years it would finally produce a world-colossus, or impossible gigantic monstrosity.

ARTHUR ALLIN.

UNIVERSITY OF COLORADO.

---

*BINOCULAR FACTORS IN MONOCULAR VISION.*

ALL experiments in monocular vision have to be made with one eye closed or covered. Some writers have maintained that binocular factors are by no means eliminated under these circumstances, but that the movements of the closed eye yield just the same sensation data as would result if the eye were opened. The following observations may aid in the solution of this problem.

If an observer closes one eye and looks steadily at an object situated in the median plane and at about the same elevation as his eyes, and then suddenly opens the eye that was closed, he will note an appearance of unrest in the object. Careful observation will show that the object seems to shift horizontally in the direction of the eye that was not closed. The shifting in apparent position becomes very noticeable when the eyes are alternately closed. The object will seem to move backward and forward in a horizontal line, always moving toward the eye that has just been closed. If the object is somewhat above the elevation of the eye there will be a vertical movement downward in addition to the horizontal. This apparent change in position may be observed best when looking at distant objects; the stars and moon show it very clearly. It is evident from these facts that the closed eye is not converged toward the same point as the open eye. At the moment of opening the eye there are double images, and these double images are crossed as is shown by the direction in which the object seems to shift. In fact, it is frequently possible to see the double images, and to note that the one which appears when the eye is open is on the opposite side from that eye, that is, crossed. The crossed images indicate that the closed eye is converged beyond the object. When looking at the stars or moon, however, in order to have crossed double images the eyes must be diverged, and the distance which appears between the images makes it evident that the divergence is considerably beyond the position of parallelism.

Helmholtz* and Le Conte† have both observed that when the muscles of the eyes are relaxed in drowsiness there is a tendency for double images, which indicates divergence of the axes, to appear. Le Conte has expressly noted that the degree of divergence is so great that the axes must be considerably beyond the parallel position. Evidently the facts observed when one eye is closed are related to those which appear in drowsiness. The closed eye tends to

* Physiol. Optik 2te Aufl., p. 633.

†Amer. Jour. of Sc. and Arts (3), ix., p. 160.

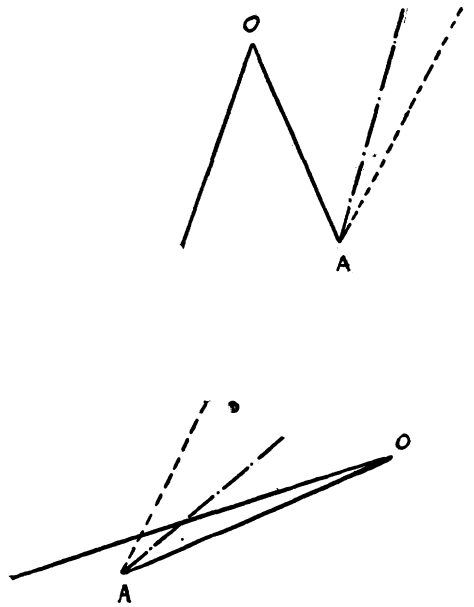
relax and in this relaxation diverges somewhat.

The observations here described have been confirmed by a number of persons. Only one case appeared in which the results were different. In this case, however, one eye is not normal in its vision and in drowsiness, as well as under the conditions discussed convergence, rather than divergence was regularly observed.

The degree of divergence is difficult to determine, as the double images last only a very short time, the convergence adapting itself very soon to the object. The phenomena described appear most strikingly in the case of very distant objects, that is, where the optical axes were at the start parallel. On the other hand, where there is an effort required in the original convergence, strong enough to give a clearly conscious impression, the closed eye does not seem to relax as much. The degree of relaxation in the closed eye seems, in general, to be inversely proportional to the degree of effort required to maintain the original convergence.

The conditions may be modified so that relaxation shall result in convergence rather than in divergence. Take an object situated so far from the median plane that the opposite eye can just see it over the root of the nose. Suppose, for example, that the object is on the right. If now the right eye be closed, while the object is fixated with the left, and then be suddenly opened, it will be observed that the double images are not crossed. This indicates that the eyes are converged to a point nearer than the object. Care must be taken in this experiment to fixate the object with the left eye. If the object is seen in indirect vision the conditions are, of course, modified.

The only inference possible from these two sets of facts is that there is some line situated between the parallel and extreme lateral positions of the optical axes towards which the closed eye tends. Le Conte has surmised: "It is probable that in a state of absolutely perfect relaxation the optic axes coincide with the axes of the eye-sockets, and it requires, therefore, some contraction to bring the optic axes to a condition of parallelism and still more to a condition of convergence, as in every voluntary act of sight."* This surmise seems to be confirmed by the facts described and by the additional fact that a certain angle can be found between the position of parallelism and the extreme lateral position at which there is no tendency for the eye to change the degree of its convergence when closed. This angle corresponds with the angle of the axes of the eye-sockets. But in any case the tendency of the closed eye to diverge is checked when the effort towards convergence is strong enough to be noticeable.




The two figures will make clear the fact. The dotted lines represent the axes of the eye-sockets towards which the eyes tend to

* Loc. cit., p. 161.

turn when closed. The mixed lines show the actual direction of the eyes when closed and at the instant of opening. The complete lines show the direction of the axes of the eyes when open. *A* represents in both cases the eye closed, *O* the object.

There is one case which offers some difficulty to this explanation; unless, indeed, it is to be regarded as an illustration of the general principle formulated above that relaxation is inversely proportional to the effort of convergence. If, as in the instance represented in the second figure, the object be far to the right, but be fixated with the right eye rather than with the left, and then the left eye be closed and opened, we should naturally expect crossed images indicating convergence beyond the object. I have sometimes found this to be the case. Sometimes, however, I have observed no double images, or even at times uncrossed double images. It would seem that in these cases the closed eye in its strained position may be converged too much. This, however, is observable only at times; the regular results are double crossed images.

So far as convergence is concerned the open eye exerts the controlling influence; its position remains unchanged. But in accommodation the relaxation of the closed eye has an important influence on the accommodation of the open eye. If an object is fixated with both eyes, and moved away to the limit of distinct vision, it will be found on closing one eye that the outlines are no longer distinct. It is, for example, impossible to read print with one eye at a distance to which it could be just clearly seen with both eyes open. The figures on the moon grow very indistinct when one eye is closed. This indistinctness may be due, in part, to the enlargement of the pupil, for the pupil of the open eye is very much enlarged in sympathy with that of the closed. But this cannot be the whole explanation. For when one eye is covered up in such a way as not to exclude the light entirely the pupil of the fixating eye is not affected as much. The outlines, however, are indistinct even in this case, showing that the accommodation of the lens has undergone a change. Whether this change in the lens is one resulting in greater or less convexity I have not succeeded in determining. The fact that a voluntary accommodation for a nearer point does not, in my case, make the object clearer, but rather the contrary, would seem to lead to the conclusion that the lens has become more convex rather than less so. Yet this does not appear to be conclusive. The main fact, however, is that there is some change in the accommodation of the lens of the open eye when one eye is closed.

The bearing of these facts on many experiments in optics will be apparent. Wundt denies complete binocular convergence when one eye is closed, while Hildebrandt and Arrer* maintained the opposite. The truth seems to be that the closed eye follows the open eye to a certain extent, and to a certain extent obeys its own tendencies of relaxation. There is a change in the size of the pupil in both eyes and a change in the accommodation of the lenses.

CHAS. H. JUDD.

WESLEYAN UNIVERSITY.

---

*A NEW NAME FOR THE NOVA SCOTIA FOX.*

IN the proceedings of the Biological Society of Washington, Vol. XI., March 16, 1897, pp. 53–55, I described the large red fox that occurs in Nova Scotia (and perhaps other parts of the Canadian and Hudsonian zones in eastern North America). Unfortunately, I used the subspecific name *vafra* that is already in use for a fossil fox —the *Canis vafer* Leidy (Ext. Mam. Faun. 1869, p. 368).

It therefore becomes necessary to re-

* 'Philosophische Studien,' XIII., p. 116 seq. Other references given in the same place.