

ART. XL.—*On our inability from the Retinal impression alone to determine which Retina is impressed*; by Prof. WILLIAM B. ROGERS.

[Read before the Am. Assoc. for the Advancement of Sci., at Newport, Aug. 1860.]

ALTHOUGH on first view it might be supposed that an impression made in either eye must necessarily be accompanied by a mental reference to the particular organ impressed, it will be seen from the following simple experiments that the impression of itself is not essentially suggestive of the special retinal surface on which it is received.

Exp. 1. Let a short tube of black pasteboard $\frac{1}{8}$ inch in diameter be fixed in a hole in the centre of a large sheet of the same material. Hold the sheet a few inches before the face of a second person and between him and a bright window, moving it to and fro until the bright circular aperture of the tube is brought directly in front of one of the eyes, suppose the left eye; and let him fix his attention upon the sky or cloud to which the tube is directed. He will feel as if the impression or image of the hole *belongs equally to both eyes* and will be unable to determine which of them really receives the light.

On moving the aperture towards the right, or nearer the nose, but not so far as to be out of the view of the left eye, or to be visible by the right, the observer will imagine that it is now in front of the right eye and chiefly seen by it. Shifting it still further in the same direction, until it is brought within view of the right eye but not fairly in front of it, it will appear as if placed before the left eye, and by an additional motion bringing it fairly in front of the right eye it will seem to be equally before both eyes or to be in the medial line between them.

Like effects may be observed by using a half sheet of rather stiff foolscap with a large pin hole in the centre. Bending this over the face and moving it until the hole is in front of one of

the eyes, the same uncertainty and contradiction will be produced as in the preceding experiment.

Exp. 2. Similar results may be obtained by rolling half a sheet of letter paper into a tube of about one inch in diameter, and holding it before and a little in advance of one eye while both are directed to a white wall some feet distant. Keeping the view *fixed* upon the wall there will be seen upon its surface a circular image of the remote aperture of the tube. This as we look intently at it will appear as if seen equally by both eyes, occupying a midway position between them. If now the eyes be converged to some point nearer than the end of the tube the circular image will appear against the side of the tube giving the impression that it is seen by the eye which is remote from the tube and is at the same time directed toward the outside. For the complete success of this experiment the wall should be only moderately bright, and but little light should fall on the exterior of the tube next the uncovered eye.

Exp. 3. Let two tubes of stiff paper each one inch in diameter and six inches long be held close to the two eyes in a converging direction so that the outer ends may touch each other. Then directing the view through them to a white wall at a short distance, the observer will see the two tubes as one, with a single circular opening clearly marked out on the wall. If now a small object as the end of the little finger be brought near and in front of one of the tubes, it will take its place within this circle and will seem to be equally an object of vision to both eyes, so that the observer will be wholly unable to decide before which eye it is actually placed.

Let the observer next direct his view to a very remote object, as the sky, seen through the window, still retaining the previous adjustment of the tubes. He will now see two circles, continuing separate as long as he keeps his eyes fixed on the distant surface; and if the finger be held up as before in front of one of the tubes it will appear within the circle which is in front of *the other eye*; thus causing the impression on the right eye to be apparently transposed to the left, and vice versa.

Exp. 4. Fasten a small disc of white paper on a slip of black pasteboard of the size suitable for a stereoscope, and place this in the instrument so that the white spot shall be centrally in front of one of the glasses.

To a person not aware of the position of the spot it will appear in the stereoscope as if equally in view to both eyes and he will be entirely unable to decide on which retina its picture is impressed. Indeed properly considered the spot does not appear directly in front of either eye but is seen at the intersection of the optic axes, in the medial or binocular direction between the two.

Let the spot be now moved toward the right side but still within the range of the left eye and it will seem to be before the right eye rather than the left. Shift it into the right compartment but not far from the dividing line and it will appear as if seen chiefly by the left eye, and finally bring it to the middle of the right compartment and it will seem as at first to belong equally to both eyes.*

Referring to the results observed in the above experiments when the object is directly in front of either eye it may be concluded that the mere retinal impression, on either eye is unaccompanied by any consciousness of the special surface impressed, and that the formation of the visual perception appertains to that part of the optical apparatus near or within the brain, *which belongs in common to both eyes.*

These observations show moreover that the *perceived direction is just as truly normal to the central part of the retina which has received no light as to that of the retina on which the white spot has been painted.* Indeed as before indicated, it is normal to neither, but is felt to be in the middle line between the two, that is, in the binocular direction. It need scarcely be added that this conclusion is at variance with the law of visible direction maintained by Brewster, which requires that the apparent direction of an object shall in all cases be normal to the part of the retina impressed.

The reference of the object in certain cases above noticed, (parts of 1, 2 and 4) to *one eye chiefly*, and that the eye from which it is *actually hidden*, is accounted for by the direction in which the other eye receives the light. As this direction, in the case of the left eye for instance, would be decidedly toward the field of view of the right eye, it would at once suggest the place of the object as somewhere before that eye, and so when the object is actually before the right eye, but in a position towards the left, it would excite the idea of an object somewhere before the left eye. As the retinal picture alone gives no indication of the particular eye in which it is formed, but only excites a visual consciousness common to both, the object in these cases will seem to be visible by both eyes but chiefly by that before which the suggestion just mentioned would naturally place it.

A like explanation applies to the transposition observed in Exp. 3, when the view is directed to a distance through the converging tubes. Here the false visual reference of the finger depends on the fact that the circle in front of either eye is sugges-

* The effect here described is one of a series of phenomena which Dr. O. W. Holmes attributes to an *actual transfer* of impressions from one eye to the other, and which he proposes to explain by the hypothesis of reflex vision. Proc. Am. Acad. Arts and Sciences, Feb. 1860.

tive, merely by its position, of a *special vision by that eye*, while from the conditions of the experiment these circles are in fact reversed in their places as compared with the tubes and eyes to which they appertain.

We have seen in the above experiments that when an object is presented to one eye without any accompanying circumstances leading us to refer the visual act specially to this or to the other eye we have a consciousness of seeing it equally with both eyes. *The same result occurs when separate objects are presented to the two eyes*, provided as before, extraneous sources of suggestion are excluded.

Exp. 5. Thus if we place on the black slide of the stereoscope two spots, differing either in shape or color, one before each eye, we perceive them both in the middle or binocular direction, each seemingly visible in an equal degree to both eyes, the one being seen through or upon the other according to the fitful attention or suggestion of the moment. A pleasing modification of this experiment is made by using two unequal white spots on the black slide and interposing a green or other colored glass between one of them and the lens. The spot which appears colored will give as strongly the impression of being seen by both eyes as the white one, in spite of our knowledge of the position of the colored glass.

Even in cases where the two objects are wholly unlike, and at very different distances from the eyes by which they are severally regarded, this feeling of a common or united visual act in regard to each of them is often easily recognized. Of this we have a ready illustration in the familiar experiment on ocular parallax in which a distant object, hidden from one eye by an interposed finger or pencil, is seen through or behind the pencil when both eyes are directed towards the distant object.

Exp. 6. To observe this effect satisfactorily it is well to make the experiment in an apartment in which a single small lamp is placed at some distance from the spot on which we stand. Looking intently at the lamp, we bring the pencil before the face in such position as to give us an image on each side of the lamp, and then move the pencil toward the right until its left hand image seems to coincide in direction and position with the lamp, which appears to shine through or to partially replace it. As we continue to look thus at the lamp, we have a clear impression that both lamp and pencil are equally visible to both eyes, and without some consideration of the previous adjustment and motions we are unable to determine which is actually visible to the right and which to the left eye.

The same experiment furnishes also an incidental illustration of the principle of *transposed* visual reference before alluded to.

If, while the above adjustment is maintained, we contemplate the other image of the pencil situated some distance to the right of the lamp, and endeavor to decide, from the mere visual impression, to which eye it appertains, we almost unfailingly refer it to the right eye as that which most nearly fronts it, although obviously it belongs to the other, as will be found at once on closing either eye.

Where the eyes are externally very sensitive, any strong illumination of one as compared with the other will interfere with the effect above described by referring the impression specially to the eye thus unduly excited. In such cases the observation is best made in a moderately lighted room by interposing the pencil between the eye and a vertical stripe on the wall.

Exp. 7. Recurring to Exp. 2, in which with a tube in front of one eye we perceive a bright circle on the wall in the medial direction, we may obtain a pleasing illustration of the point now under consideration by bringing a dark card or book or even the hand between the uncovered eye and the wall. The spot instead of being intercepted will appear as a perforation in the opaque screen.

Here as in the case of the pencil and lamp, the bright circle and the screen are both optically referred to the intersection of the two lines of view. But the luminous circle almost or entirely obliterates the corresponding part of the screen. As the full view of the screen and its connections continually remind us that it is in front of the uncovered eye, we are led to refer the luminous circle seen as coincident with a part of it, to the same eye, and thus to believe that *we are looking through the screen with that eye*. It is however not difficult, by intently regarding the luminous circle, so to counteract the force of this extraneous suggestion as to feel even in this case as if the circle were equally in view to both eyes.

These considerations explain very simply the experiment of the pseudo-diascope described by Mr. Ward of Manchester, which like several of those above mentioned is but an instance of the old observation of Da Vinci, that when we see behind a small opaque object presented near the eyes "it becomes as it were transparent." In making this experiment with a tube of paper supported between the thumb and forefinger of the left hand and held before the right eye so that the back of the hand may be some inches in advance of the left eye, it will be noticed that the effect varies with the amount of convergence of the eyes and that the bright perforation in the hand *may or may not* be referred to the left eye according to the force of the accessory suggestions or the intentness with which we fix our gaze upon the distant spot to which the axes are converged.

In concluding, it may be remarked that the experiments which have been described are for the most part too obvious and familiar to have merited such a special notice but for the peculiar and in some respects new interpretation which they have offered of many visual phenomena. Considered in this relation we are I think entitled to conclude from them:—

First that the retinal impression of an object presented directly to either eye is accompanied by the feeling of a united visual act, and of itself gives no indication of the particular eye impressed ; and:—

Second, that the reference of the impression to one eye rather than the other is the result of collateral *suggestion*, which may either locate the image in the eye that actually receives it, or may transpose it seemingly to the other, according to the particular conditions of the observation.