STEREOPSIS II.

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The objective in this final paper is to give you a few instances which may be examined in order to demonstrate some facts about binocular single vision. These facts are not easily reconciled with the alleged law of relative displacement. This principle implies that the control of the third dimension rests solely with the position of object in the horopter which are projected upon dissimilar retinal points and are seen singly. Such a proposal, it is at once evident, takes no stock of the fact of the strength or weakness of the figure itself, or the strength or weakness of the ground in which it is seen; and it implies that several such matters play no important role in the final perceptual product. The problem usually is solved by asserting that stereopsis is achieved when fusion takes place. This word "fusion" is a form of verbal magic. No one clearly understands what it means.

A further difficulty which points to the fact that the law of relative displacement is not a scientific law at all was pointed out by Ernst Mach about 1865. Mach showed that stereo-vision may be attained where the right and left figures are shown successively. The temporal interval separating the separate exposures can be large enough so that fusion of the second sensory stimulus with the after-discharge of the previous first one is impossible, yet stereopsis is perhaps even more perfect under these conditions than it is with the stereogram viewed in the conventional manner. The greater increased depth effects seen in motion picture photography is ample testimonial to this fact.

A further difficulty with the principle of relative displacement arises out of the known facts regarding retinal rivalry. Washburn has shown that rivalry goes on constantly during stereoscopic vision. Further she has demonstrated experimentally that when rivalry stops there is no stereopsis. If these results are true then all stereoscopic vision results from successive stimulation and alternative suppression in each of the two eyes.

A third interesting light upon the demands of the law of relative displacement arises out of the experiences in our own laboratory with an instrument known as the Kirschmann universal stereoscope. This is a device which enables the experimenter to place the two test objects in a practically limitless number of relative positions in three-dimensional space. For example, the right eye figure can be set at such an eccentric angle with respect to the left that tremendous fore-shortening is introduced into the right eye image. By such means the limits can be measured designating the points at which break-fusion occurs. If we plot the stereo-horopter by such means, we may observe that in some meridians there is an almost unbelievably wide latitude within which stereoscopic vision is not interfered with by image displacement in the slightest degree, whereas in other meridians the range of toleratin may be a matter of a degree or two of visual angle.

Finally we must consider the suggestion made originally by Von Frey that the whole retinal process in the discrimination of the third dimension serves merely as a trigger to release motor processes which are the true vehicles which carry the meaning of solidity and distance. The simple beginning of this function is to be observed in the phenomenon of visual apparent movement and in the so-called illusions of reversible prospective. This is why an early paper in this series asked you to make some observations along these lines.

For several years I have observed and been interested in the large possibilities of improvement through training in stereoscopic skill. It is a common experience in our laboratory that students studying visual space develop rapidly the ability to see in the third dimension. The real possibilities here are essentially unexplored at the present time. The architect, the engineer, and the draftsman as well as the professional microscopist all know full well the essential truth of the above assertion relative to the matter of regarding this visual function as a skill.

Let us go back to Slide No. 4 described last month. Let us modify this slide so that to the left we have a pair of parallel lines, to the right we have a single ve tical line. The instant we attempt visual superposition by means of prisms or decentered spheres, fusion takes place and the right hand member of the left pair is fore-shortened and appears to lie in a plane nearer the observer. If now we close the top and bottom of the left parallel lines with even a fine hair line that is barely visible and reexamine this figure, fusion is immediately made impossible. Nothing has been changed which would be demanded by the law of relative displacement in this case. However, the minute we transform the two parallel lines into what the observer now describes now describes as a single rectangle, this new figure resists any tendency to transform or distort it. Rivalry will be seen. There is no fusion. Obviously, therefore, a closed figure has a member inertia. It tends to maintain itself. It brooks no compromise in the attempt to make a new three-dimensional form. The only conclusion that one cna draw from such observation is that the intrinsic form organization of the figures comprising any stereogram is a highly important factor in determining the degree of binocular single vision and of depth and solidity. And, the perceptual frames of reference (habit relief) are just as important as figure properties, because the stimulus pattern can never be more than a part of the total essential process.

Let us now examine a further simple case. The two stereograms in Figure 1 show first a solid pyramid which extends toward the observer. The second figure is identical with the first except that the apex of the pyramid has been cut off to form a small plane surface. If you draw these figures and examine them in a stereoscope, you will find that the truncated pyramid possesses a distinctly greater degree of tri-dimensionality than does the upper figure. Write out your own analysis of the conditions which produce this differential effect.

Another interesting phenomenon is experienced when we view Figure 2. Note that it consists of a single straight line on the left and an obtuse angle on the right. Logically, perhaps, we should predict that the stereoscopic combination of these two different figures should produce something resembling an elongated capital letter k. If you observe this figure, you will see that nothing of the sort happens. Here is a complete suppression of the left hand member. The angle formed by the right hand figure seems to rest with its legs touching the plane of the card and with the apex near to the observer and rotated slightly into a new position. Here we have an instance of stereopsis without fusion. The dominant figure maintains itself with the slight concession of a change in position.

If you examine Figure 3 stereoscopically, you will boserve the well-known phenomenon of luster. Here we have a case of superposition of a black and white object. In the ordinary sense of the term fusion, they should mix or blend to produce a gray. However, the resultant discrimination is that of luster, in which both figures appear as filmy transparencies. This must then be still another kind of fusion and it presents a most difficult problem for those who insist upon a rigid adherence to the teachings of conventional physiological optics for the explanation of stereoscopic effects.

Now make another stereogram similar to Figure 3 except that in this instance the black figure is on the right as before and the left is entirely white, omitting the boundary lines which enclosed the white space to the left in the previous instance. Note before you examine this new figure stereoscopically that all of the same conditions, except one, obtain here as before. If the two halves of this stereogram are superposed visually, there should be the same mixture of white and glack which gave luster previously. Try it and observe carefully what happens.

The upper of the two stereograms in Figure 4 gives a clear tri-dimensional form which seems upon examination to stand out in front of the white plane of the card with a single point at the rear in contact with this plane. The lower stereogram is a similar solid surrounded by circles of slightly different diameters. Note that the effect of these circles is to differentiate the ground into at least two planes. Note and carefully describe the difference in the stereoscopic appearance of this second stereogram compared to the first. Look at it several times.

These are only a few of many illustrative examples of the general fact that the phenomena of stereoscopic vision are by no means simple. When we extend our observations still further by utilizing the after-image procedure for example, a whole new realm in the investigation of stereopsis is opened to us. It simply is not possible in the limited space here to do more than mention the fact, so brilliantly demonstrated by Professor Kohler at our recent research conference here, that the after-effects of visual stimulation of this sort play an amazing role in all functions involving tri-dimensional vision.

During the past two years, I have sought to interest you in some of the important possibilities of the study of psychological optics. This work how comes to a close. It is my hope that you have received from these papers some stimulation to lead you to an expanded concept of the lines along which subsequent developments must proceed if optometrists are to achieve a professional status other than that of mere technologists. For to learn to control functions we must first learn to describe them clearly and fully.

Figure No. 3

Figure No. 1

Figure No. 2

Figure No. 4