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Illusions

During the past summer a change of plan was made concerning the content of this series of papers. This change was made following suggestions from well known persons in optometry. It was decided to present a series of rather simple experimental demonstrations which the readers of these papers can make in their own offices. Each month we shall present one or more of these experiments or demonstrations. After making the observations consider the principles involved and the ways in which use can be made of the materials either in the present form or in some modified forms in daily practice. We hope it will be found possible for many optometrists to utilize some of these things in practice. Some of them may be discovered to be applicable in diagnosis and in visual training or retraining.

The construction and assembly of details will be simple, so that no particular difficulty will be experienced. The materials in most instances will be found readily available at the stationers, the time store, or perhaps in the office.

We propose to have you demonstrate to yourself a number of phenomena of psychological optics which will prove both interesting and instructive. We want you to catch something of the spirit of investigation by the first hand experience of doing these experiments and interpreting them for yourself. When you develop some interesting variation, use, or interpretation we suggest that you write us about it so that we may serve as a sort of clearing house for these ideas. We may even look forward to a time when highly valuable facts may be formulated by men in different sections of the country pooling their efforts and observations according to some carefully made plan.

For those who wish to go a little more deeply into any problem in the series we shall suggest a number of references for further reading.

Supplementing this first paper is the first of four parts of an extensive discussion by Dr. McFadden of the basic problem of Visual Acuity and its Measurement. Taken together these four papers will give you a valuable summary of the theory, previous experiments and literature on the problems relating to the concept of acuity, together with a summary of Dr. McFadden's own contributions on this problem.

With regard to the demonstrations, it is our purpose to suggest to you some problems and questions relating to the demonstrations which should be taken up and freely discussed in your group meetings. Particular emphasis should be placed upon two things: first, clear understanding of the principles in psychological optics involved; and second, in identification of these places in your thinking and practice where the principles and demonstrations may be put to practice. In the laboratory we are bound to see these phenomena in a different light from those of you engaged in daily clinical practice. From time to time we shall suggest certain possibilities along the above lines. The discovery of the uses and applications must, however, be left largely to our own ingenuity and cleverness.

Someone has paraphrased the proverb to read "Seeing is deceiving." In the perception of lines, forms and movements of ovjects in space we commonly experience distortion or deviation from "reality" in our interpretations of these things. One classification of such phenomena names them <u>illusions</u>. But what is an illusion?

Here at once we encounter a most interesting and difficult problem. If we seek for a dictionary definition of the term "illusion," we customarily meet with the statement that it is a misinterpretation or a false perception of some class of observations or processes experienced. The chief difficulty with such definitions is that they do not define because it is impossible to establish on any scientific footing a concept that an illusory experience is necessarily false. Nor is it possible to establish the fact that is is a misinterpretation, since we shall presently show you types of visual illusions which fail to meet such stipulations.

It is suggested that you try to formulate for yourself a definite and comprehensive statement as to what constitutes an illusion. Try to make your formulation precise and limited so that it includes only those phenomena which may be truly classed as illusions.

In the series of papers during the past year some pains were taken to discuss the characteristics of visual perception for several classes of objects. It might be profitable to reread these sections particularly with respect to the concept that everything we perceive assumes the form of a figure upon the ground. It should be borne clearly in mind that part of the ground in any perceptual experience is the perceiver's own frames of reference. Whenever a figural experience is set in an inappropriate ground the resulting interpretation is most likely to be in error. The qualitative and quantitative nature of the resulting interpretation may therefore depend upon a conside able number of factors, part of which are characteristic of the stimulus figure and its relations and part of which may derive from the set, attitude, expectancy or self-imposed instruction contributed by the perceiver himself. We have pointed out in the past that many phases of our visual perceptions of form, position, size, movement, and similar properties of things are susceptible to practice effects and are intimately related to the motor aspect of experience. What we do with any object or what it does to us becomes largely instrumental in recasting the form of our perception and interpretation of that object. Even the anatomical and neurological structure of the visual end organ demands that objects in different spatial positions can not be uniformly and isomorphically projected upon the sensative surface of the retinas. We must consider the retina as a first zone for trnasformation of things seen.

Care should be taken with respect to the normative phase of the problem of illusion. There are undoubtedly as many visually experienced distortions of space and form which are perfectly normal, conventional, every-day experiences as there are which may be classified as abnormal, erroneous or unnatural. It is for this reason that we must exercise considerable care in the theoretical formulation of our concept of illusion in order to bring it into accord with the fundamental theory of perception. Let us look at a few examples of visual space illusions.

Note carefully Figure 1 which is known as Mach's book. As you look at this figure it may be seen either as a book opened toward or away from you. If you look at this figure it may seem that the book is opened away from you, if your fixation is on the middle vertical line. If either of the other two vertical lines is fixated, the book immediately is seen in a new orientation, that is, toward you. This constitutes one of the simplest illusions of reversible perspective. The facility or nimbleness of one's vision may be indicated by the rapidity or number of times per minute one is able to change by shifting the point of regard the perceptual orientation of this figure. It would be interesting to try timing a few patients with different types of cases to note variations amongst them in this respect.

Try the figure both in the vertical and horizontal orientation. Try it both monocularly and binocularly.

It should be noted that in simple illusions of reversible perspective of this type we are dealing with one of the most elementary considerations in change of point of regard in a bi-dimensional figure which does not move. Further, it should be noted that we are dealing with one of the simplest and most fundamental considerations in stereoscopic vision. The two-dimensional figure takes on third-dimensional or depth properties when the observer himself does something, and this change occurs equally well whether the figure is viewed binocularly or monocularly. It might be interesting to view the figure through slight fogging lenses and to time the reversals when the figure is reduced in size by the use of appropriate lenses.

Fig. 1

Fig. 2

This figure is known as Necker's cube. Look at the figure and regard it as a series of diamonds, triangles and squares laid upon a flat surface. See if you can voluntarily suppress for any length of time its tridimensional property. Determine what change in fixation precedes or accompanies the transition in perspective as the cube becomes a solid figure and record the number of positions the solid figure can take.

Fig. 3

This figure is known as Schroder's stair figure. Note that if the proximal lines determining the near ends of the steps are fixated the figure is seen as a series of stair steps. If the distal lines are fixated, it immediately becomes a cornice, or if the central lines are fixated the same result follows. Record the average number of voluntary reversals you can make in one minute and compare this number with that secured in Fig. 1. Does the degree of complication of the figure influence the rate of voluntary reversal?

Fig. 4

This figure provides a further illustration of the well known illusion of reversible perspective. Its usual title is "How many cubes?" It will immediately be seen that whether 6 or 7 cubes are seen will depend upon the phase of reversal of the figure.

Fig. 5

Figure 5 is the well known Jastrow illusion. From a piece of stiff white cardboard, prepare four pieces twice the size of those used in the illustration. Arrange them as in the above figure except that the additional two are to be placed above the positions shown in Fig. 5. Examine them carefully and note that the top figure gradually diminishes in apparent size and the illusion persists regardless of change in fixation. This can be demonstrated by removing the bottom figure and placing it at the top. In this instance the position of any of these figures with respect to its neighbors is a decisive factor in determining its apparent size. A method could be devised for measuring accurately the reduction in size occasioned by the relative position of any one of these figures. It might be interesting and instructive to work out the details of such a method and take a series of measurements comparing, for instance, the responses of young children and adults to this illusion. Such results should throw light on the experience theory of perception or the problem of nativism vs. empiricism. In other words, if the illusory effect is a product of experience then we should expect the younger subjects to show less measurable effect of change in relative position.

Figure 6 might be called the "high hat" illusion. It is introduced to illustrate a further phase of relative position in space. How does the horizontal width of the rim of the hat compare to its heighth? Although the two dimensions are equal the vertical component is overestimated.

Fig. 6

Fig. 7

Figure 7 represents a whole class of illusory experiences which are usually characterized as filled vs. unfilled space. The problem is to compare the length of the diagonal line representing the lid with the diagonal of the square representing the box. If the hinged lid were rotated until its distal end meets the opposite corner of the box, namely, the lower right hand corner, will it fall short of coincide or extend beyond the limits of the square? Here, again, a mechanical model could be made and measurements taken to indicate the extent of the illusion.

Fig. 8

This figure is known as Ebbinghaus' circles. It represents a class of illusions in which the size of the figure is influenced by the ground in which it is set. The problem is to compare the relative sizes of the inner circles surrounded respectively by larger and smaller circles. The diameters of the inner circles are the same.

Fig. 9

Figure 9 illustrates the change in the relative sizes of the two circles enclosed within the angle. Both figs. 8 and 9 illustrate the fact that our judgments of the size of any object are largely dependent on the surrounds of that object.

A

B

C

Fig. 10

One of the most widely known visual space illusions is known as the Muller-Lyer figure. There are numerous variants of the principle exhibited by this figure. The problem is to judge the relative lengths of the horizontal lines between the arrowheads. The following instructions will tell you how to construct this figure so that it may be made adjustable and exact measurements of the extent of illusion determined in any orientation in space. It is suggested that you try it on yourself. Find the average of ten determinations when the figure is seen in the horizontal, and of an equal number in the vertical orientation. It is further suggested that the figure be viewed first at one meter, than at three meters, and the influence of visual angle upon the size of the error thus determined. It may interest you to know that no fewer than a dozen theories have been proposed to account for this illusion. These may be found in Titchener, E. B., Experimental Psychology, Instructor's Manual, Qualitative, 321-328 inclusive.

From a piece of white cardboard prepare parts A and B of Figure 10. The piece on which A is to be drawn should be about 10 by 30 centimeters. Make the distance between the arrowheads 20 centimeters. Draw the arrowheads at 30 degrees from the horizontal. The lines should be approximately 3 millimeters thick. Cut a slit from X to Y and insert B so that the totall appearance will be like that of C in Figure 10. This will provide you with an adjustable Muller-Lyer figure.

There are scores of other forms of visual illusions.. The above examples may be sufficient to give you a start toward the problem. Some references follow:

REFERENCES

1. Titchener, E. B., Experimental Psychology, Student's and Instructor's Manuals, Qualitative. Mc Millan, New York, 1905.

2. Luckiesh, M., Visual Illusions, Their Causes, Characteristics and Applications. Van Nostrand, New York, 1922.

3. Wallin, J. E. W., Optical Illusions of Reversible Perspective. Privately printed, Princeton, N. J., 1905.

4. Woodworth, R. S., Experimental Psychology. Holt, New York, 1938.

5. Koffka, Kurt. The Principles of Gestalt Psychology. Harcourt-Brace, New York, 1935.

6. Ellis, W. F., Source Book of Gestalt Psychology. Harcourt-Brace, New York, 1938.

7. Troland, L. T., The Principles of Psychophysiology, 3 volumes. Van Nostrand, New York, 1930.