The assimilation theory applied to a modification of the Müller-Lyer illusion

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The assimilation theory of illusions, which utilizes the principle that large magnitudes in a series are underestimated and small magnitudes are overestimated, was applied to a modification of the Müller-Lyer illusion. A close link was shown to exist between the Müller-Lyer illusion, a modification of the Müller-Lyer illusion, and the Sander parallelogram. In addition, a new illusory target was predicted.

If a line is located in a context of different contours, that line may undergo apparent distortions in size, shape, position, or direction depending upon the nature of the context. Such distortions are called "geometrical illusions" and have been the subject of intensive empirical and theoretical work in the past 100 years.

In the early part of the 20th century, various theories of illusions were offered, but most of these were unsatisfactory either because they were too vague to yield testable predictions or because they made incorrect predictions (Gregory, 1966). Recently, there has been a renewed interest in explaining illusions. These attempts are typified by Gregory's inappropriate constancy scaling theory (1963), Fisher's attempt to relate the Müller-Lyer to the Ponzo illusion (1967), Pressey's assimilation theory (1967), and Chiang's physiological theory (1968).

A favored approach in testing the adequacy of theories of illusions has been to modify targets in certain ways and to determine what predictions a theory would make about the phenomenal changes that should result. A failure to make a correct prediction is viewed as a disconfirming instance of the theory. Such an approach has been used by Pressey and den Heyer (1968), Pressey and Sweeney (1969), and Restle (1969) in their evaluation of Chiang's theory.

Morgan (1969) has focused on a theoretically interesting modification of the Müller-Lyer illusion which is shown in Fig. 1. A standard line, bounded by an arrowhead at one end and an arrow feather at the other, is bisected by a dot. The midpoint appears to be displaced toward the arrowhead. Morgan has argued that "no account of it can be given by Fisher's hypothesis, for the pairs of lines on each side of the horizontal are neither converging nor diverging..." Morgan goes on to claim that this illusion also raises considerable difficulties for Gregory's inappropriate constancy scaling theory.

A question that now arises is whether or not Chiang's and Pressey's theories are consistent with the illusion shown in Fig. 1. Basically Chiang's theory assumes

Fig. 2. The dots within the obliques are hypothetical peaks of excitation.

that a contour is represented by a distribution of excitation in which the subjective location of a contour corresponds to the peak of excitation. In addition, it is argued that if two contours are very close together, their excitations will summate to yield a subjective contour located somewhere between the objective positions of the contours. If this analysis is pursued for an acute angle, it will be seen that, at the apex, the peak of excitation will not correspond to the objective location of the contours. Rather it will be shifted just to the inside of the acute angle as shown in Fig. 2. Now if a midpoint is placed in the middle of the *objective* end-points, it will appear displaced toward the arrowhead of the *subjective* end-points. It appears, therefore, that Chiang's theory is able to explain the target shown in Fig. 1. However, in a further modification, as shown in Fig. 3, contours are removed so that no acute angle is present. In this case there can be no shifting of peaks of excitation and, hence, no illusion. Yet an illusion remains. Thus, it must be argued

that Chiang's theory is not the correct interpretation for either the Müller-Lyer illusion or its various modifications.

Pressey's theory is basically an information-processing approach in which the major explanatory construct is assimilation. The term "assimilation" means that, in a group of entities, the extremes take on the properties (or become more like) the average of the entities. The concept of assimilation is by no means new to psychology and has been labeled by a number of terms including "the central tendency effect," "regression to the mean," and "leveling."

Assimilation is such a widespread phenomenon that Helson (1967, p. 95) has postulated it as one of the basic principles of behavior. A typical and easily understood example of assimilation is provided in judgments of magnitudes. Generally speaking, the principle is that, whenever judgments of a series of magnitudes are made, the larger magnitudes will be underestimated and the smaller magnitudes will be overestimated. It will be noted that in both cases the extremes become more like the average magnitude.

Assimilation is used to explain the Müller-Lyer illusion in the following manner: Arrowheads placed at the ends of a standard line force the individual to make judgments not only of the standard line but also of an indefinite number of lengths defined by the obliques.² This notion is exemplified in Fig. 4. Here the standard line (AB) is the longest line in the series, and, according to the assimilation principle, it should be underestimated. A similar analysis can be made for the arrow-feathers portion of the illusion. In such a case the standard line would be the *smallest* line in the series and, thus, it would be overestimated.

From the above analysis of the Müller-Lyer illusion, it is a simple step to an explanation of the modification shown in Fig. 1. In this case, the presence of the

Fig. 1. A modification of the Müller-Lyer illusion.

Fig. 3. A further modification of the Müller-Lyer illusion.

Fig. 4. Hypothetical magnitudes within which the longest line (AB) is embedded.

Fig. 5. See text for explanation.

Fig. 6. A simplification of Fig. 5 (AB = BC).

obliques leads to judgments not only of the distances along the standard line but also of all the distances defined by the obliques. This idea is clarified in Fig. 5. Now consider a simplified version of Fig. 5 (as shown in Fig. 6) and recall that the task set for the S is to make judgments of equality. In Fig. 6, AE is equal to CD, AB is equal to BC, but BE is shorter than BD. The line AB then becomes assimilated with the line BE and appears to be shorter. The line BC, on the other hand, assimilates with the line BD and appears to be longer. Another way of saying the same thing is that, if a S wishes to equate BE with DB (which he might inadvertently do because of the set to make judgments of equality), he must move the midpoint toward the arrow feather. But, as he does so, the line AB begins to enlarge and BC begins to decrease in size. This result conflicts with the tendency to equate AB and BC. The net result is that the individual selects the midpoint of line AC to be some compromise between the tendency to equate BE with BD and AB with BC. And, of course, this compromise is somewhere nearer the arrow feather than the arrowhead.

It is obvious, then, that the assimilation theory correctly predicts the modification of the Müller-Lyer illusion shown in Fig. 1. However, so far the analysis has been

Fig. 7. Target with BE = BD.

essentially ad hoc in the sense that the target is given, and the theory is fitted to explain the phenomenon yielded by the target. But ideally a theory should yield predictions about what should appear when different targets are constructed or when different responses are demanded. A prediction that follows directly from the above analysis is that if, in Fig. 6, the S is asked to draw a dot on the line AC so that the line BE appears equal to line BD, his PSE should fall somewhere nearer the arrowhead than the POE. The reason for this is that his general set to equate magnitudes makes him equate not only BE with BD but also AB with BC. But these are conflicting tendencies. As BE and BD approach equality, AB and BC become increasingly different. The net result is that the PSE is located in a compromise position that is nearer to the arrowhead than the POE. Figure 7 illustrates the apparent disparity between BE and BD when the two lines are, in fact, equal. The PSE in this case would fall somewhat to the left of the POE.

A close inspection of Fig. 7 indicates that it is a modification of the classical Sander parallelogram. By joining DE and BF, Fig. 8 is obtained. Thus, a step-by-step application of assimilation theory has provided a link between the Müller-Lyer illusion, a modification of that illusion (Fig. 1), and the Sander parallelogram (Fig. 8).

In Fig. 9, the distance between AB and BC is objectively equal but for many Os, AB appears shorter. It will be noted that Chiang's theory would predict no difference between AB and BC, since the peak of excitation would coincide with the objective crossing point of the two lines. On the other hand, assimilation theory could explain Fig. 9 by the simple added assumption that it is the obliques AD and AE (and not AF and AG) that are effective in forming the context in which AB is perceived. This is not an unreasonable assumption when the nature of the task given is taken into account. The S must judge AB, which means that attention will be focused primarily in the region between A and B. Any contours within that region will be more effective in forming a context than contours outside that region. Hence, the operating context for AB will consist of magnitudes shorter than AB, which means that AB will appear shorter than BC.

It is clear that, on the whole, assimilation theory possesses the necessary elements to provide a satisfactory theory of geometrical illusions. However, the present writer has found that the generation of predictions has been somewhat hampered by lack of evidence on the manner in which assimilation

Fig. 8. The Sander parallelogram.

Fig. 9. A modification of the Müller-Lyer illusion.

changes with variations in the nature of the context. For example, it is not clear to what extent the range of the magnitudes affects assimilation. Such data would enhance the ability of assimilation theory to explain phenomenal changes that occur when stimulus variables of geometrical illusions are altered.

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NOTES

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2. This statement should not be interpreted as meaning that the theory is essentially an eye movement or acuity theory. All that is intended, at this stage, is that there is a mechanism by means of which magnitudes are judged and that the contextual contours result in magnitudes other than the criterion magnitude being processed by the mechanism. The more appropriate term is "interference theory," since the context interferes with the veridical judgment of the magnitude.

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