Observations on Chiang's "new" theory of geometrical illusions

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Several observations are reported which conflict with predictions derived from a recent theory of illusions presented by Chiang. It was concluded that Chiang's analysis of the processes underlying contour formation is inadequate to explain a number of illusions such as the Poggendorff and the Muller-Lyer.

Recently Chiang (1968) has presented a theory of the Poggendorff illusion from which he derives explanations for a large number of illusory patterns including the Muller-Lyer, Zollner, Wundt, and Hering figures.

The basic construct underlying Chiang's theory is similar to that proposed by Marshall and Talbot (1942) in their theory of contour formation. Basically it is assumed that a contour is represented by "a normal distribution of excitation, symmetrical about its own axis transversely and extending as a 'ridge' throughout the longitudinal extent of the contour." (Osgood, 1953, p. 237). Furthermore, the subjective location of the contour corresponds to the *peak* of the distribution of excitation. If two contours are widely separated the distribution of excitation will be, according to Chiang, bimodal with the result that two separate contours will be perceived. If, however, the two contours are close together the distribution of excitation will summate and produce one peak. The subjective location of the phenomenally single contour will be roughly in the middle of the positions of the two objective contours.

From the assumptions that each contour has associated with it a band or spread of excitation that extends beyond the contour and that the excitations from contours that are close together will summate, an analysis of what occurs when viewing an acute angle can be readily made. In Fig. 1, the solid lines define the objective contours and the dashed lines represent the spread of excitation from the lines. The point at which AB and BC join is clearly the point at which excitations from the two contours will summate. Since the subjective location of a contour falls roughly in the middle of the distribution of excitation, phenomenally the contours at the apex will shift to the inside of the angle (shown by the arrows). The net result will be, according to Chiang, a "rotation" of the contours to form a less acute angle. From this, it is a short step to an explanation of the Poggendorff illusion seen in Fig. 2. Angles ABC and DEF appear more obtuse than they are objectively with the result that when AB is projected toward E it appears to be above E.

Although this type of analysis is superficially convincing it encounters difficulties when a more complex pattern is utilized. In Fig. 3a two lines cross each other so that two acute and two obtuse angles are produced. Figure 3b represents the hypothetical patterns of excitation around the contours and 3c represents the predicted subjective location of the contour (recalling that the subjective location is in the middle of the spread). Figure 3c is identical to Chiang's own Fig. 3 (1968) but the point which is overlooked by Chiang is that although his theory predicts that two crossed lines should appear as in Fig. 3, phenomenally they do *not* appear broken. They appear as two continuous lines which cross each other. This means that in order to account for the phenomenal fact an additional assumption is needed in Chiang's theory. One might speculate that some sort of averaging mechanism operates to take the "line of best fit" through the asymmetrical pattern of excitation so that a single line would be perceived. But as soon as such an assumption is introduced it is obvious that the lines of best fit are precisely those shown in Fig. 3a, i.e., corresponding to the objective location of the contours. This means that there is no enlargement of the acute angles. The main point of the argument is that, while Chiang's theory may be able to explain how a single acute angle may appear phenomenally

larger, it has difficulty in showing how two acute angles produced by crossing lines (Fig. 3a) can both appear larger. Moreover, it is necessary to show that both acute angles become phenomenally larger to explain a variation of Poggendorff's illusion shown in Fig. 4. Here the two short diagonals actually intersect the vertical contours and the illusion still occurs. Unless Chiang can explain how the four acute angles in Fig. 4 all become phenomenally larger he cannot explain this particular version of the illusion.

Another variation of the Poggendorff illusion is shown in Fig. 5a and 5b. An examination of the configurations reveals that in 5a, in which the contours forming the obtuse angles are removed, the illusion is markedly reduced. However, in 5b in which the

Fig. 1. A schematic representation of the pattern of excitation surrounding an acute angle.

Fig. 2. The Poggendorff illusion.

Fig. 3. A schematic representation of the pattern of excitation surrounding crossed lines and the predicted percept.

Fig. 4. A variation of the Poggendorff illusion.

Fig. 5. Variations of the Poggendorff illusion.

portions of the vertical lines forming the acute angles are eliminated, the illusion is quite salient.

According to Chiang's analysis, however, it is the acute angle in the Poggendorff figure which is primarily responsible for the illusion. If hypothetical patterns of excitation are constructed then it is clear that it is Fig. 5a which should produce the classical Poggendorff illusion.

In addition, the illusion should be very strong because the contours forming the angle are close together hence facilitating summation of excitation. In regard to Fig. 5b, however, the prediction will be that the illusion will be very weak since the contours forming the angles are farther apart. In addition, the *direction* of the illusion, if any is present, should be reversed. The theory thus makes predictions which are not only contrary to, but the reverse of, the phenomenological facts.

Still in regard to Chiang's theory, it is informative to quote Kohler and Wallach's (1944) comments on illusions. They state that "At this point a sweeping generalization may at first appear quite natural. Small angles . . . always grow. But it has long ago been formulated as a rule that in a number of well-known illusions small angles also grow. Not only the Poggendorff illusion may seem to be interpretable in this fashion but also the distortions which the Zollner- and Hering-pattern exhibit. Again, if sets of straight lines pass through an outline circle this figure may be deformed in various ways. The deformations are analogous to the one observed in the Hering pattern."

"A particularly simple pattern is that of the Poggendorff illusion. It certainly seems at first an attractive thesis that in this figure the two parts of the interrupted oblique line are not seen as continuations of each other because . . . each turns away from the vertical with which it is in contact. If this were the case 'small angles would grow' in this pattern just as they do in figural after-effects. But we cannot be sure that this is the right interpretation of the illusion because the observed distortion allows also for a different interpretation: if, without turning, both parts of the interrupted line move toward the side of their acute angle, one upward and the other downward, then the same effect will be obtained. In order to determine which alternative is actually realized we have merely to add a neutral landmark, for instance, a *continuous* line which, at some distance, lies parallel to the interrupted line. It will be seen that in this pattern there is

Fig. 7. The Mueller-Lyer illusion.

Fig. 6. This variation of the Poggendorff illusion demonstrates displacement rather than rotation of contours.

only the faintest, if any, indication that the parts of the interrupted line are turned. On the other hand, it is perfectly clear that these parts have not the same distance from the control line; and the direction of the difference is the one which corresponds to the illusion. Thus we learn that in an illusion the rule about the growth of small angles may *seem* to apply while actually there is no connection between the rule and the nature of the illusion. Any serious consideration of such instances as the Zollner- and Hering-illusion will lead to similar doubts with regard to these patterns."

Kohler and Wallach's argument that in the Poggendorff illusion the distortion is not due to "rotation" of angles but rather to displacement of contours is vividly demonstrated in Fig. 6. This pattern is taken from Tolansky (1964) and shows a single vertical line placed above, and objectively in the middle of, two parallel vertical lines. The vertical lines are separated by two diagonal lines to form a variation of the Poggendorff pattern. Figure 6 clearly shows that there is no "rotation" of the vertical line on top; rather, it appears to be displaced, in its entirety, to the O's left. It is difficult to see how Chiang's theory would be able to explain this phenomenon.

Finally, Chiang has argued that his theory can explain the Muller Lyer illusion shown in Fig. 7. The "arrow feathers" at the ends of AB increase the apparent length of that line. The reason for this, according to Chiang's theory, is clear when the analysis given in Fig. 1 is recalled. The peak of excitation in angle ABC falls somewhere between B and D. If such an angle is placed at the end of a line, as in Fig. 7, then the entire line will appear lengthened. Conversely, the line will appear shortened when "arrow heads" are located at the ends of a line.

However, Chiang's analysis is probably incorrect when viewed in the light of a recent finding by Mountjoy (1966). Mountjoy has shown that in the configuration with the arrow heads, the distance CD is underestimated but the distance between the tips of the arrow heads (GH and G'H') is overestimated. If the analysis of the pattern of excitation around an angle shown in Fig. 1 is correct, then it is difficult to see how Chiang would explain Mountjoy's observation. Apparently it would have to be argued that the portion of the contour labelled A shifts to the O's left; but there seems to be no reason why this should be the case. Thus, once again, while Chiang's explanation seems superficially correct, a closer analysis reveals that it is probably not the correct interpretation of geometrical illusions.

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