Poggendorff illusion: Effects of intelligence, viewing distance, and space between the vertical lines

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The effects of intelligence, distance to the stimulus, and the space between the vertical lines on the magnitude of the Poggendorff illusion were determined for 10 college students and 10 institutionalized retardates. No differences were found as a function of intelligence or the distance to the stimuli. The magnitude of the illusion increased directly with the space between the vertical lines.

When a straight diagonal line is separated into two sections by a space bordered by two vertical lines, as in Fig. 1A, a perceptual distortion occurs so that the right diagonal section appears displaced below the extension of the left diagonal section. While this distortion, known as the Poggendorff illusion, has been noted for many years, no satisfactory explanation has been formulated (Boring, 1942; Wohlwill, 1960; Over, 1968).

Traditionally, the magnitude of the illusion, defined as the deviation of the apparent extension from the physical extension, has been measured by the method of adjustment in which one diagonal section is moved up or down until it appears to be an exact extension of the other diagonal section. Recently, however, the method of production has been introduced in which one of the diagonal sections of the illusion is omitted, as in Fig. 1B. The S is required to make a mark on the vertical line where the diagonal line would hit if it were extended. While it might be argued that this new figure is a different illusion, there is evidence to suggest that the same mechanisms are responsible for both. Pressey & Sweeney (1969) report obtaining the typical practice effects using the method of production with college students. They also report (Pressey & Sweeney, 1970) that the illusion decreases with age when measured by the method of production, replicating the trend found with the method of adjustment (Vurpillot, 1957; Leibowitz & Gwozdecki, 1967). Besides being a very quick method requiring little in the way of equipment, the method of production avoids the errors of anticipation and perseveration inherent in the method of adjustment. Thus, it may be a preferred method when the Ss to be tested are children or retardates.

The use of retardates in perceptual research allows for the separation of physical factors which develop with

chronological age (CA) from those cognitive factors which should develop with mental age (MA). Any differences between retardates and CA normal controls would suggest that cognitive development is related to the processes responsible for the magnitude of illusion, while no differences would indicate that physical maturation is related to the processes responsible for the magnitude of the illusion (Pollack, 1964). Although there have been reports that cognitive factors are related to the magnitude of the Poggendorff illusion, independent of CA (Pressey, 1965; Leibowitz & Gwozdecki, 1967), these findings have recently been questioned (Spitz, Goettler, & Diveley, 1970). One purpose of this investigation was to examine further the role of intelligence on the Poggendorff illusion by comparing retardates and normals.

A second purpose of this investigation was to examine the functional relationship between the magnitude of the illusion and the distance between the vertical lines. Velinsky (1925) has shown that the magnitude of the illusion increases with increases in the distance between the vertical lines. This same functional relationship would be expected here.

A third purpose of this study was to investigate the role of the distance from the S to the stimuli. Details concerning this variable are often omitted in reports on the Poggendorff illusion, perhaps indicating that it has been assumed to be an unimportant factor. However, a change in distance will change the visual angle of the figure. If the illusion is caused by retinal mechanisms, it might be expected to change with the retinal size of the figure. If changes in retinal size do not have an effect, other mechanisms would be implied.

DESIGN

The illusion was investigated under six conditions in a 2 by 2 by 3 factorial design varying type of S

(retardate and normal), distance from the S to the stimuli (25 and 50 cm), and the space between the vertical lines of the illusion (2.5, 5, and 10 mm). The figures were presented in the same random order for each S at each distance. Half of each group of Ss was presented with the figure at 25 cm and then at 50 cm, while the other half of each group received the opposite order of presentation.

SUBJECTS

The Ss were 10 undergraduate students at Richmond College. They ranged in age from 19 to 23, averaging 21.8 years. The retarded Ss consisted of 10 cultural familials, without indications of organic or neurological impairments, from Willowbrook State School. They ranged in age from 16 to 19, averaging 18.1 years. The mean IQ for the retardates was 54.8, with a standard deviation of 8.73. All Ss had normal vision with or without correction.

APPARATUS

The training procedure was conducted on a blackboard with white chalk. The test stimuli consisted of photocopies of two vertical lines, 72 x .04 mm, with a diagonal line, 27 x .04 mm, at a 30-deg angle 24 mm below the top of the left vertical line. The vertical lines were separated by 2.5, 5.0, or 10.0 mm. Two rods, 25 or 50 cm, were used to maintain the distance from a S's head to the testing surface.

PROCEDURE

The retarded Ss went through a training procedure leading up to the actual testing conditions to insure that they understood the task. A horizontal line and three vertically separated dots were drawn on a blackboard. The S had to indicate which dot would be hit by the line if the line was extended. Upon correct completion, the dots

Fig. 1. The Poggendorff illusion as traditionally presented (A) and as presented by the method of production (B).

were connected by a vertical line and the S was asked to make a mark on the vertical line where the horizontal line would hit if it were extended. A second vertical line was then drawn between the first vertical line and the horizontal line but touching the end of the horizontal line, and the S again indicated where the horizontal line would hit the vertical line. At this point, a diagonal line was drawn approximately at a 45-deg angle downward from the intersection of the horizontal and vertical line away from the second vertical line. If S now made a mark on the second vertical line which was above the marks he had made to the horizontal line, it was assumed that he understood the task. The normal Ss went through only the last two steps of this training procedure.

Each S made six judgments on each test stimuli at each distance. Thus, 36 separate measures of the illusion were obtained for each S.

RESULTS

For each S, the magnitude of the illusion was defined as the mean deviation of the six judgments of the particular sized stimulus at the particular distance from the S. The group means and standard deviations are presented in Table 1. For each group, at each distance, the magnitude of the illusion as well as the standard deviation increased as the space between the vertical lines increased. A 2 by 2 by 3 analysis of variance with repeated measures indicated that retardates did not differ from normals ($F = 0.63$; $p > .25$), that the distance from the S to the stimulus was not an important variable ($F = 0.10$, $p > .50$), and that the space between the vertical lines of the illusion was an important determinant of the magnitude of the illusion ($F = 175.29$; $p < .001$). None of the interactions were significant. For the retardates, each of the six conditions was correlated with CA and IQ. The correlations ranged from -0.22 to 0.49 , none of which were significant.

DISCUSSION

No significant differences were found between retardates and CA normals. This finding, along with the lack of any significant correlations with IQ, indicate that cognitive development is not related to the magnitude of the illusion. Although Leibowitz & Gwozdecki (1965) did

Table 1
Illusion in Millimeters as a Function of Distance to and Space Between the Vertical Lines

mm to Stimulus	mm Between Vertical Lines		
	2.5	5	10
250 mm			
Normals	1.6	3.5	8.0
SD	0.6	0.8	2.2
Retardates	1.7	4.8	9.6
SD	0.9	2.4	3.9
500 mm			
Normals	2.1	3.5	8.5
SD	0.8	1.3	2.1
Retardates	1.6	4.0	9.0
SD	1.1	1.9	3.0

report differences between retardates and normals on the Poggendorff illusion, Spitz, Goettler, & Divelez (1970) have argued that this may have been due to the use of the method of adjustment. The usefulness of the method of adjustment with retardates and normal children has been seriously questioned (Gerjuoy & Winters, 1969; Wohlwill, 1960). The findings of this study, using the method of production, and those of Spitz, Goettler, and Divelez, using the method of constant stimuli, suggest that retardates do not differ from CA normals on the Poggendorff illusion when the method of adjustment is not used to measure the illusion.

As predicted, the magnitude of the illusion was functionally related to the separation of the vertical components of the stimuli. These results are quite comparable to those obtained with the traditional psychophysical techniques employing the same angle of the diagonal and separations of vertical lines. In an effort to look further at this relationship, an additional 10 college Ss were tested using the identical procedure, except that the separations between the vertical lines were 1.5 and 20.0 mm. When the distance to the figures was 25 cm, mean illusions of 0.1 and 11.5 mm, respectively, were obtained. When the figure was 50 cm from the S, mean illusions of .4 and 11.5 mm, respectively, were obtained, indicating that this relationship continues at least up to a 20-mm separation of the vertical components of the figure. This result does not have any obvious explanation, although it has been known at least since 1925 (Velinsky).

While it is tempting to associate this relationship with the well-known enhancement of the magnitude of acute angles, there is a continually growing body of evidence that the illusion is not dependent upon acute angles. In fact, Restle (1969) has demonstrated that the illusion is reversed when only acute angles are presented and unchanged when only obtuse angles are presented.

The distance from the S to the figure was not a determinant of the magnitude of the illusion in this study. Differences in illusion magnitude attributable to this variable were very small. Thus, it would appear that it is the physical, rather than the retinal, distance between the vertical components of the illusion which is correlated with the magnitude of the illusion.

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