STIMULUS DETERMINANTS OF THE MAGNITUDE OF THE MUELLER-LYER ILLUSION¹

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Summary.—It has been assumed, on the basis of research carried out more than 50 yr. ago and lacking adequate controls, that the magnitude of the Mueller-Lyer illusion is inversely related to the angle between the oblique lines and directly related to the length of the oblique lines of the figure (up to some maximum length). The present study investigated, under controlled conditions, the relation between the magnitude of the illusion and these two characteristics of the figure. Data confirmed earlier research and indicated no significant interaction between these two variables. Both angle and length of the oblique lines are linearly related to the magnitude of the illusion.

The Mueller-Lyer illusion was discovered nearly 80 yr. ago (Mueller-Lyer, 1889). Since that time it has been the object of a great deal of empirical and theoretical interest. Many investigations were carried out within two decades of its discovery in an effort to determine what variables influenced its magnitude. In an investigation of some of the stimulus determinants of the magnitude of the illusion Heymans (1896) found a decrease in the illusion as the angle between the obliques was increased. In addition, with the angle between the obliques and the length of the horizontal line held constant, the magnitude of the illusion increased as the length of the obliques increased. However, a maximum point was reached beyond which the illusion began to decrease. Other early investigators (Lewis, 1909; Scripture, 1905; van Biervliet, 1896) have reported similar results. Heymans also reported a decrement in the illusion with practice.

Although most current psychology textbooks and reviews of the literature on this topic take for granted the relations between the magnitude of this illusion and the angle and length of the oblique lines, this is hardly justified because of the very crude investigations conducted by the earlier *Es* and the lack of attempts to confirm these early findings.

The precise relation between the magnitude of the Mueller-Lyer illusion and the length and angle of the oblique lines cannot be considered firmly established. Furthermore, these two characteristics of the figure have never been investigated in a single experiment to see how they might interact to influence the illusion. The present investigation was designed to examine the influence of these two variables on the magnitude of the illusion.

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Method

Ss were students selected at random from an introductory psychology course at McMaster University. A total of 160 Ss were tested as 16 groups of 10 (6 males and 4 females). The average age of Ss was 20.1 yr.

The apparatus was a rectangular wooden panel 48 in. wide and 26 in. high. A piece of white stagblank, which served as a homogeneous background, was attached to the front of the panel. The stimulus (the Mueller-Lyer figure constructed of 10-ply stagblank and painted flat black) was attached to the center of the panel and held firmly in place. The horizontal portion of the figure was 20 cm. in length. The lines of the figure were 4 mm. in width. The movable center arrowhead of the figure was attached to a string that came through two small holes in the panel. The string was moved by a pulley driven by a reversible, variable speed, electric motor fixed to the back of the panel. The motor could be operated either by E or by a remote control key on the table in front of S. The position of the center arrowhead could be measured to the nearest millimeter by a scale on the back of the panel. When S's key was depressed, the center arrowhead moved at a speed of 1.4 cm. per second.

The apparatus was set on a table 60 in. from S's head. A chin rest attached to the end of the table served to hold the head stationary and at eye level with the stimulus. After S was seated, he was instructed to adjust the center arrowhead so that the two horizontal segments of the figure appeared to be equal in length. At the beginning of each trial, the adjustable center arrowhead was set by E obviously too far to the right or to the left of the center position. These pre-trial settings were made according to a predetermined random schedule. Ss were observed by E throughout the experiment by means of a mirror located behind S to ensure that S's chin was kept on the chin rest at all times and that he did not use aids, such as his hands, to gauge the length of the stimulus.

Ss, assigned at random to groups, judged the figure 30 times each. One-half of the Ss (N = 5) in each group viewed the stimulus figure with the standard part (the portion with the inward-turned obliques) on the left; the other half, with the standard part on the right. The oblique lines which formed the three arrowheads of the figure were varied along two dimensions, angle and length. (Angle refers to the angle formed by the two oblique lines of each arrowhead.) Four angles (30°, 60°, 90°, and 120°) were combined with each of four lengths (1, 2, 3, and 4 cm.) to make a total of 16 figures. Thus, each group of 10 Ss saw only one combination of angle and length.

RESULTS AND DISCUSSION

The mean estimate of the illusion for each of the 16 groups is indicated in Table 1. It can be seen that the magnitude of the illusion decreases as the angle between the oblique lines increases. The magnitude of the illusion increases as the length of the oblique lines increases. Both of these effects are significant (p < .001) as indicated by the analysis of variance summarized in Table 2.

Length		М			
	30°	60°	90°	120°	
1 cm.	6.21	6.06	5.02	3.02	5.08
2 cm.	7.34	6.73	5.64	5.90	6.40
3 cm.	10.25	8.42	9.41	5.79	8.47
4 cm.	11.97	8.39	8.21	6.96	8.88
М	8.94	7.40	7.07	5.42	

TABLE 1 Mean Illusion (in millimeter

Note.-Entries represent mean estimate based on 30 trials for each of 10 Ss.

A trend analysis indicated that both the length and the angle of the oblique lines show a linear relationship (p < .001) to the magnitude of the illusion. There was also a decrement in the magnitude of the illusion with practice (p < .001).

These data indicate a marked direct relation between the magnitude of the Mueller-Lyer illusion and the length of the oblique lines and a marked inverse relation between the magnitude of the illusion and the angle between the oblique lines. This confirms earlier findings of Heymans (1896) and Lewis (1909).

TABLE 2								
SUMMARY OF	ANALYSIS	OF	VARIANCE					

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Source	df	MS	F	P					
Angle	3	15,054.53	7.56	<.001					
Length	3	23,008.00	11.55	<.001					
Angle 🗙 Length	9	1,678.07	0.84						
Within-cells	144	1,992.01							

Both relations were best described as linear functions in accord with earlier reports. Table 1 shows that as the length of the oblique lines increases from 3 to 4 cm., the magnitude of the illusion increases less rapidly than it does when the obliques increase from 1 to 2 cm. or from 2 to 3 cm. This is in agreement with Heymans' maximum law. The absence of angle \times length interaction suggests that these variables operate independently of each other to determine the magnitude of the illusion. With the exception of this finding the present experiment reveals nothing new but clearly confirms the earlier work.

REFERENCES

BIERVLIET, J. J. VAN. Nouvelles mesures des illusions visuelles chez les adultes et chez les enfants. Rev. Phil., 1896, 41, 169-181.

HEYMANS, G. Quantitaetive Untersuchungen ueber das "optische Paradoxon." Z. Psychol., 1896, 9, 221-255.

LEWIS, E. O. Confluxion and contrast in the Mueller-Lyer illusion. Brit. J. Psychol., 1909, 3, 21-41.

MUELLER-LYER, F. C. Optische Urtheilstäuschungen. Arch. Physiol., Suppl. Bd., 1889, 263-270.

SCRIPTURE, E. W. The new psychology. (2nd ed.) New York: Scribner's, 1905. Accepted April 6, 1967.