

THE MÜLLER-LYER ILLUSION IN SCHIZOPHRENIC PATIENTS*

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THE Müller-Lyer illusion is one of the best-known geometrical optical illusions. It was described by Müller-Lyer in 1889 (7) and first studied quantitatively by Heymans in 1896 (5).

Figure 1 illustrates this illusion:



FIG. 1.—Müller-Lyer figure used in the experiment.

Segments “a” and “b” are the same length (each 2 inches). However segment “a” which ends with two “arrow feathers” looks longer than segment “b” which ends with two “arrow heads”.

The literature on the subject of the Müller-Lyer illusion is very extensive and will not be reviewed in this paper. It is important to mention, however, that no significant correlation has been found between intelligence and susceptibility to this illusion (3), and also that there are no reliable sex or age differences in the sensitivity to it (4, 10). The latter case applies to adults only; in young children the age is important because as children grow older they become less susceptible to the illusion (10). Since it occurs not only in human beings but also in animals, it must be due to some basic property of the nervous system (11).

Boring (2) in his review of the subject mentions twelve theories which were put forward by the early investigators to explain the phenomenon. The majority stressed the importance of the “total impression” as the determinant of judgment. Others, such as Wundt (12), have stressed the importance of eye movement. However the subsequent finding that the illusion still occurs when the figure is exposed tachistoscopically for a fraction of a second casts some doubt on this latter explanation as there could be no effective eye movement in such a short interval of time. The Gestalt School of psychology explained the Müller-Lyer illusion and the other geometrical optical illusions as a particular instance of a more general principle of dynamic interaction of various

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parts of the visual field (6). The percept was not only determined by the particular stimulus, but also by the whole momentary visual field, which produced certain "forces" in analogy to an electric or a magnetic field. In the particular case of the Müller-Lyer illusion the "arrow feathers" would structure the whole visual field in such a way that "forces" will be produced which would "stretch" the perceived line. On the other hand, the "arrow heads" would structure the visual field in such a way that opposite "forces" will be produced which would "compress" the perceived line.

One can see that the Gestalt School threw its support on the side of the "total impression" theories of the early investigators. In spite of the wealth of theories there is not yet any certainty about the causation of this illusion. However it is obvious that the global type of perception, encompassing the whole field, as against the more analytical perception concentrating on the line itself to the exclusion of the "arrow feathers" and "arrow heads", is conducive to the enhancement of the illusion. Recent investigations showed that subjects who perceive more "analytically" on various visual tests are less susceptible to the Müller-Lyer illusion than are those who perceive more globally (8). Weckowicz and Blewett (11) showed that in schizophrenic patients there is correlation between size constancy, concept formation and the ability to perceive embedded figures. They put forward a hypothesis that in these patients cognitive process and, therefore, perception, is more global, less differentiated and less analytical than that of normal people. This is due to the fact that schizophrenic patients are not capable of shutting off information which is irrelevant to the task in hand. In the case of perception they are incapable of concentrating on one part of the visual field to the exclusion of other parts. They are therefore much more "field-bound", much more at the mercy of all the stimulation which comes from the environment than are normals. One of the deductions from this hypothesis is that schizophrenic patients are more sensitive than non-schizophrenics to those geometrical optical illusions which depend on the influence of the total visual field on one particular part, singled out for attention. The Müller-Lyer illusion fulfils this condition, so that schizophrenic patients should be more susceptible to it than non-schizophrenic controls. This paper reports the results of an experiment carried out to test this deduction from the major hypothesis.

METHOD

A set of fifty-six Müller-Lyer figures was used. Each figure was four inches long. The proportions of the two segments varied. There were four groups of fourteen figures each. The lengths of the segment between the "arrow feathers" in different groups varied by one-sixteenth of an inch from one and seven-sixteenths to two and four-sixteenths. In each case the length of the segment between the "arrow heads" was the remainder of four inches. The figures were drawn in blue ink on four by six inch white cards. The "arrow feathers" and "arrow heads" intersected the base line respectively at 150 degrees and 30 degrees. They were one-half inch in length. An additional card in which two segments were separated by a vertical short line served as a demonstration card. The cards were shown on a special small stand, which was completely covered by the card. The stand was always put at the same place on the table so that the position from which the figures were observed and the distance from the eyes differed only slightly from one presentation to another. To avoid changes in illumination, the cards were shown in artificial light (ordinary

electric bulbs) with the blinds drawn. The figures were always shown with the segment between the "arrow feathers" on the left side of the subject's visual field. The time of exposure was not controlled but the subjects were encouraged to give quick responses.* The cards were presented in random order. Before each experiment, the cards were shuffled. The subject was first shown the demonstration card and the experimenter explained to him what was meant by the longer and shorter segments. He was then instructed to tell each time whether the left or right segment was longer, or whether both were the same. He was told to use his first impression and he was encouraged to make his judgment as quickly as possible. After each judgment, a new card was put on the stand. Each subject was shown all fifty-six cards.

SAMPLE

The sample consisted of three groups. The first group was twenty-seven chronic schizophrenic patients. In all cases the diagnosis of schizophrenia had been firmly established by all psychiatrists who examined them. There were sixteen males and eleven females. Nine patients were diagnosed as hebephrenic, six patients as paranoid, two as simple, two as catatonic and eight as undifferentiated schizophrenics. The mean age of the schizophrenic subjects was thirty-eight years (range 25–55). No patient in whose case there was a possibility of mental deficiency or organic brain disease was included. Only patients who would co-operate in the experiment were included in the sample.

The second group was twenty-eight normal controls. They were members of the domestic and nursing staff of the hospital and some were voluntary visitors. There were seventeen males and eleven females. The mean age of the normal controls was thirty-five years (range 19–71).

The third group was nineteen non-schizophrenic patients. There were eleven males and eight females. Three patients were diagnosed as involuntarily melancholic, three as psychopathic personality, two as manic-depressive psychosis, three as alcoholic, three as epileptic, two as psychoneurotic and three were miscellaneous. Some depressives had undergone recently electric shock treatment. The mean age of the non-schizophrenic patients was thirty-five years (range 13–71). No subject with gross refraction error was included in the sample.

The subjects who used glasses for reading were instructed to use them in the experiment. Since there is no significant correlation between intelligence and susceptibility to the Müller-Lyer illusion (3) the samples were not matched for intelligence.

RESULTS

Subjects whose threshold for the Müller-Lyer illusion is low would judge the "arrow feather" framed segment longer than the other segment at smaller ratios of the two segments. On the other hand, subjects whose threshold for the illusion is high would require greater ratios of the two segments to make this judgment. (Ratio $\frac{a}{b}$ in Fig. 1). In this experiment the segment, framed by the "arrow feathers" was always on the left side of the visual field. Therefore the subjects in whom the illusion is produced by smaller ratios of the "arrow

* The time of exposure influences the susceptibility to the illusion (1). However, in all experiments where time is rigidly controlled, schizophrenic patients are usually penalized as they perform worse under stress conditions produced by timing.

feather" segments to the "arrow head" segments would judge the left segment longer more frequently than the subjects in whom the illusion is produced by greater ratios. The number of times the subject judged the left segment longer than the right segment was taken as his score of susceptibility to the Müller-Lyer illusion. In view of the fact that measurements could only be interpreted as having been made on an ordinal scale and not on an interval or ratio scales,* and in view of the fact that the variance of the scores of the schizophrenic group was much greater than that of the other groups, non-parametric statistics were used.

The median frequencies of "left longer than right" judgments for the three groups were as follows:

Schizophrenic patients	..	..	..	..	35.5
Normal controls	..	..	..	..	28.5
Non-schizophrenic patients	..	..	..	..	33.0

The statistical significance of the differences among the scores of the three groups was determined by ranking. The Kruskal-Wallis non-parametric one-way analysis of variance was performed on the ranks of the scores with the following results: $H=10.26$ (d.f.=2; $p<0.01$). This value of "H" shows that the three samples did not come from the same population as far as the sensitivity to the Müller-Lyer illusion is concerned. To test the difference in ranking between individual groups, the Mann-Whitney "U" tests were used. The results are summarized in Table I.

TABLE I

Groups	"U"	Z ¹
Schizophrenics vs. normals	159.5	3.69***
Schizophrenics vs. non-schizophrenics	172.5	1.89**
Non-schizophrenics vs. normals	166.5	2.16*

¹ Z is corrected for ties.

² Two asterisks denote $p<0.01$.

³ One asterisk denotes $0.05>p>0.01$.

DISCUSSION

The results show that there is a very significant difference in the susceptibility to the Müller-Lyer illusion between normals and schizophrenics and that there are less significant differences between both normals and non-schizophrenics and non-schizophrenics and schizophrenics. Schizophrenics are by far the most susceptible to the illusion of all the three groups. How can these results be interpreted? If there were no difference between normals and non-schizophrenics, the results would confirm the deduced hypothesis that greater susceptibility to the Müller-Lyer illusion is quite specific for the schizophrenic illness and is due to the peculiarities of the perceptual, and speaking more generally, cognitive processes of these patients. However, non-schizophrenic mental patients were found to differ from normals in the same direction as schizophrenics although to a lesser degree.†

* It is obvious that responses given to different ratios of segments cannot be regarded as equal units on a ratio scale. To use ratio scale on the data it would be necessary to give different weightings for smaller ratios and lower weightings for greater ratios.

† In order to check these differences by parametric statistics the average length of the "arrow feather" segment judged equal to the "arrow head" segment was found. In other words, the Point of Subjective Equality (P.S.E.) was calculated for each subject. The results obtained by analysis of variance were similar to those found by the previous method. However, in view of a lack of homogeneity of variance non-parametric statistics were considered more applicable to the data.

There are two possible explanations of this. The first, in our opinion less likely, is as follows: The susceptibility to the Müller-Lyer illusion does not depend on a specific diagnosis, but is a result of mental illness as such. Its cause could be explained as "emotional disturbance" or "regressive tendencies" of mentally ill people. However, this explanation, in order to account for the statistically significant difference between schizophrenics and non-schizophrenics, requires two assumptions. The first assumption is a positive correlation between the severity of mental illness and susceptibility to the illusion; the second assumption is that schizophrenics are more severely ill than other groups of mental patients. At the present, evidence in support of these assumptions is lacking.

The other explanation, preferred by the authors, is the following one: The samples used in the experiment were not homogeneous enough. In the sample of normal controls were included a few university students who worked as summer relief nurses. These subjects, although they denied it, could have been familiar with the Müller-Lyer illusion and could have artificially lowered the scores of the normal group. The statistically significant difference between the schizophrenic patient group and non-schizophrenic patient group is much more important. Thus the authors believe that two independent factors were responsible for the differences obtained. The first was a non-specific one, perhaps due to the fact that the normal control sample was not properly matched with the other samples. The second was more specific and was responsible for the difference in the sensitivity to the Müller-Lyer illusion, found between schizophrenic and non-schizophrenic patients. Schizophrenics are more susceptible to the Müller-Lyer illusion than non-schizophrenics. Thus a deduction from a more general hypothesis that perception and, speaking more generally, cognition in schizophrenic subjects is more global, less differentiated and analytical than that of non-schizophrenic subjects has been confirmed by the experiment. This shows that schizophrenics have difficulty in maintaining a perceptual set and in concentrating on one part of the perceptual field to the exclusion of other parts. In broader context it means that these patients are less capable of shutting off information which is irrelevant to the task in hand.

SUMMARY

Susceptibility to the Müller-Lyer illusion was tested in schizophrenic patients, non-schizophrenic mental patients and normals. A significant difference was found in the susceptibility to the illusion between the groups. Schizophrenics were more susceptible to the illusion than the other two groups. Non-schizophrenics were less susceptible than schizophrenics and more susceptible than normals. The significance of this finding for the cognitive process in schizophrenic patients was discussed.

REFERENCES

1. ANDREWS, T. G., and ROBINSON, I. P., "Time error and the Müller-Lyer illusion", *Amer. J. Psychol.*, 1948, **61**, 229-235.
2. BORING, E. G., *Sensation and Perception in the History of Experimental Psychology*, 1942. New York: Appleton Century Inc.
3. CROSLAND, H. R., *et al.*, "Intelligence and susceptibility to the Müller-Lyer illusion", *J. Exp. Psychol.*, 1927, **10**, 40-51.
4. HARTMANN, G. W., and FRICHE, A., "Differential susceptibility of children and adults to standard illusions", *J. Genet. Psychol.*, 1933, **42**, 493-498.
5. HEYMANS, G., "Quantitative Untersuchungen über das 'Optische Paradoxon'", *Z. Psycho.*, 1896, **9**, 221-255.
6. KAFKA, K., *Principles of Gestalt Psychology*, 1935. New York: Harcourt, Brace.

7. MÜLLER-LYER, F. C., "Optische Urtheilstauschungen", *Arch. Physiol.*, Suppl. Bd., 1889, 262-270.
8. SCHILLER, L., "Global perception and personality type", *Z. Psychol.*, 1942, **25**, 101-155.
9. WALTERS, A., "A genetic study of geometrical-optical illusions", *Genet. Psychol. Monogr.*, 1942, **25**, 101-155.
10. WARDEN, C. J., and BAER, J., "The Müller-Lyer illusion in the ring dove", *J. Comp. Psychol.*, 1929, **9**, 275-292.
11. WECKOWICZ, T. E., and BLEWETT, D. B., "Size Constancy and Abstract Thinking in Schizophrenic Patients", *J. Ment. Sci.* (in press).
12. WUNDT, W., "Die geometrischoptischen Fälschungen", *Abh. Sächs. Wiss. Math.-phys. Cl.*, 1898, **24**, 53-178.