VISUAL ILLUSIONS AS A FUNCTION OF THE DENSITY OF THE FUNDUS OF THE EYE

A Thesis

Presented to

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Master of Arts

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by

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ABSTRACT

Pollack and Silvar (1967) have hypothesized that the fundus-density of the human eye is related to susceptibility to geometric illusions. Using a between race design, they found that Caucasian children were more susceptible to the outgoing Müller-Lyer illusion than Negro children. The purpose of the present study was to assess the generality of Pollack and Silvar's hypothesis using a within race design (Caucasian college students), additional controls, and different sized targets of several illusions. 74 Ss were divided into five fundus-density groups on the basis of relative perceived fundus darkness. 10 mm, 35 mm, and 60 mm sized targets of the outgoing and ingoing Müller-Lyer illusions, and the horizontal-vertical illusion served as the targets. Control cards of the same length were also presented to control for estimation bias. Fundus-density was not found to be a significant variable, at the .05 level, nor did fundus-density interact significantly with any other variable. Illusion, target size, and the illusion x size interaction were significant at the .05 level, or better. Specifically, with an increase in target size, the ingoing Müller-Lyer illusion and the horizontal-vertical illusion remained relatively the same. However, the outgoing Müller-Lyer illusion decreased as a function of target size. These results were explained in terms of assimilation theory (Pressey, 1967, 1970a, 1970b, 1971).

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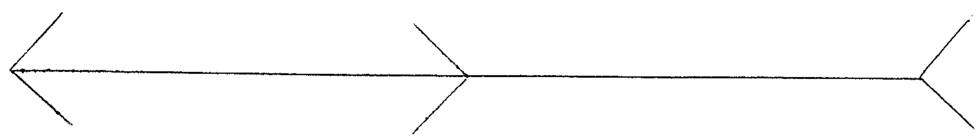
CHAPTER I

INTRODUCTION

It is well known that things are not always what they seem. Often in the psychology of perception, this distinction has been conceptualized in terms of the objective and the subjective, or the real and the illusory. Traditionally, an illusion has been defined as a mis-taken percept. That is, an event which does not correspond to the objective situation. Phenomenologically, an illusion has been defined as a perceptual judgment, which is the net result of past experience and present stimulation. Merleau-Ponty (1945) contended that there was no one correct way of perceiving a stimulus. In line with this, Boring (1942) has argued against considering illusions as a separate class of perception. Rather, he contends that when the general laws of perceptual processes are known, the illusions will also be understood. Boring also pointed out that, since the beginning of experimental psychology, illusions have been used to study distortion of visual space. In attempting to develop theories of the origins and mechanisms of illusions, psychologists have investigated the influence of stimulus and organismic variables on the magnitude of illusions. Two of the first illusions to be studied experimentally were the Müller-Lyer figure and the horizontal-vertical illusion (Woodworth & Schlosberg, 1954).

Methods of Measuring Visual Illusions

The Müller-Lyer figure. In 1889, Müller-Lyer discovered that if outgoing obliques (arrowfeathers) were placed at the end of a standard line, that line would appear elongated. On the other hand, if ingoing obliques (arrowheads) were placed at the end of a standard line, that line would appear shrunken. This illusion is shown in Figure 1.



a b

Fig. 1. The Müller-Lyer illusion, Brentano version in horizontal orientation. Line a, surrounded by two arrowheads, appears shorter than line b which is surrounded by two featherheads. The two lines are physically equal in length.

Different psychophysical methods have been used to study the Müller-Lyer illusion (Stevens, 1951). The major techniques that have been used include: the method of adjustment, the method of limits, the method of paired comparisons, and the method of constant stimuli. The method of reproduction has also been used, but less frequently.

The method of adjustment requires a subject to adjust a stimulus until it is subjectively equal to or in a particular relation to some criterion. The method of limits requires a subject to signal the apparent relation of a stimulus, whose upward or downward movement is controlled by the experimenter, to a criterion. The method of paired comparisons requires a subject to indicate which stimulus of a pair is greater, in terms of a given attribute. Stimuli are presented in pairs, and each stimulus is paired with each other stimulus. The method of constant stimuli requires a subject to say which comparison stimulus is greater or less than a standard. Several comparison stimuli are paired at random with a fixed standard until the particular relationship, as it appears to the subject, is established. Finally, the method of reproduction requires a subject to reproduce a given relationship, as it appears to him, by responding directly (i.e., not by verbal report) on a stimulus figure or in the immediate area of the figure.

The Horizontal-vertical illusion. In 1851, Fick noticed that a vertically extended length, as compared with a horizontally extended physically equal length, was overestimated. That is, the vertical was perceived as greater than the horizontal although both lengths were physically equal. This phenomenon is shown in Figure 2.

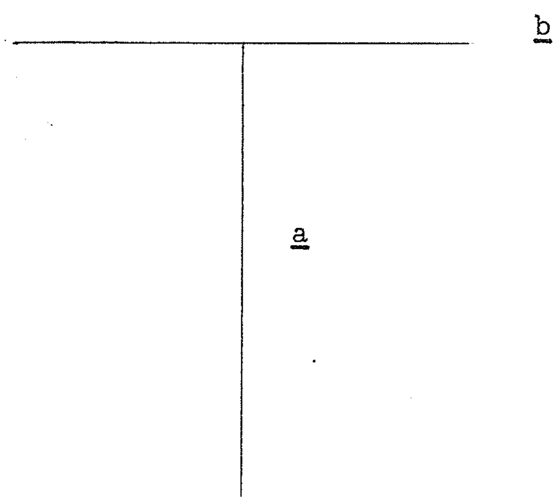


Fig. 2. The horizontal-vertical illusion, or T-figure. The vertical line *a* is perceived as greater than the horizontal *b*. The two lines are physically equal in length.

Different psychophysical methods have been used to study the horizontal-vertical illusion. The three most frequently used techniques are similar to those used for the Müller-Lyer figure. To date, however, the method of reproduction has not been used to study the horizontal-vertical illusion.

<u>The control issue</u>. There has been a lack of use of a control condition in the study of visual illusions, especially in earlier researches. The logical necessity of a control condition has been pointed out by Pressey (personal communication, 1969). Some subjects may have a systematic pre-experimental response bias to underestimate or overestimate a standard line. Hence, when arrowheads are added to a standard line (the ingoing Müller-Lyer form), the illusory effect of shrinkage could combine with a subject's underestimation bias yielding an exaggerated illusion. In line with this reasoning, when arrowfeathers (the outgoing Müller-Lyer form) are added to a standard line, the subject's underestimation bias could be operating yielding a disproportionately small illusion. Similarly, if a subject had a pre-experimental response bias to overestimate, the opposite results could be expected. The same argument holds for other illusions of extent including the horizontal-vertical illusion.

The magnitude of the Müller-Lyer and horizontal-vertical illusions has been investigated as a function of different stimulus and organismic variables. Findings of investigations with several stimulus and organismic variables are presented. However, since the present study is an empirical investigation of visual illusions as a function of eye pigmentation density and stimulus target size within a single cultural group, studies concerned with these last two variables are presented in greater detail.

Stimulus Variables: Major Studies with the Müller-Lyer Illusion

Since the beginning of experimental psychology, a large number of studies have dealt with stimulus variables influencing the magnitude of the Müller-Lyer illusion. Magnitude of the illusion has been found to vary with the length of the obliques (Dewar, 1967a; Heymans, 1896; Lewis, 1909). Dewar found that the magnitude of illusion was directly related to the length of the obliques. That is, as the length of the obliques increased, relative to length of the shaft, the magnitude of the illusion increased. Other investigators (Heymans, and Lewis) demonstrated this with the additional finding that a maximum point was reached beyond which the illusion began to decrease.

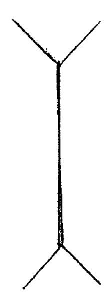
Investigators have also found that the magnitude of the illusion varies with the angle of the obliques (Dewar, 1967a; Heymans, 1896; van Bierliet, 1896). Heymans found that as the angle became more acute, the magnitude of the illusion increased. Van Bierliet demonstrated this finding in the same year. In a systematic study, Dewar found no angle by length interaction. Rather, he confirmed the earlier findings that the magnitude of the illusion increased as the angle between the obliques increased, and that the magnitude of the illusion increased as the length of the obliques increased.

Binet (1895) investigated the separate effects of each Müller-

Lyer form. He used a method of constant stimuli, and compared each form to standard lines. In the first trial, he compared a 20 mm outgoing form to standard lines. The amount of illusion was approximately 25%. He also compared a 26 mm ingoing form to standard lines. The amount of illusion was approximately 7%. He used the 26 mm ingoing form because he claimed it appeared equal to the 20 mm outgoing form. Binet concluded that the effect of the illusion of elongation was about four times as great as the effect of the illusion of shrinkage with small standards (or targets). Several problems confounded the accuracy and conclusiveness of these results. First, Binet did not use a control condition. Second, the target size was not equivalent for both forms of the illusion (20 mm versus 26 mm). Therefore, an accurate appraisal of any differential illusory effects, as a function of illusion form, was not possible. Another early investigator studied the separate effects of each Müller-Lyer form. Smith (1906) used a method of reproduction to study correlations between the two forms of the Müller-Lyer illusion. He used a control condition to check for any residual response bias, and he found a slightly negative correlation ($\underline{r} = -.26$) between the two forms. The magnitude of the outgoing form was one-quarter larger than the magnitude of the ingoing form of the illusion. However, Smith dropped one third of the subjects from the experiment, a tactic for which he did not provide a rationale. Furthermore, Smith did not provide an estimate of the probability that his results were due to chance. Pressey (personal communication, 1969) recalculated Smith's data and found that $\underline{p}$ was greater than .05. Thus Smith had not found a significant difference, at the .05 level, in illusory effect between the two forms of the Müller-Lyer illusion.

Many investigators have found that the magnitude of the illusion decreases with practice (Dewar, 1967b; Judd, 1902; Köhler & Fishback, 1950a, 1950b; Lewis, 1908; and Mountjoy, 1958, 1963). This finding has been reliably demonstrated with a variety of stimulus figures and methods.

The effect of target size is a variable which was investigated in early researches (Binet, 1895; Heymans, 1896). However, there has been a lack of systematic validation of the early findings. Binet completed several investigations of target size, one of which is of direct importance here. He used a method of constant stimuli to study the magnitude of two Müller-Lyer forms in children (aged 9 to 12 years). In the first trial, subjects were required to compare seven vertically oriented <u>ingoing</u> Müller-Lyer forms varying in length from 90 mm to 150 mm, to a vertically oriented <u>outgoing</u> Müller-Lyer form, 100 mm in length, which served as the standard. Length of obliques was held constant at 40 mm across all forms. Ingoing and outgoing vertically oriented Müller-Lyer forms are shown in Figure 3.

A. 

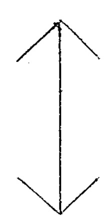
B. 

Fig. 3. A. Outgoing form of the Müller-Lyer illusion, in vertical orientation.
B. Ingoing form of the Müller-Lyer illusion, in vertical vertical orientation.

In the second trial, subjects were required to compare twelve ingoing forms, varying in length from 18 mm to 40 mm, to an outgoing form, 20 mm in length, which served as the standard. Length of obliques was held constant, at 8 mm, across all forms. The major finding was that the illusion was stronger for figures of small standard than for figures of large standard. The mean percentage of amount of illusion across size was approximately 33% for the 20 mm standard, and 22% for the 100 mm standard. In general, the younger subjects were more susceptible to the illusion. However, Binet found differential starting effects with his method such that overestimation on descending trials was greater than underestimation on ascending trials. Several problems confounded the accuracy and conclusiveness of the results of this experiment. First, Binet was measuring one illusion, the elongating or outgoing form, in terms of another illusion, the shrinking or ingoing form, without determining the identity of the elongating and shrinking effects. Second, he did not use a control condition to minimize the possible effect of a pre-experimental response bias. And third, magnitude of the Müller-Lyer illusion has been demonstrated to vary directly with the length of the obliques (Dewar, 1967a; Heymans, 1896; Lewis, 1909). It has been found as the length of the obliques increases, the magnitude of the illusion increases. Length of obliques was held constant in both trials of the Binet experiment. Hence, the possibility of length of obliques interacting differentially across target size was uncontrolled since the length of the obliques was not proportionally the same across target size.

Heymans (1896) also investigated the effect of target size on the magnitude of illusion. He used a method of adjustment. Subjects had to compare a movable line (the outgoing component) to a standard line (the ingoing component). The figure used was the Brentano version of the Müller-Lyer illusion (shown in Figure 1). Heymans found that the amount of illusion decreased slightly with an increase in target size--from 25% to 21% over target lengths of 25, 50, 75, 100, and 150 mm. Several problems confounded the accuracy and conclusiveness of these results. First, Heymans did not use a control condition. Second, Heymans was measuring one illusion, the shrinking or ingoing form, in terms of another illusion, the elongating or outgoing form.

To date, a controlled systematic study of the effect of target size on the Müller-Lyer illusion has not been completed.

<u>Organismic Variables: Major Studies with the Müller-Lyer Illusion</u>

The magnitude of the illusion has been found to decrease with age (Binet, 1895; Piaget, 1969; van Biervliet, 1896). Several investigators (Walters, 1942; Wapner & Werner, 1957) have studied age changes in the Müller-Lyer illusion more closely. They found that the illusion decreased with age to 10 to 12 years, then increased slightly from 15 to 19 years.

The magnitude of the illusion as a function of intelligence and retardation has also been investigated. Williams (1902) found that intelligence and susceptibility to the illusion were not related. However, Crossland, Taylor and Newson (1927, 1929) suggested that there was a negative relationship between high intelligence and a high degree of susceptibility to the illusion. More recent work with retardates has suggested that severity of retardation is negatively related to susceptibility to the Müller-Lyer illusion (Spitz & Blackman, 1958).

Susceptibility to the illusion has been found to be positively related to schizophrenia (Wapner & Werner, 1957; Weckowicz & Whitney, 1960; Witkin _et al_., 1954, 1962). That is, schizophrenic patients perceive a greater illusion than do normal controls. Finally, the magnitude of the illusion has been found to decrease with prolonged fixation and/or inspection (Day, 1962; Pollack & Chaplin, 1964; Selkin & Wertheimer, 1957).

The magnitude of the illusion has been found to be related to the culture within which the individual has been reared. Using a method of adjustment, Rivers (1905) investigated visual and tactile perception in the Todas of Southern India and Englishmen. He found that the Englishmen were more susceptible to the whole Müller-Lyer figure than the Todas.

Segall, Campbell, and Herskovits (1963, 1966) have conducted a large part of the research on cultural differences in the perception of geometrical illusions. In 1963, they published data from 15 societies (12 non-Western and three Western) which showed substantial intersocietal differences in susceptibility to the whole Müller-Lyer figure. Using a method of constant stimuli, Segall, Campbell and Herskovits (1963) found that on the Müller-Lyer illusion the three Western samples made significantly more illusion-produced responses than did the non-Western samples.

Recently, magnitude of the Müller-Lyer illusion has been studied as a function of eye pigmentation. Silvar and Pollack (1967) evaluated differences in pigmentation of the fundus of the eye in American Negro and Caucasian children between the ages of 8 and 12, and found that racial differences significantly ($p < .001$) predict discernible differences in the density of the fundus. Negroes were found to have a darker (more dense) fundus than Caucasians. In a subsequent study, Pollack and Silvar (1967) investigated the perceptual consequences of this finding. Two groups of 15 (13 Negroes, two whites) and 20 subjects (one Negro, 19 whites), matched for age, school grade, economic status and reading achievement level, were divided into darkly pigmented and lightly pigmented fundus categories, respectively. Using a convergent method of limits with stimuli constructed for tachistoscopic use, Pollack and Silvar found that darkly pigmented subjects were significantly less susceptible ($p < .01$) to the outgoing Müller-Lyer illusion than lightly pigmented subjects. However, Pollack and Silvar did not use a control condition in their study.

In a previous research, Pollack (1966) has distinguished between two kinds of developmental change:

> "One kind, properly labeled developmental, reflects qualitative changes in the underlying processes that determine perceptual behavior, even though these changes may be continuous. The other kind involves quantitative changes due to a continuing adaptation or aging of peripheral receptor systems, including, perhaps, the primary projection areas of the cortex" (p. 82).

Pollack has argued that the second kind of change is non-developmental because it does not involve a change in the organism's method of handling sensory input, but, rather, in the <u>efficiency</u> of the organism's receptor system. Hence, Pollack contended that ontogenetic changes in Piagetian Type I (1969) illusions (illusions that decrease with age such as the Müller-Lyer and the horizontal-vertical) are due to degenerative changes in the visual apparatus, which are a function of the continuing adaptation or aging of the organism, and not a function of the organism becoming progressively more analytical. He cited as evidence the fact that there was a correlation of -.99 between age and density of primary projection cortical cells over a range of 95 years (Brody, 1955). That is, as the visual apparatus ages, the density of primary projection cortical cells decreases. Pollack (1963) has argued that this may indicate a loss of cerebral sensitivity with age as well as a loss in more peripherally defined functions. Also, Pollack pointed out that Weale (1963) has reported that the density of the fundus increases with age and there is a corresponding decrease in light transmission through the crystalline lens with age (Weale, 1961a, 1961b).

<u>Stimulus Variables: Major Studies with the Horizontal-Vertical Illusion</u>

The magnitude of the illusion has been found to vary as a function of form and direction of the illusion. Finger and Spelt (1947) were two of the first psychologists to discover that the illusion was smaller if set in the form of an L instead of a T. Piaget (1969) has found, using his clinical concentric method, that the minimum illusion occurred when the form was any L-shaped continguration (└ , ┘ , ┌ , and ┐). The illusion was maximum when either the T or inverted T-form was used, and the illusion was moderate when the modified T-forms were used ($\dashv$ and $\vdash$ forms). Kunnapas (1955) used a method of constant stimuli and four conditions of the illusion, arranged according to four directions ($\perp$, $\vdash$, $\top$, and $\dashv$) of the dividing line. In general, Kunnapas found two illusions: the classical overestimation of the vertical as compared to the horizontal and the overestimation of the dividing line <u>per se</u>. Piaget corroborated these findings and contended that "two deformations [illusions] are involved, one being the horizontal-vertical effect and the other the overestimation of an intersector, which is due to the inequality of the intersector and the two parts of the divided line" (p. 12). Both investigators noted that to refer to the illusion as horizontal-vertical was wrong because the horizontal is overestimated (not underestimated) when the figure is in the $\vdash$ form. This is due to the inequality of the intersector and the two parts of the divided line, and not to the horizontal-vertical effect since here it is the vertical line and not the horizontal line which is being intersected. Finally, Pollack and Chapanis (1952), using the L-form of the illusion, found that as the orientation of the variable line (the vertical) was varied in 10-degree steps away from or to the standard (the horizontal) the magnitude of the illusion increased. That is, as the variable line became more vertical it was underestimated. In general, the investigators found that any slanted line appeared longer than a horizontal line; hence, it was underestimated and yielded a negative constant error.

Several investigators (Mountjoy & Chordes, 1958; Valentine, 1912) have investigated decrement to the horizontal-vertical illusion as a function of practice. The results have indicated a decrease in the magnitude of the illusion with practice. Although this phenomenon was also demonstrated with the Müller-Lyer figure, the functions of the decrement have not been found to be identical.

The effect of target size (or the length of the standard) on the horizontal-vertical illusion has been investigated (Begelman & Sternfield, 1967). Using a method of adjustment, these investigators found that as the length of the standard (either horizontal or vertical) increased the amount of illusion decreased from 7.8% (for a 50 mm standard) to 2.7% (for a 200 mm standard). Two problems are involved. First, the investigators did not use a control condition to minimize the effect of any response bias in estimating either horizontal or vertical lengths. Second, the method of adjustment may be confounded since two illusions seem to be operating when this method is employed (Piaget, 1969)--the illusion of the intersector, and the illusion of the divided line. It appears, in the horizontal-vertical illusion, that the intersector is elongating and that the divided line is shrinking. In any event, the method of adjustment does not control for these differential effects since with this method one component is compared (adjusted) to another.

Organismic Variables: Major Studies with the Horizontal-Vertical Illusion

The magnitude of the illusion has generally been found to decrease with age (Rivers, 1905; Walters, 1942; Winch, 1907). Walters used a method of limits with subjects aged 6 to 19 years. She found a function which was more variable at the earlier ages, and a slight increase in the illusion in the oldest subjects.

Kunnapas (1957a, 1957b) has investigated the illusion as a function of surrounding fields which are more or less similar to the shape of our visual field. He found overestimation of vertical distance to be greater in fields which were less vertical, or fields which were more akin to the oval or elliptical shape of our visual field such as rectangles. In line with this, Kunnapas (1958) has found that the vertical line in the illusion is overestimated when the observer's head is in the vertical position but underestimated when the observer's head is shifted to the horizontal position. Hence, the illusion has been found to vary as a function of observer orientation.

The magnitude of the illusion has been found to be related to the culture within which the individual has been reared. Rivers (1905) found that Englishmen were less susceptible to the T and L-forms of the horizontal-vertical illusion than Todas in Southern India. Data from Segall, Campbell and Herskovits' (1963, 1966) research corroborated the finding that non-Western subjects were more susceptible to the horizontal-vertical illusion than Western subjects. These investigators used the T and ⌉ forms of the illusion, and found that non-Western subjects had significantly, at the .05 level, more larger mean scores on the horizontal-vertical illusions than Western subjects. The authors also factor analyzed their data and two orthogonal factors emerged; the Müller-Lyer illusion loaded highly on one, and the horizontal-vertical illusion loaded highly on the other. They concluded that the data indicated not only cross-cultural differences in susceptibility to illusions, but also systematic variation in those differences across two classes of illusion. Unfortunately, these investigators did not use any control conditions.

Statement of the Problem

Fundus-density may be an important organismic variable to investigate. However, problems with Pollack and Silvar's (1967) findings necessitate further study in order to assess the generality of these findings. Pollack and Silvar found a correlation between fundus-density and susceptibility to the outgoing Müller-Lyer illusion, and hypothesized a mechanism--that fundus-density mediates susceptibility. Here, the task was to investigate the effect of fundus-density on several illusions under different, but more controlled conditions. First, Pollack and Silvar employed a between race design. That is, although they compared a light pigmentation group to a dark pigmentation group, the majority (95%) of the former group were Caucasian children, and the majority (87%) of the latter group were Negro children. Thus racial and/or cultural difference, and not a difference in fundus-density, is a logical rival hypothesis to account for the finding that lightly pigmented subjects were more susceptible to the illusion. Second, Pollack and Silvar did not use a control condition; the logical necessity of a control condition has been pointed out above. Also, these investigators used one illusion in their study--the outgoing Müller-Lyer form. The present study employed a within race design (only subjects from one race in the same culture were used) with a different age group, and a different method of measuring several illusions, including approximately the same size of the illusion Pollack and Silvar originally used. A method of production was employed because it has been demonstrated to be a rapid and reliable measure of illusions of size and direction (Pressey & Bayer, 1970; Pressey, Bayer, & Kelm, 1969; Pressey & Sweeney, 1969). Furthermore, this method is not confounded by the starting effects Binet (1895) and many other investigators have found using methods of adjustment. A different population was employed to assess the generality of Pollack and Silvar's findings in another age group. Several illusions were used in the present study to assess whether the effect of fundus-density was specific to either form of the Müller-Lyer illusion, or the horizontal-vertical illusion. It has been pointed out above that differential effects may be operating in each of the two Müller-Lyer forms. Hence, a finding with one form may not hold with the other form. To date, a systematic controlled study of the effect of target size on the Müller-Lyer illusion has not been completed. Binet's (1895) early investigation of target size and the two forms of the Müller-Lyer has not been extended, to any great degree. Here, target size was systematically varied across both forms of the Müller-Lyer illusion, and the T-form of the horizontal-vertical illusion in order to collect reliable and controlled data. Further, the method of production was used in the investigation of the horizontal-vertical illusion. This method seems appropriate for investigating this illusion since it minimizes the interaction of the illusion of the insector and the illusion of the divided line by only requiring the subject to reproduce the horizontal component and not compare a horizontal to a vertical component, or vice versa.

In sum, the main purpose of this study was to assess the generality of Pollack and Silvar's (1967) hypothesis that eye pigmentation is related to susceptibility to the Müller-Lyer illusion. A secondary purpose was to complete a controlled systematic study of the magnitude of both forms of the Müller-Lyer and horizontal-vertical illusions as a function of target size.

CHAPTER II

METHOD

Subjects

*S*s were 74 men enrolled in the introductory psychology course at the University of Manitoba. These students were required to serve as *S*s for psychology experiments as part of their course requirements. The sample was restricted to Caucasian Manitobans between the ages of 18 and 22 years who had good (normal) vision, with or without glasses. The mean age of the sample was 20.38, and *S*s who normally wore glasses did so during the testing.

Apparatus

The apparatus consisted of a white target holder that was 36.8 cm wide and 39.5 cm high. The face of the holder was tilted backward 20 degrees from the perpendicular so that it would be easier for *S* to mark his response directly on the target. A chin rest was placed in front of the holder (and perpendicular to the line of sight) so that the distance between the *S*'s eyes and the face of the frame was approximately 41 cm. One lamp (lit by a 100 Watt blue light bulb) was placed on each side of the target holder approximately 25 cm away from, but perpendicular to, the side of the holder.

Materials

Nine targets and three control cards were prepared (see Figures 4 to 15). Each target and control card was printed separately in black ink on a 21.5 cm high by 28.0 cm wide sheet of white paper. All lines and dot(s) on every target were .5 mm wide.

Three different sized targets of the ingoing Müller-Lyer illusion, in vertical orientation, were used. The distance between apices was 10 mm, 35 mm, and 60 mm, respectively (see Figures 4 to 6). The maximal dimensions of these stimulus targets were (vertical by horizontal) 1° 24' x 30', 4° 54' x 1° 42', 8° 18' x 3°, respectively. The obliques were one-quarter of the length of the shaft in each target, or 2.5 mm, 8.75 mm, and 15 mm, respectively. Each target was centered about an imaginary point 60 mm from the top of each sheet and 14 cm from either side. A dot was located perpendicular to the right and slightly below the top apex of each target. The location of this dot was determined by the distance between apices and length of obliques. For the 10 mm target, a dot was located at a point 10 mm to the right of the figure (5 mm to the right of the imaginary point), and 2.5 mm below the top apex. Similarly, for the 35 mm target, a dot was located at a point 35 mm to the right of the figure (17.5 mm to the right of the imaginary point), and 8.75 below the top apex. Finally, for the 60 mm target, a dot was located at a point 60 mm to the right of the target (30 mm to the right of the imaginary point), and 15 mm below the top apex.

Three different sized targets of the outgoing Müller-Lyer illusion, in vertical orientation, were used. The distance between apices was 10 mm, 35 mm, and 60 mm, respectively (see Figures 7 to 9). The maximal dimensions of these stimulus targets were (vertical by horizontal) 2° x 30', 6° 36' x 1° 42', 11° 12' x 3°, respectively. The placement and

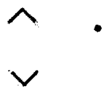


Fig. 4. Ingoing Müller-Lyer illusion, 10 mm.

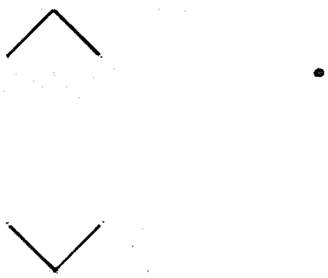


Fig. 5. Ingoing Müller-Lyer illusion, 35 mm.

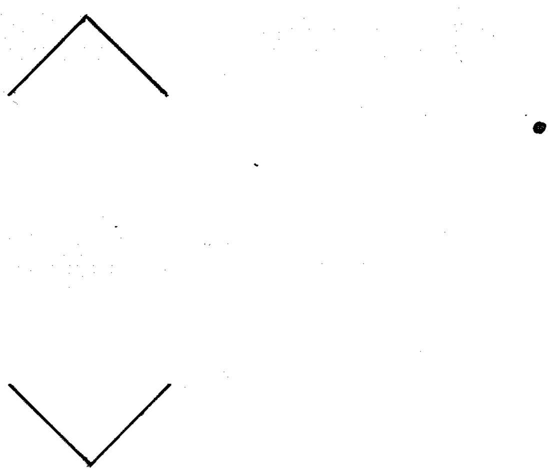


Fig. 6. Ingoing Müller-Lyer illusion, 60 mm.

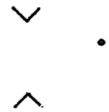


Fig. 7. Outgoing Müller-Lyer illusion, 10 mm.

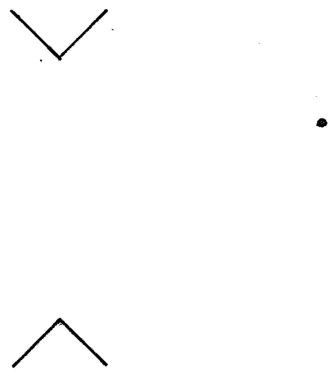


Fig. 8. Outgoing Müller-Lyer illusion, 35 mm.

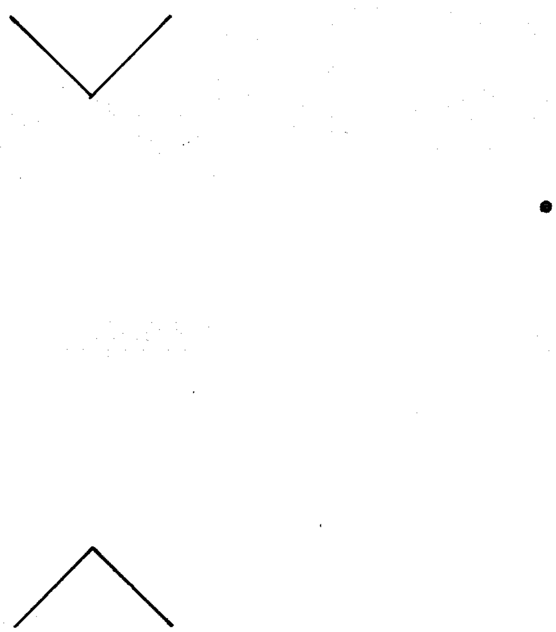


Fig. 9. Outgoing Müller-Lyer illusion, 60 mm.

other dimensions of these targets were identical to the corresponding set of ingoing targets except that, here, the obliques faced outward.

All angles formed by the ingoing or outgoing obliques of the Müller-Lyer figures were 90 degrees.

Three different sized targets of the horizontal-vertical illusion were used. The lengths of the horizontal component were 10 mm, 35 mm, and 60 mm (see Figures 10 to 12). A dot indicated the midpoint of each horizontal component. The visual angle of each stimulus length was $1^{\circ}\ 24'$, $4^{\circ}\ 54'$, $8^{\circ}\ 18'$, respectively. For each target, the horizontal line was parallel to the top of each sheet. The dot which indicated the midpoint of each horizontal corresponded to the imaginary point. Thus every target was centered about the same point.

Three control cards were used: a 10 mm control, a 35 mm control, and a 60 mm control (see Figures 13 to 15). These cards served as a control for length: distance between the apices of the Müller-Lyer targets, and vertical length of the horizontal-vertical target. The control cards were identical, in terms of placement, to the Müller-Lyer targets <u>except</u> that no angles were drawn, only dots were drawn where the apices had been.

Procedure

<u>Fundus ratings</u>. <u>S</u>s were individually assigned and divided into five groups depending on the relative perceived darkness (density) of the pigmentation of the Fundus-oculi. The area of the retina viewed was between the macula lutea and the optic disc. This area was chosen for two reasons: (1) the relative absence of blood vessels on the retinal

Fig. 10. Horizontal-Vertical illusion, 10 mm.

Fig. 11. Horizontal-Vertical illusion, 35 mm.

Fig. 12. Horizontal-vertical illusion, 60 mm.

Fig. 13. Control card, 10 mm.

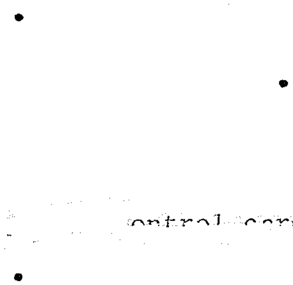


Fig. 14. Control card, 35 mm.

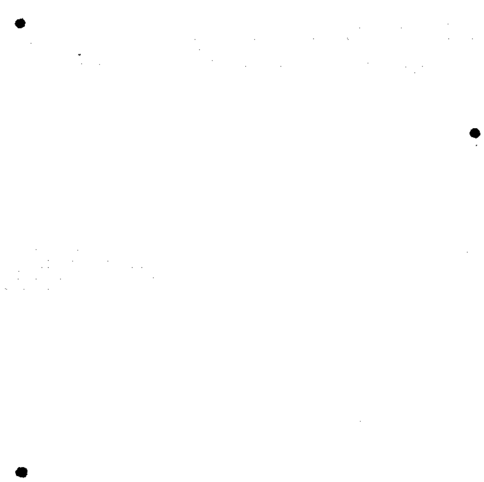


Fig. 15. Control card, 60 mm.

surface, and (2) the ease with which this area can be located consistently and focused upon.

E and a co-rater[1] performed the ratings in a dark room. Ss were subsequently divided into five density groups from light (Group 1) to dark (Group 5). Group 1 contained 15 Ss; Group 2 contained 9 Ss; Group 3 contained 21 Ss; Group 4 contained 15 Ss; and Group 5 contained 14 Ss. Two raters were used since the groups were established on the basis of relative pigmentation darkness rather than measurement of the absolute amount of pigment epithelium. Judgments were made independently between E and the co-rater. Overall percentage of agreement between raters was approximately 24%. Combining Groups 1 and 2, considered as a light pigmentation group, yielded a higher percentage of agreement, 33%. Likewise, combining Groups 4 and 5, considered as a dark pigmentation group, yielded a higher percentage of agreement, 28%. Group 3, the middle pigmentation group, yielded the lowest percentage of agreement, 10%. Agreement between E and the co-rater was low. Logically, it is probable to assume that this was a function of the fact that E was relatively untrained in the operation of the opthalmoscope, an instrument the co-rater very frequently uses, and in subsequently making accurate pigmentation darkness judgments. Hence, in the opinion of E a more valid analysis of the data was considered probable on the basis of the co-rater's judgments alone. Furthermore, the co-rater was a qualified professional, and it was assumed he was capable of making accurate

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[1] David Bryer, O.D. (Doctor of Optometry) served as the co-rater. At this time, he was employed as an optometry intern at Finkleman Optometrists, Kenaston Building, Winnipeg 2, Manitoba.

pigmentation darkness judgments.

The instrument used to rate fundus-density was a battery handle May opthalmoscope (manufactured by American Cytoscope Makers, Inc.). The opthalmoscope light was not intense enough nor the viewing time per S long enough to cause bleaching of the retina to any significant extent. Even if this did occur, it had no bearing on the classification procedure as the amount of the retinal pigment in the pigmentary epithelial layer does not vary with the state of light adaptation of the eye.[2]

Each S was rated as he appeared for classification on one of the two days. Fundus rating required approximately five minutes per S. All Ss were tested on the experiment proper seven days later from the time they were rated, in the order they signed up.

Presentation of stimuli. All Ss received all treatments, and each S was tested individually. A method of production was employed. The testing took place in a small room, illuminated by two 100 Watt bulbs. The S sat in front of the apparatus and was shown four targets (shown in Figures 6, 9, 12, and 15) for approximately five seconds each; this order was constant across Ss. E read the instructions (in Appendix) aloud. All sets of instructions specified that only one choice on each target could be made, and that judgments were to be made visually (i.e., arm or finger movements attempting to measure the distance were not allowed). The first set of instructions, for the Müller-Lyer targets explained that the task was to mark a point, on a given signal,

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[2] Personal communication from Dr. David Bryer, 1970)

which was below but in line with the dot on the right so that it indicated the distance, as it appeared to S, between the apices of the angles on the left. The second set of instructions, for the horizontal lines, explained that the task was to mark a point, on a given signal, which was below but in line with the dot on the horizontal so that it indicated the length, as it appeared to S, of the horizontal. The third set of instructions, for the control cards, explained that the task was to mark a point, on a given signal, which was below but in line with the single dot on the right so that it indicated the distance, as it appeared to S, between the two dots on the left.

The stimuli were individually presented in four consecutive randomized blocks of twelve targets for each S. No block contained more than one of each target and the order of presentation was random for all Ss. Hence, each S was presented with 48 targets in all, four trials with each target.

A needle point black ink drafting pen was used by the Ss to make their response.

A Lafayette-type memory drum was employed to control for intertrial interval. The drum was set at five seconds after which a loud click was made. This was the signal S was instructed to listen for, and then make his judgment. E took away the target as soon as possible, and each new trial began as soon as the next target was placed on the stand. Testing required approximately 15 minutes per S.

The illuminance of the stimuli was approximately 10 foot-candles.

Dependent Measures

The dependent measures were of three types: control card scores, illusion target scores, and amount of illusion. Three control scores were calculated for each S, based on mean response to the 10 mm, 35 mm, and 60 mm cards. Since all illusions involved a distortion of vertical length, the control cards served as a control for the Müller-Lyer forms and the horizontal-vertical illusion. Nine illusion scores were calculated for each S based on mean response to the three sizes of the Müller-Lyer forms, and the horizontal component of the horizontal-vertical illusion. Each S served as his own control, and amount of illusion was defined and calculated by subtracting out each S's control scores from his illusion scores in the appropriate direction as predicted by the illusion. Scores were then converted into percentages so that amount of illusion would be comparable across size.

Data analysis. Three analyses of variance (mixed factorial design, Myers, 1966) were carried out. In the first analysis, the main effects were illusion (ingoing Müller-Lyer, outgoing Müller-Lyer, and horizontal-vertical), size, and fundus-density. In the second analysis, the main effects were control scores, and fundus-density. In the third analysis, the main effects were illusion (ingoing Müller-Lyer and outgoing Müller-Lyer only), size, and fundus-density.

CHAPTER III

RESULTS

Main Analysis

A mixed factorial design analysis of variance with one between subjects factor (fundus-density) and two within subjects factors (illusion, size) was conducted on the data. The dependent measure was the amount of illusion on each target. The results of this analysis are summarized in Table 1.

TABLE 1

ANALYSIS OF VARIANCE OF AMOUNT OF ILLUSION ON ALL SIZES OF ALL TARGETS ACROSS THE FIVE FUNDUS-DENSITY GROUPS

Source of Variation	DF	SS	MS	F
Den	4	0.1022	0.0255	1.424
Error 1	69	1.2378	0.0179	
Ill	2	1.9535	0.9768	41.962***
Den Ill	8	0.2125	0.0266	1.141
Error 2	138	3.2122	0.0233	
Siz	2	0.0395	0.0197	5.295**
Den Siz	8	0.0428	0.0053	1.434
Error 3	138	0.5146	0.0037	
Ill Siz	4	0.0851	0.0213	3.566*
Den Ill Siz	16	0.0706	0.0044	0.739
Error 4	276	1.6475	0.0060	
Error due to approximation		0.1130		
Total	665	9.2314		

*$p < .05$
** $p < .01$
***$p < .0005$

Three significant effects are evident from the table. The F value for illusion was 41.962 (df = 2/138, $p < .0005$), and for size it was 5.295 (df = 2/138, $p < .01$). The F value for the illusion x size interaction was 3.566 (df = 4/276, $p < .05$). None of the remaining F values was significant at the .05 level. Fundus-density was not significant, $.10 < p < .25$.

The graph in Figure 16 indicates that the high F value for the main effect of illusion is based mostly on the large difference, in amount of illusion, between the horizontal-vertical illusion and the Müller-Lyer illusions. It is also evident from the figure that the ingoing Müller-Lyer illusion remained relatively the same as target size increased; the outgoing Müller-Lyer illusion decreased as target size increased; and the horizontal-vertical illusion remained relatively the same as target size increased.

Additional Analyses

Müller-Lyer data. A mixed factorial design analysis of variance was conducted as in the main analysis except that here the scores of the horizontal-vertical illusion were dropped out. In other words, the dependent measure was the amount of illusion on the ingoing and outgoing Müller-Lyer targets only. The results of this analysis are summarized in Table 2.

Two significant effects are evident from the table. The F value for size was 9.827 (df = 2/138, $p < .0005$). The F value for the illusion x size interaction was 6.112 (df = 2/138, $p < .005$). None of the remaining F values was significant at the .05 level. If one compares

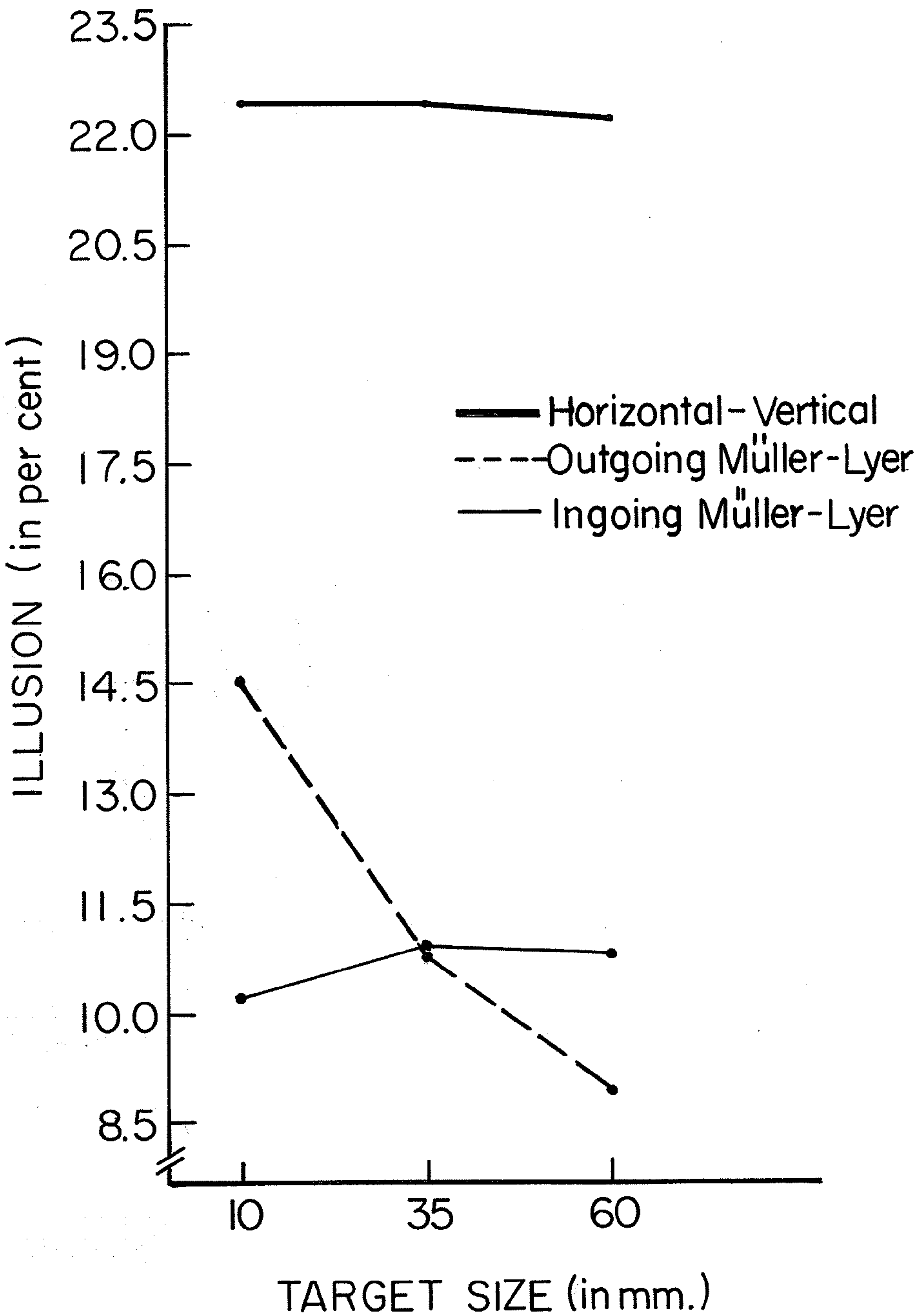


Fig. 16. The magnitude of the horizontal-vertical illusion, and the outgoing and ingoing Müller-Lyer illusions as a function of target size. The standard error at each point is .009.

TABLE 2

ANALYSIS OF VARIANCE OF AMOUNT OF ILLUSION ON ALL SIZES OF BOTH MÜLLER-LYER TARGETS ACROSS THE FIVE FUNDUS-DENSITY GROUPS

Source of Variation	DF	SS	MS	F
Den	4	0.0346	0.0087	1.017
Error 1	69	0.5873	0.0085	
Ill	1	0.0059	0.0059	0.319
Den Ill	4	0.1259	0.0315	1.706
Error 2	69	1.2723	0.0184	
Siz	2	0.0481	0.0241	9.827**
Den Siz	8	0.0153	0.0019	0.781
Error 3	138	0.3378	0.0024	
Ill Siz	2	0.0754	0.0377	6.112*
Den Ill Siz	8	0.0217	0.0027	0.440
Error 4	138	0.8507	0.0062	
Error due to approximation		-0.0283		
Total	443	3.3467		

* $p < .005$
** $p < .0005$

Tables 1 and 2, it is evident that the effect of illusion was chiefly a function of the horizontal-vertical illusion since the effect is no longer present when the horizontal-vertical scores are dropped out. Similarly, in this analysis the illusion x size interaction was stronger. Thus it appears that the effect of size is specific to the outgoing form of the Müller-Lyer illusion since the ingoing Müller-Lyer illusion and the horizontal-vertical illusion were relatively straight line functions of size.

<u>Contral data</u>. A mixed factorial design of analysis of variance

with one between subjects factor (fundus-density) and one within subjects factor (control scores) was conducted on the control data. The dependent measure was the control score on every control card. The results of this analysis are summarized in Table 3.

TABLE 3

ANALYSIS OF VARIANCE OF CONTROL SCORES ON ALL SIZES OF THE CONTROL CARDS ACROSS THE FIVE FUNDUS-DENSITY GROUPS

Source of Variation	DF	SS	MS	F
Den	4	102.1261	25.5315	1.356
Error 1	69	1299.2385	18.8295	
CTL	2	87453.3750	43726.6875	9009.070*
Den CTL	8	37.6664	4.7083	0.970
Error 2	138	669.8008	4.8536	
Error due to approximation		705.0952		
Total	221	90267.3125		

* $p < .0005$

One significant effect is evident from the table. The F value for control (score) was 9009.070 (df = 2/138, $p < .0005$). None of the remaining F values was significant at the .05 level. The extremely high F value for control (score) is not at all surprising since the control cards differed across three levels of size (10 mm, 35 mm, and 60 mm), and the control scores obviously approximated the objective value of the respective control cards. The lack of a significant density x control interaction is important because it indicates that control scores did not differ significantly across density groups.

CHAPTER IV

DISCUSSION

Fundus-Density

No significant difference, at the .05 level, was found between the fundus-density groups for the magnitude of the different sized illusions used in this study, nor did fundus-density interact with any of the remaining variables. These results do not concur with Pollack and Silvar's (1967) findings which showed that eye pigmentation is related to susceptibility to the Müller-Lyer illusion. In addition, fundus-density was not related to susceptibility to the horizontal-vertical illusion. However, it could be argued that the fundus-density rating technique, employed in this study, was not reliable enough to yield discriminative density groups. Hence, the nature of the eye pigmentation and illusion susceptibility relationship could not be clearly specified. However, the technique used here was very similar to that of Pollack and Silvar. In both studies, one professional was used to make darkness judgments. Perhaps the next logical step is to employ two professionals as raters so that a meaningful coefficient of reliability could be obtained.

The validity of the data in the present study can be demonstrated by comparison to previous findings. Even though a different method (than that of Pollack and Silvar, 1967) was employed in a different population, the data can be shown to follow logically from previous findings. In Pollack and Silvar's study, children were divided into light and dark density groups. The light group yielded a 17.68% illusion on the outgoing Müller-Lyer form. The dark group yielded a 12.86% illusion on the same form. In the present study, young adult Ss yielded a 14.50% illusion on the outgoing form of the Müller-Lyer illusion of approximately the same size as that used by Pollack and Silvar. The Müller-Lyer illusion is a Piagetian (1969) Type I illusion--it decreases with age. This finding is based on data mainly from white populations. Pollack and Silvar's light density group was 95% white, and this group yielded a 17.68% illusion. Thus the expected decrease in illusion (from 17.68% to 14.50%) with age is demonstrated when Pollack and Silvar's data is compared to the data presented here. The point is that the data from the outgoing Müller-Lyer illusion which directly links this study with Pollack and Silvar's is congruent with previous research, which has shown that the illusion decreases with age. Furthermore, these data were obtained with different psychophysical methods, both of which have been demonstrated to be reliable methods of measuring illusions of size. In sum, it seems unlikely that the method confounded the data.

The fact that Pollack and Silvar (1967), in actuality, were using a between race design probably accounts for their results since it is well known that magnitude of illusions varies with race and/or culture. And Pollack and Silvar's light density group was 95% Caucasian, and the dark density group was 87% Negro. Hence, the effect of race and/or culture is a logical rival hypothesis to account for the finding that lightly pigmented subjects were more susceptible to the outgoing Müller-Lyer illusion than darkly pigmented subjects. Thus the present study's results do not support Pollack and Silvar's hypothesis that "optical pigmentation, rather than race membership is the more important variable related to susceptibility to the illusion[s]" (p. 84). Rather, race membership, and not optical pigmentation, may be the more important variable.

Although the two racial groups in Pollack and Silvar's (1967) study were living in the same environment, some other race-related factor or variable may have accounted for their differential results. Furthermore, the fact that Pollack and Silvar did not employ a control condition may have accounted for their findings. The logical necessity of a control condition has been pointed out. Interestingly, in the present study, Ss in Density Group 1 were found to be overestimators. They overestimated the objective length of the control lines by 2.3 per cent, and subsequently yielded a greater illusion on the ingoing Müller-Lyer form and less of an illusion on the outgoing Müller-Lyer form. If a control condition had not been used, a disproportionately large outgoing illusion and a disproportionately small ingoing illusion may have resulted. Conversely, Ss in Density Group 2 were found to be underestimators. They underestimated the length of the control lines by 4.0 per cent, and subsequently yielded a greater illusion on the outgoing Müller-Lyer form and less of an illusion on the ingoing form. If a control condition had not been used, a disproportionately large ingoing illusion and a disproportionately small outgoing illusion may have resulted. In addition, Ss in Group 1 yielded a higher horizontal-vertical illusion than Ss in Group 2. In other words, in comparison to the other three density groups, Group 1 Ss tended to overestimate the horizontal length while Group 2 Ss tended to underestimate the horizontal length. These relationships between type of illusion, magnitude of illusion, and density group are shown in Figure 17. At this point, there is no way of assessing whether or not Pollack and Silvar's sample was contaminated by overestimators or underestimators since a control condition was not used. However, the possibility of an estimation bias has been shown empirically to be relevant.

Target Size

In the main analysis, illusion, size, and the illusion x size interaction was significant at the .05 level, or better. The highly significant effect of illusion was due to the fact that the horizontal-vertical illusion was larger than the Müller-Lyer illusions. The significant effect of size was specific to outgoing form of the Müller-Lyer illusion. The ingoing form was relatively uneffected by size. Specifically, as the size of the outgoing form increased, the amount of illusion decreased; and as the size of the ingoing form increased, the amount of illusion remained relatively the same. This is an intriguing finding which has not been previously demonstrated. In reviewing the various theories of illusions, E has selected the theory that can logically explain these results.

Recently, Pressey's (1967, 1970a, 1970b, 1971) assimilation theory has been formulated to explain geometric illusions of size, area, and direction. The concept, assimilation, asserts that in a group of entities, or a series of stimuli, the extremes take on the properties

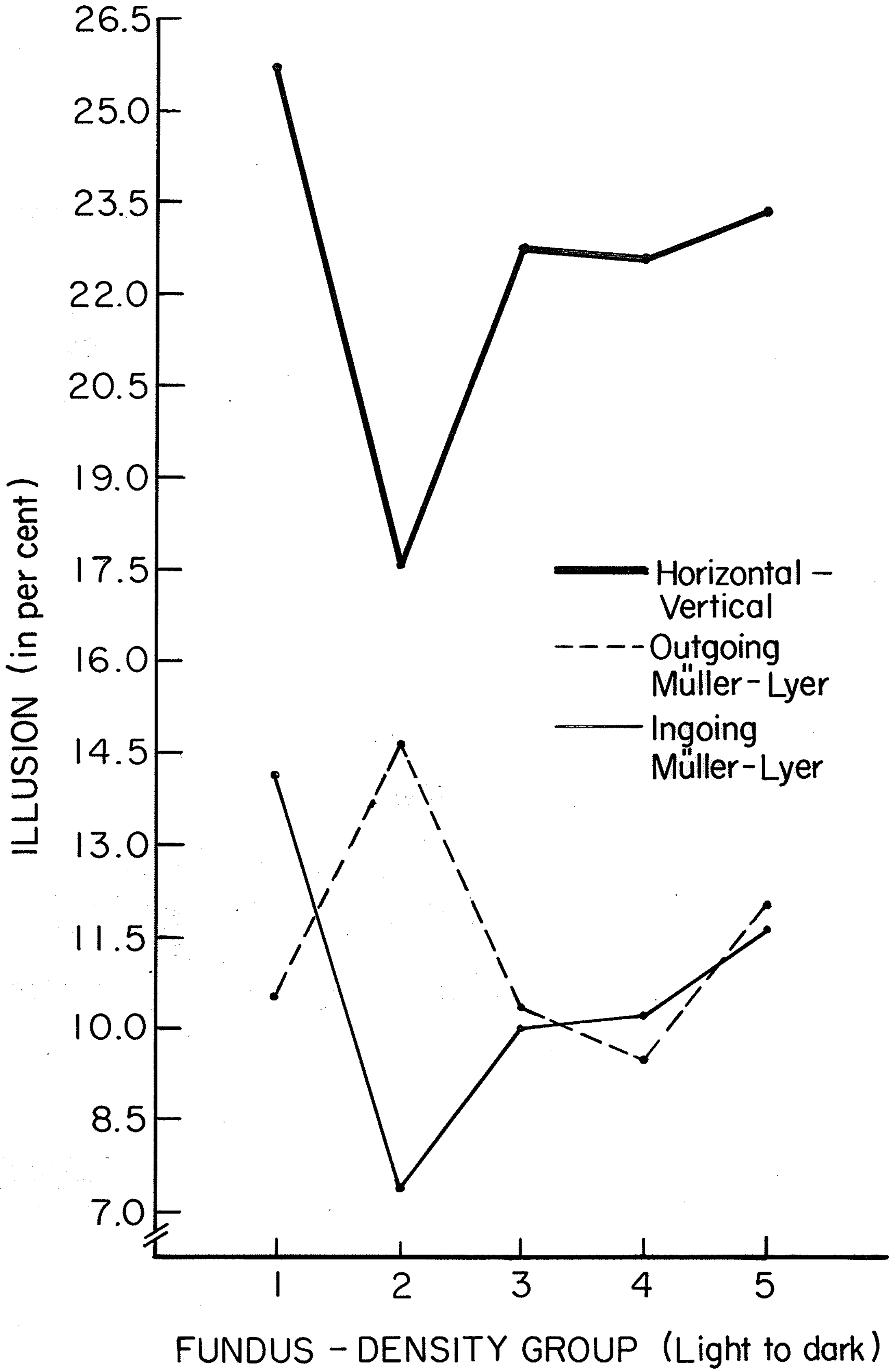


Fig. 17. The magnitude of the horizontal-vertical illusion, and the outgoing and ingoing Müller-Lyer illusions as a function of fundus-density.

(or become more like) the average of the entities, or the mean of the series of stimuli. This concept forms the major postulate of assimilation theory.

Postulate 1. "Whenever judgments are made of a series of magnitudes, the smaller magnitudes in that series will be overestimated and the larger magnitudes will be underestimated" (Pressey, 1971, p. 172).

This postulate can be applied to both forms of the Müller-Lyer illusion (see Figure 3). For the outgoing form, the shaft length (or distance between apices) is embedded in a context of varying lengths, which is determined by the contours formed by the arrowfeathers. This is clarified in Figure 18.

The theory maintains that the subject is judging not only the length between apices, but also all possible lengths that are determined by the contours of the arrowfeathers. Hence, since the shaft length is the shortest extent in the context, it is overestimated and an

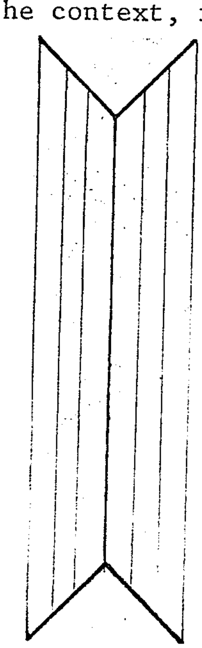


Fig. 18. The outgoing Müller-Lyer form, with extents.

illusion of elongation results. Similarly, for the ingoing form, the shaft length is embedded in a context of varying lengths, which is determined by the contours formed by the arrowheads. This is clarified in Figure 19.

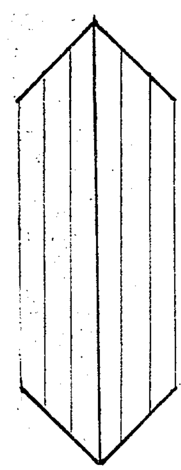


Fig. 19. The ingoing Müller-Lyer form, with extents.

Hence, since the shaft length is the longest extent in the context it is underestimated, and an illusion of shrinkage results.

Another postulate was formalized in order to delineate the effective context in which extents lie and judgments are subsequently made. An attentional factor was postulated which might be related to how the context was circumscribed.

Postulate 2. "Other things being equal, a context which falls within the attentive field will be more effective than a context outside that field" (Pressey, 1971, p. 172).

The theorist contends that there are two ways of specifying the boundaries of the attentive field. The first is empirical. Empirically, eye movements might be measured in order to circumscribe the context; the assumption that what one looks at is what one is attending to is implicit in this technique. The second is logical. Logically an illusory figure, by the nature of the figure itself, defines what response is required by the subject. We may then assume that the subject's attention will be focused on the elements that are to be judged within the particular figure's context. This procedure is adopted here in an attempt to explain the results of this study.

Ingoing form of the Müller-Lyer illusion. This illusion only varied slightly as a function of size; the amount of illusion remained relatively the same across size. Assimilation theory would contend that the attentive field would not vary, in this case, as a function of size since the ingoing contours (arrowheads) would continue to remain within the attentive field. This is clarified in Figure 20.

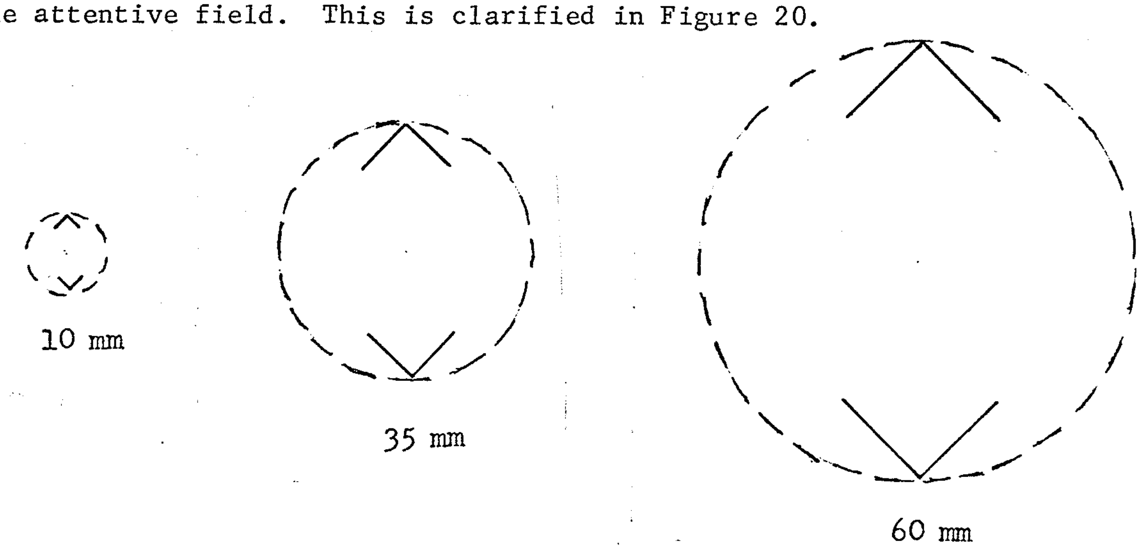


Fig. 20. Three sizes (10 mm, 35 mm, and 60 mm) of the ingoing form of the Müller-Lyer illusion. The dotted line circumscribes the attentive field.

Since the attentive field remains proportionally the same, the theory would predict that the amount of illusion would remain relatively the same across size because the context, essentially, is not changing. In other words, for each of the three ingoing Müller-Lyer forms, the attentive field is proportionally the same since the contours always fall within the field. (All Müller-Lyer targets have been drawn in proportion to shaft length, and the obliques in each target are one-quarter of the shaft length, or distance between apices.) Thus, the shaft length is still judged in relation to the original extents which are determined by the contours. The results of this study support this prediction.

Outgoing form of the Müller-Lyer illusion. This illusion varied greatly as a function of size; the amount of illusion decreased as target size increased. Assimilation theory would contend that the attentive field would vary, in this case, as a function of size since the outgoing contours (the arrowfeathers) would gradually be displaced outside this field. This is clarified in Figure 21.

Since the extent of the boundary of the attentive field decreases, the theory would predict that the amount of illusion would decrease with an increase in target size because the context is changing in the sense that the shaft length is being judged in different contexts. In other words, the range in which judgments of the varying extents are being made is getting smaller in a direction determined by the attentive field whose area is gradually decreasing in proportion to an increase in target size.

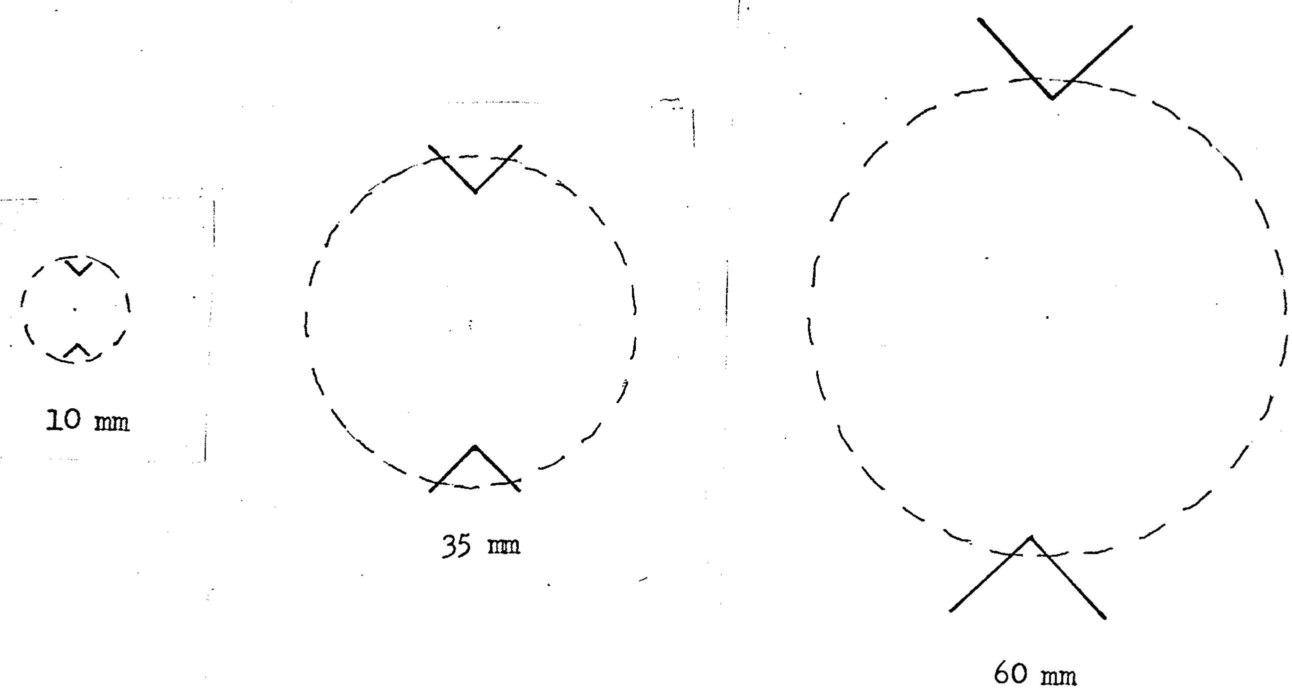
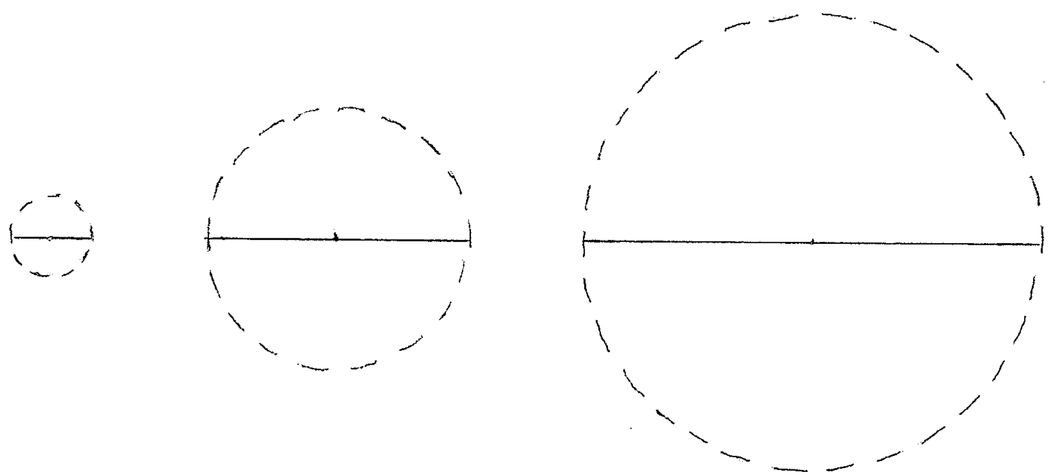


Fig. 21. Three sizes (10 mm, 35 mm, and 60 mm) of the outgoing form of the Müller-Lyer illusion. The dotted line circumscribes the attentive field.

Since the direction of this decreasing range is towards the apices of the arrowfeathers, the illusory effect of the arrowfeathers is minimized, and the figure is seen more veridically. In other words, the discrepancy between the shaft length of the extents is smaller. Hence, the amount that the figure will be overestimated is smaller. The results of this study support this prediction.

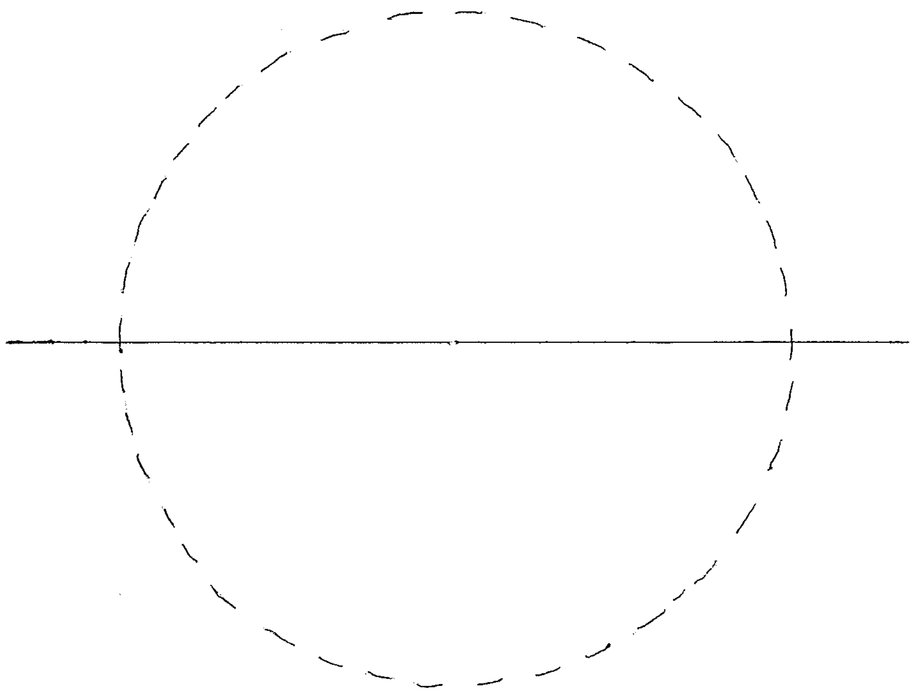
Horizontal-vertical illusion. This illusion varied minimally as a function of size; the amount of illusion remained virtually the same across size. Assimilation theory would contend, in this case, that the attentive field would not vary as a function of size since the contour (the horizontal component) would continue to remain within the attentive field. This is clarified in Figure 22.



10 mm   35mm   60 mm

Fig. 22. Three sizes, (10 mm, 35 mm, and 60 mm) of the horizontal component of the horizontal-vertical illusion. The dotted line circumscribes the attentive field.

Since the attentive field remains proportionally the same, the theory would predict that the amount of the illusion would remain relatively the same across size because the context, essentially, is not changing. In other words, the horizontal length is not displaced outside of the attentive field. The results of this study support this prediction. However, would this relationship hold if the horizontal component was systematically increased? At some point, the extreme end parts of the horizontal would lie outside the attentive field. This is clarified in Figure 23.



120 mm

Fig. 23. The horizontal component of the horizontal-vertical illusion, 120 mm. The dotted line circumscribes the attentive field.

In this case, the theory would predict that the magnitude of the illusion would increase since part of the figure would lie outside the range of the attentive field, and would not be taken into account when judging the figure. Moreover, since the amount of illusion would have to be measured in terms of the <u>whole</u> figure, the illusion would be considerably larger than that of a figure whose extent lies within the attentive field. This case, of course, assumes that the subject's head is fixed. However, if the subject were systematically allowed to move his head, the notion of overlapping attentive fields might emerge. To date, this notion is still an empirical and theoretical question. It might be interesting to study integration of perceptual data from different attentive fields as a function of fixed viewing time and target size.

Finally, how might assimilation theory explain the proportionately greater amount of illusion with the horizontal-vertical figure than with either Müller-Lyer form? The horizontal figure only contains one contour--the horizontal length. On the other hand, the Müller-Lyer forms contain several contours (four obliques). Perhaps several contours operate more efficiently to define the location of a response. In other words, an illusory figure, by the nature of the figure itself, defines the location of a response <u>perhaps</u> more or less efficiently. The mechanism involved in judging horizontal length in vertical terms may operate less efficiently than the mechanism involved in judging Müller-Lyer forms, and a greater amount of illusion may be the result. Analogously, it is well known that the location of a point is more or less precise as a function of the number of lines which pass through it. In a sense, the horizontal length may be conceived as a single line figure while each Müller-Lyer form may be conceived of as multiple line figures. The greater illusory response in the former case may be a function of the fewer number of contours, which operate to define a greater illusory response.

CHAPTER V

SUMMARY AND CONCLUSIONS

The hypothesis that fundus-density of the human eye is related to susceptibility to visual illusions (Pollack & Silvar, 1967) was tested using a within race design. Originally, Silvar and Pollack (1967) had found that racial differences could reliably predict differences in the darkness of eye pigmentation. They later found that children, rated as having light pigmentation, were less susceptible to the outgoing form of the Müller-Lyer illusion than children rated as having dark pigmentation (Pollack & Silvar, 1967). However, 95 per cent of the light group was Caucasian, and 87 per cent of the dark group was Negro. Hence, race may have been a confounding variable.

The present study was designed to assess the generality of Pollack and Silvar's (1967) findings. A within race design was employed to control for racial and/or cultural factors. 74 male college students were divided into five groups on the basis of perceived fundus darkness. All _S_s were tested, using a psychophysical method of production, on several illusions of different target sizes. 10 mm, 35 mm, and 60 mm sized targets of the ingoing and outgoing forms of the Müller-Lyer figures, and the horizontal-vertical illusion were used. Control cards of the same lengths were also used as a control for any estimation bias.

Fundus-density was not found to be a significant variable at the .05 level, nor did fundus-density interact with any other variable. Illusion, target size, and the illusion x size interaction were significant at the .05 level, or better. Specifically, with an increase in target size, the ingoing Müller-Lyer illusion and the horizontal-vertical illusion remained relatively the same. However, the outgoing Müller-Lyer illusion decreased as a function of target size. These results were explained in terms of assimilation theory (Pressey, 1967, 1970a, 1970b, 1971). The probability that the attentive field of the ingoing Müller-Lyer form, and the horizontal-vertical illusion did not change as a function of target size was shown. Further, the probability that the attentive field of the outgoing Müller-Lyer form did change as a function of target size was shown. In sum, the results of the present study did not concur with Pollack and Silvar's (1967) hypothesis or findings. The possibility that this was a function of Pollack and Silvar's design was discussed since it is well known that magnitude of illusions vary with race and/or culture.

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APPENDIX

Set 1: Instructions for Müller-Lyer Targets.

Your task is to mark a point, on a given signal [E demonstrates click] , which is below but in line with the dot on the right so that it indicates the distance, as it appears to you, between the apices of the angles on the left. Remember, you are only allowed to make one judgment. You are to make your judgment visually--do not use your arm or hand. Listen for the click then make your judgment, after which I will quickly place a new target on the stand.

Any questions?

Set 2: Instructions for the Horizontal Line Targets

Your task is to mark a point, on a given signal [E demonstrates click] , which is below but in line with the dot on the horizontal line so that it indicates the length, as it appears to you, of the horizontal. Remember, you are only allowed to make one judgment. You are to make your judgment visually--do not use your arm or hand. Listen for the click then make your judgment, after which I will quickly place a new target on the stand.

Any questions?

Set 3: Instructions for the Control Cards.

Your task is to mark a point, on a given signal [E demonstrates click], which is below but in line with the single dot on the right so that it indicates the distance, as it appears to you, between the two dots on the left. You are to make your judgment visually--do not use your arm or hand. Listen for the click then make your judgment, after which I will quickly place a new target on the stand.

Any questions?