The Effect of Age and Sex Upon the Mueller-Lyer and Horizontal-Vertical Illusions

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Abstract

A group of children aged 6-12 years from Kuwait were tested on Mueller-Lyer and Horizontal-Vertical illusions. The significant differences among different age groups for the Mueller-Lyer illusion is consistent with many studies, and could be explained by the Perspective and Piaget Theories. However, the sex differences for both illusions did not fit the hypothesis, but is similar to a 1992 study conducted on Kuwaiti children by Shehab.

Introduction

Form perception is one of the important psychological aspect but is not always accurate. Some cases, known collectively as the geometrical illusions, involve line drawings in which some attributes of perceived stimuli (for example size, shape, direction) differ considerably from their corresponding physical values (Dember and Warm, 1981).

There are two important classes of size illusion figures, those of linear extent and those of area. Over the past years it has become clear that visual-geometric illusions are composite effects caused by a number of different distortion-producing mechanisms acting in concert (Robinson, 1972; Girgus & Coren, 1973a; Girgus et al, 1975; Coren & Girgus, 1975; Coren et al, 1976; Coren & Porac, 1984; Predebon, 1984; Berry et al, 1992). The mechanisms that produce these distorted percepts have been divided into two general classes: structural and strategic (cognitive). The first class includes structural aspects of the visual system (Coren & Porac, 1984; Gillam & Chambers, 1985; Weintraub & Schneck, 1986; Girgus & Coren, 1987; Coren et al, 1988). The second class of mechanisms includes judgemental or information processing strategies which are more cognitive in nature (Beckett, 1989; Predebon, 1986; Day & Joly, 1987; Girgus & Coren, 1987; Post & Chaderjian, 1987; Rowe-Boyer & Brosvic, 1990).

There are various theories which explain the perception of illusion and we will try to explain a number of them. The Computational Theory which is developed by Marr (1982) assumed that stable and reliable representation of objective shape cannot be derived in a single step. Marr assumed four successive stages to build shape perception: the retinal image or the low-level because they deal with early visual processing, the primal sketch sometimes called intermediate-level vision which deal with the properties of surfaces, the 2.5 - D sketch or the rough information about depth and orientation of the visible surfaces are extracted and the picture of the world begins to appear, and the 3-D model representation or the high-level representations which make explicit objects present in a scene and their spatial disposition (Gordon, 1989; Roth & Frisby, 1986). According to this theory illusion could occur when the visual system try to make the perception of the objects stable or reliable or in another word the visual system try to correct the perception of the illusion figures while there are no bias needs to be corrected and that could cause illusion.

In **The Theory of Direct Perception**, Gibson sees the input for visual perception not as two dimensional retinal image, but as a complex pattern of light which is specifically structured by the surfaces from which it has been reflected (Roth & Frisby, 1986). Roth and Frisby stated that according to

Gibson the total information in the optic array is so rich and complex it provides a direct basis for a person's interactions with the world. There is no need for processes to transform the input into intermediate representations. Gibson believed that most illusions are an unfair test of what the visual system can do with the information from the natural environment.

The Perspective Theory of illusions is one of the important theories which explain how these illusions occurred. This theory has been developed by Tausch (1954) and Gregory (1966). In their explanations, they frequently referred to the size constancy theory, perceptual illusions of size depend on misjudgment of size produced by monocular cues depth. The illusion figures suggest depth by perspective, and this suggestion of depth is said to produce changes in apparent size.

The ecological hypothesis follows from the perspective theory, on the assumption that the interpretation of perspective is learned. Two applications of the ecological explanation are the Carpentered World hypothesis and the Open Area hypothesis. People who experience a carpentered world should perceive the Mueller-Lyer figure with in-going shafts (<————>) as an outside corner of a building, and the figure with out-going shafts (>————<) as an inside corner of a room. According to the size-constancy explanation the far object (the inside corner) is enlarged and the close object (the outside corner) is diminished. People who live in an open area experience the need to expand the apparent distance in front of them. Consequently they should perceive a vertical line (as in the Horizontal-Vertical illusion) as a road stretching away into the far distance in front of them.

One could find some similarities between the above theories. The computational theory could be close to the perspective theory in explaining the illusions, since in both theories the perception depend upon understanding the world and how much the environment could affect the perception of a person. The first level of the computational theory (the low level) is like the Direct theory in taking advantage of the information available in the pattern of light reaching the eyes.

The Optical Aberration Theories: Illusion involving crossed lines explained by Einthoven (1898) who proposed that aberrations of the lens of the eye makes the retinal image unclear. The degree of aberration depends on the closeness of the elements of the distal stimulus. Chiang (1968) in his Diffraction Theory proposed that lines running close together affect one another. That pattern of two lines on the retina would be like such a diffraction pattern because of the blurring and diffusing effect of the media and the construction of the eye.

Eye movement theories: According to Over (1968), errors occur in the perception of illusory figures because surrounding contours modify the extent and direction of eye movements during the scanning of particular parts of the figures. Carr (1935) believed that eye react to accessory lines and as a result pass more easily over unfilled than filled extents. Landauver, Rhine and Rumiz (1968) concluded from their study regarding the eye movements that vertical eye movement are more restricted than horizontal movements, due both to the anisotropic nature of visual space and to the structure of the muscles that conduct eye movements.

Regarding the Mueller-Lyer (M-L) illusion, numbers of studies have shown that magnitude of the illusion decreases from childhood to young adulthood (Coren & Girgus, 1978). Some other investigators have reported a decrease in M-L illusion magnitude from childhood to young adulthood, low illusion magnitude scores in the middle adult years, and then an increase in the strength of the illusion in late adulthood (Eisner and Schie 1971; Wapner, Werner and Comali, 1960 as cited by Porac & Coren, 1981). Predebon (1984) in his study on 5-11 and 18 year-olds found a linear decrease in the M-L illusion magnitude. Some other investigators did not find significant differences among different ages (Pollack, 1972; Hartman et al, 1972; Simon & Ward, 1974; Youn et al, 1986). The study done by the present author on Kuwaiti and Scottish children showed a linear positive age trend for the M-L illusion (Shehab, 1992). Regarding the Horizontal-Vertical illusion, a decrease in the susceptibility to this illusion was found (Winch, 1907). A slight decrease for the T form of the Horizontal-Vertical illusion was found by Fraisse and Vautrey (1956). However, other authors did not find any significant differences of this illusion (Grieve et al, 1983). A linear increase with age in the susceptibility to the T form of the Horizontal-Vertical illusion on Kuwaiti and Scottish children was found (Shehab, 1992).

According to the sex related differences, some researchers indicated that boys are more susceptible to the Mueller-Lyer and Horizontal-Vertical illusions than girls (Stewart, 1973; Fraisse & Vautrey, 1956). Walters (1942) found that boys are more susceptible to the M-L illusion from age 6 to 13 except 8 years old and 19 years old, while girls are more susceptible form age 14 to 18. Walter, also found that boys are more susceptible to the H-V illusion than girls from age 6-19 years old. Shehab (1992) found that girls are more susceptible to the M-L illusion for the Scottish sample, and that boys were more susceptible to the T form of the Horizontal-Vertical illusion for the Kuwaiti sample.

The **purpose of the present study:**

1. Identify the direction of the age trend in susceptibility to M-L and H-V illusions.
2. Indicate the difference between boys and girls in perceiving the illusion figures.

METHOD

Subjects

The subjects were aged 6-12 years and consisted of 281 children from Kuwait city. The children were almost equal socially and economically; they were middle class children. The children were approximately equally distributed between the sexes and age groups. The children were selected by their school teachers and the school psychologist as being normal in health and educational achievement. Children aged 6-10 years were in primary schools, while children 11 and 12 years of age were in intermediate schools.

Kuwaiti children live in a carpentered environment. Therefore, a high susceptibility to the Mueller-Lyer illusion would be expected.

Table 1

The number of the children of both sexes from each age group.

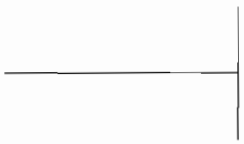
Age	Males	Females
6	20	19
7	20	19
8	17	20
9	7	20
10	35	21
11	21	22
12	20	20
Total	140	141

Apparatus and Procedure

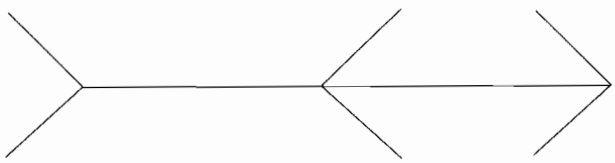
Adjustable method is used with both figures of illusion. For the Mueller-Lyer illusion, both forms, the one with in-going shafts and the out-going shafts are representing in the same board. While the out-going shaft form is constant with a length of 10 cm. The line of the in-going shaft form is movable and has a scale of -10 to 10 cm. The T form of the Horizontal-Vertical illusion is used in this research. The bisected line of this figure is constant with a length of 10 cm, while the other line is movable with a length of -10 to 10 cm.

The child was seated opposite the experimenter in a well light place in a quiet room. The wood board of each illusion is placed on the table in front of the child. The child was asked to move the movable line until he/she feel that both lines (line with in-going shafts and the line of out-going shafts of the M-L illusion; and the bisected line and the other line in the H-V illusion) are equal. For the Horizontal-vertical illusion the bisected constant line is displayed vertically, while the movable line is displayed horizontally.

Figure 1
The Horizontal-Vertical and the Mueller-Lyer illusions.



Horizontal-Vertical illusion.



Mueller-Lyer illusion

RESULTS

Developmental trends

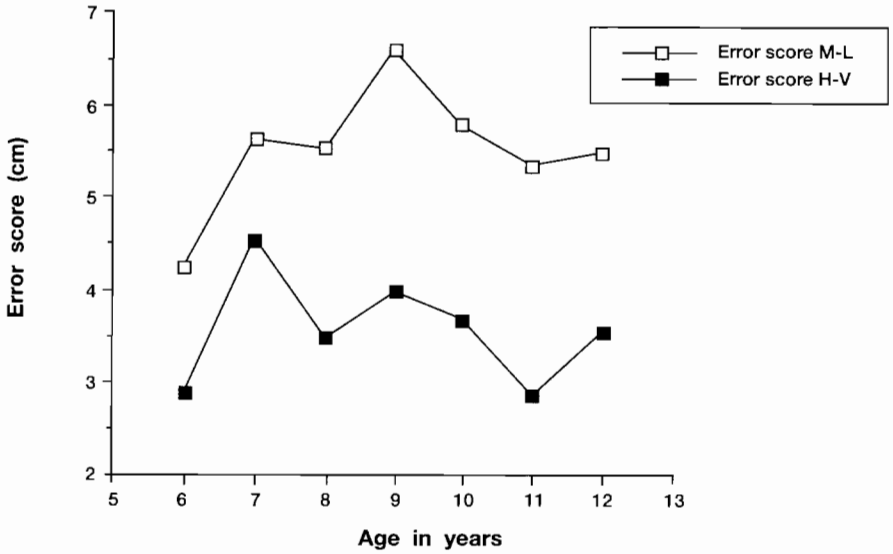
By using one way ANOVA a significant age trend for the Mueller-Lyer illusion (F=2.94, d.f.6, p=0.0086) was found. The illusion score was calculated by using the error scores. For example, the six year olds had a score of -4.25 cm. To know the exact length of the comparison line (line with in-going shafts, which suppose to be overestimated) we subtract the error scores from 10 cm. The exact length of the compared line (line with out-going shafts). Children of nine years old showed the highest error score of illusion, while children of six years old showed the lowest error score of illusion (see Table 1).

However, the horizontal-vertical illusion did not show any significant age trend (F=1.45, d.f.6, p=0.195). As show for the M-L illusion, the six year old children had the lowest error score of the H-V illusion. Seven year old children had the highest error score of illusion (see table 2 and figure 2).

Table 2
Illusion error score in cm. For the different age groups of the Mueller-Lyer (M-L) and Horizontal-Vertical (H-V) illusions

	Mueller-Lyer	Horizontal-Vertical
6 years	4.25	2.89
7 years	5.64	4.55
8 years	5.55	3.50
9 years	6.63	4.00
10 years	5.78	3.68
11 years	5.34	2.88
12 years	5.48	3.56
Total	5.49	3.56

Figure 2
Illusion error scores in cm. For the different age groups of the M-L and H-V illusions.



Sex differences

Gender differences were measured by t-test. the Mueller-Lyer illusion showed a significant gender difference between boys and girls (F= 4.88, d.f.1, p=0.028). Boys had higher illusion error score than girls (boys = 5.78 cm., girls = 5.20 cm.). Also, the Horizontal-Vertical illusion showed higher significant differences between boys and girls (F=7.68, d.f.1, p=0.006). Boys had higher H-V illusion error scores than girls (boys = 4.43 cm,. girls = 2.70 cm.).

DISCUSSION

The clear differences between age groups for the Mueller-Lyer illusion are similar to most researches. The increase that has been found for some age groups (6-7, 8-9, 11-12 years old) could be an application of the perspective theory which supposes that the susceptibility to the illusion should increase with age. Children in this study live in a carpentered environment, and as the Perspective Theory assumed children who live in a carpentered environment would be more susceptible to the Mueller-Lyer

illusion than younger ones. Regarding the ecological hypothesis of the perspective theory, older children have more experience of their environment than younger ones, so they should be more susceptible than younger ones to these illusions. Piaget's theory of Centrations, could explain the decrease in some age groups of the Mueller-Lyer illusion (7-8, 9-11 year olds). According to Piaget's theory, there are two types of illusions, the illusion that decrease with age or intellectual development primary or type 1 illusion, and those that increase with age secondary or type 2 illusion. Mueller-Lyer is considered to be type 1 illusion, so, it is suppose to decrease with age. The last study that has been carried out by the present researcher on Kuwaiti children showed a linear increase with age for the M-L. In both studies the 9 year olds had the highest illusion error score, and if we exclude the five year olds from the first study, then the six year olds had the lowest illusion error score for both studies. The computational theory assumed that illusion occur when the perception system try to make the perception stable and reliable and try to correct the appeared bias in perception. Depending on that, older children would be more susceptible than younger ones to the Mueller-Lyer illusion, since they have more developed perception and experience of the world. The result of current study contradict other studies which found a decrease in the susceptibility to the Mueller-Lyer illusion (Comali, 1956; Coren & Girgus, 1978; Predebon, 1984). Also, it differs from the others which found no significant differences between age groups (Pollack, 1970; Hartman et al, 1972; Simon & Ward, 1974; Youn et al, 1986). However, the study showed similar results to the study that has been conducted by the present researcher on Kuwaiti and Scottish samples which showed an increase in the susceptibility to the Mueller-Lyer illusion with age. The differences between the study and other studies could be because of the differences in the apparatus, or the sample or the method, the age of a sample playing a big part in any differences between studies.

The non-significant differences that had been found for the Horizontal-Vertical illusion could be explained by the perspective theory. The ecological hypothesis of an open area assumed that people live in an open area like fields or deserts where the apparent distance is extending in front of them would be more susceptible to the Horizontal-Vertical illusion than others. Also older children should be more susceptible to this illusions than younger ones because of their experience of their environment. The subjects in the current study live in a city and their experience of open area is limited, and that could explain why we did not find significant differences between the age groups.

If we consider the structural mechanism as a cause of the illusion, we expect to find sex differences in illusion figures. For example there is a sex difference in the crystalline lens (Girgus et al, 1975), the amount of pigmentation being greater for boys; also, visual acuity is generally higher in boys than girls (McGuinness, 1976a, McGuiness, 1976b, Ross & Woodhouse, 1979). So, girls should be more susceptible to some illusion than boys. This hypothesis did not apply in this study since for both illusion figures boys were more susceptible to illusion than girls. The result of the Horizontal-Vertical illusion is similar to what had been found in Shehab 1992.

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