Effect of practice versus information on the visual illusion

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Abstract: Objective The Müller-Lyer illusion is a visual illusion in which a horizontal shaft with an inward-pointing chevron (fins-out) affixed to each end is perceived longer than a shaft with outward-pointing chevrons (fins-in). The goal of this study was to compare the effects of experience and knowledge about the Müller-Lyer illusion on participants' perceptual precision.

Method Participants were undergraduate students ($n = 108$) who were not familiar with the Müller-Lyer illusion prior to the experiment. The task of participants was to adjust one movable line to make it equal to the other in Müller-Lyer figure. They received ascending and descending Müller-Lyer trials in three blocks with 20 trials each. The Experimental Group received information about the Müller-Lyer illusion prior to the third block. **Results** For the Experimental Group, the amount of departure in Block 3 was reduced significantly compared with previous blocks. **Conclusion** Knowledge about the mechanisms underlying visual illusions may play an important role in helping individuals overcome them.

Keywords: Müller-Lyer; visual illusion; perception

1 Introduction

Perception is the process of giving meaning to sensory stimuli by interpreting and organizing them^[1]. Perceptions are of paramount importance in developing our understanding of the world. However, discrepancies might exist between our perceptions and objective reality; the discrepancy might take the form of an illusion. Illusions can influence an individual's decision-making, especially in situations in which such decisions have important consequences. Therefore, studying the processes by which individuals can correct the misleading effects of illusions is important.

Visual deviations from reality have been demonstrated particularly with specially designed geometrical figures^[2]. A well-known example of a visual illusion is the Müller-Lyer illusion (Fig. 1), which was created approximately a century ago. Despite the fact that both shafts in Fig. 1 are of equal length, Shaft b appears longer than Shaft a. There are several theories about the reasons for this illusion^[1,3,4]. The

most frequently cited theory about the Müller-Lyer illusion is that of Gregory^[5]. Gregory's theory implies that the shaft with fins-in is perceived to be closer to the observer, whereas the fins-out shaft is perceived to be farther from the observer. To test the alternative hypothesis that the source of the illusion is not due to the perceived distance between the two lines-and-fins, McGraw and Stanford^[6] used two separate lines-and-fins (an outward-pointing and an inward-pointing one), which were suspended in an experimental chamber. Their results indicated that the fins-out line was perceived to be closer than the fins-in line. They concluded that the interior corner of the shaft was perceived to be closer than the exterior corner, indicating that the key assumption of Gregory's theory is either false or unfalsifiable.

Fig. 1 Müller-Lyer illusion. Although equal in length, Line b seems longer than Line a.

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Dichotomous models of perception and action posit dissociation between cognitive processes about the visual characteristics of objects and the visual and motor processes responsible for reacting to the object^[7]. However, recent findings are inconsistent with the dichotomy of perceptual and motor systems. For example, Predebon^[8] showed that although perceived extent of the shaft and perceived position of the fins in Müller-Lyer figures were largely independent of each other; the illusion was more likely to influence pointing actions if the action was based on the extent information than on chevrons' position information. Lavrysen *et al.*^[9] also showed a relationship between perceptual and motor systems when performing on the Müller-Lyer illusion such that the type of information available for movement planning (i.e. about the figure but not about the hand) mediated the size of the illusory effects.

In all of the theories of visual illusions, the relationship between perception and previous knowledge about the world is considered to be an important relationship^[10]. It has been demonstrated that having knowledge about the nature of the actual stimulus elements in the Müller-Lyer illusion may reduce the experience of the illusion, although the illusion is not completely eliminated^[11]. In addition, it has been found that the illusion is reduced with practice. In previous research, significant declines in the illusion have been found only on repeated trials that provided either continuous or intermittent practice^[12]. The present study tested the relative effects of practice on and information about the Müller-Lyer illusion on overcoming the illusion. It was predicted that information would lead to a greater decline in the illusion than would practice.

2 Materials and methods

2.1 Participants Participants in the Experimental Group were 88 (54.5% female, mean age = 22.6 years, SD = 3.1) psychology undergraduate students, who were enrolled in an experimental psychology module in the School of Psychology, Ferdowsi University of Mashhad, Iran. Controls were 20 optometry undergraduate (100% female, mean age = 23.5, SD = 2.2), who started their clinical observation in Mashhad Medical Sciences University. All participants were unfamiliar with Müller-Lyer illusion prior to the experiment.

2.2 Apparatus The Müller-Lyer test was constructed of wood and consisted of two parts. The fixed part included a shaft with an outward-pointing chevron at the end. The adjustable, sliding part included a shaft with an inward-

pointing chevron at the end (Fig. 2). To insure suitable contrast between the lines and the background, the lines were drawn in white color with a black background. The chevrons on the fixed and sliding shafts were of equal size.

2.3 Procedure Participants were tested individually in a sound-controlled room in the Experimental Psychology Laboratory. After reading the information sheet and signing the consent form, the participants were given an optometric examination to determine if he or she had uncorrected refractive problems. Although those with refractory problems were tested, they were excluded from the data analyses.

Next, based on guidelines provided by Fraisse^[13], the first block of experimental trials was started. The participant was asked to adjust the movable segment of the apparatus until he or she considered it equal in length to the fixed (criterion) segment. The block of trials included: (a) 10 descending trials in which the movable segment was set obviously longer than the criterion one; and (b) 10 ascending trials in which the movable segment was set obviously shorter than the criterion one (Fig. 2).

Next, the second block of trials was begun and was conducted in the same manner as the first block. Prior to the third block of trials, only the participants in the Experimental Group were given information about the Müller-Lyer illusion. The experimenter explained that the chevrons at the end of the shafts cause perceptual misjudgments, such that outward-pointing ones cause the line to be perceived as shorter than do the inward-pointing ones. The Experimental Group was then told to try to ignore the chevrons when adjusting the movable shaft to equate the length of the two lines. Therefore, the third block again included 10 descending and 10 ascending trials.

Fig. 2 The apparatus used in this study. (a) The length of the movable segment is equal to the length of the criterion one; (b) the movable segment is obviously longer than the fixed, criterion one; (c) the movable segment is obviously shorter than the fixed, criterion one.

Average visual misjudgments in millimeters were calculated for each block of trials, separately for the descending and ascending trials. The length of the sliding segment was the index of magnitude of the illusion and was measured in millimeters. A positive number indicated that the adjusted line was longer than the baseline (the fixed part), and a negative number indicated that it was shorter than the baseline.

3 Results

On all three blocks of trials, participants made misjudgments about the length of the line on both descending and ascending trials. First, for the Experimental Group, independent *t*-test analyses showed no difference in perceptual departures between descending and ascending trials on the first [$t(87) = 1.17, P = 0.2$], second [$t(87) = 0.3, P = 0.7$], or third [$t(87) = 0.52, P = 0.6$] block of trials. In addition, the average absolute measured departure of the adjustable line from the fixed line that the experimenter set prior to each trial did not differ on the ascending and descending trials across the two blocks of trials [$t(87) = 0.78, P = 0.43$]. Second, and similar to the Experimental Group, the Control Group showed no difference between ascending or descending trials on the first [$t(38) = -0.80, P = 0.4$], second [$t(38) = -0.70, P = 0.4$] and third [$t(38) = -0.44, P = 0.6$] block of trials. Therefore, the ascending-descending dimension was not considered in the next analyses.

The degree to which participants' adjustments of the movable line differed from the length of the fixed line was compared across the three blocks of trials (Tab. 1). To do so, a repeated-measures ANOVA was conducted, in which Trial Block (with three levels) was the dependent variable and Group (with two levels) was the fixed factor. Gender was not entered into the model because earlier research^[14] shows that gender is not an issue with sensitivity and responsivity to the illusion. Mauchly's *W* test was significant, indicating that the sphericity assumption was not met [$W(2) = 0.80, P < 0.001$]. Accordingly, the Huynh-Feldt correction was applied. There were significant main effects for Trial Block [$F(1.71, 181.64) = 14.50, P < 0.001, h^2 = 0.12$] and the interaction between Trial Block and Group [$F(1.73, 184.27) = 3.62, P = 0.035, h^2 = 0.033$]. Post hoc comparisons were performed using the Bonferroni adjustment for multiple comparisons, showing that departures on Block 3 were significantly smaller than those reported on Block 1 and Block 2. Performing pairwise comparisons using

Tab. 1 The values of the perceptual departures from the criterion segment in each block (mean $\pm$ SD)

	Block 1	Block 2	Block 3
Exp	-14.37 $\pm$ 16.10	-12.81 $\pm$ 17.33	-4.66 $\pm$ 12.97
Ctrl	-32.51 $\pm$ 10.97	-27.77 $\pm$ 12.83	-27.75 $\pm$ 16.18

Note: Exp, Experimental Group; Ctrl, Control Group.

paired-samples *t*-tests confirmed the source of difference. The control group did not show any changes across the three blocks (all $P > 0.05$). However, although the Experimental Group did not show a difference between departures on Block 1 and Block 2 [$t(87) = -1.79, P = 0.08$], the departures on Block 3 (which followed knowledge) were significantly smaller than the departures on Block 1 [$t(78) = -7.61, P < 0.0001$] and on Block 2 [$t(78) = -5.75, P < 0.0001$].

In conclusion, the results show that practice across Block 1 and Block 2 did not significantly reduce the size of Müller-Lyer illusion. However, the information that the experimenter was provided about the illusion prior to the third block of trials significantly reduced participants' misjudgments about the length of the movable shaft.

4 Discussion

Vision is more than light radiation entering the eyes to form the retinal images. Although humans' eyes resemble a window opening to the outside world, visual perception is not a mere reflection of the objective world; rather, the visual perception is combined with people's knowledge about the world. Although perception organizes sensory stimuli, sometimes the perception does not correspond to the outside world. Visual illusions are the examples of this inconsistency. The Müller-Lyer illusion is one of the geometrical illusions, in which a person's perception does not correspond to the objective properties of the stimulus.

In the present study, participants were unable to adjust the length of the movable line to match the fixed line in the Müller-Lyer figures. During the second block of trials, neither the ascending nor descending adjustments were influenced by participants' practice on Block 1. During the third block, the magnitude of the departures from the criterion line was significantly reduced only for the Experimental Group, who had received relevant knowledge about the illusion. Rock^[1] suggested that with experience, frequent exploration, and practice with different kinds of geometrical illusions, people learn to compensate for perceptual

illusions. However, the present results indicated that practicing with 40 trials did not help participants in the control group to overcome the visual illusion. However, being given information about the illusion was effective in reducing the values of departures by the Experimental Group. These findings support the results of previous researches^[12].

The present study used a version of the Müller-Lyer illusion, in which lines and fins were not separated, because we assumed that with this version the visual illusion cannot be attributable to the distance perception. The finding that participants perceived the fins-in line shorter than the fins-out line challenges^[6] is in support of a distance-based explanation of the illusion. The present version virtually eliminates distance perception, which is the key explanation of the illusion when the two line-and-fins are presented separately. The present results suggest that there are explanations for the Müller-Lyer illusion other than those suggested by Gregory^[5] and McGraw and Stanford^[6]. We suggest that the position of the area that the fins cover per se is the cause of the illusion. The fins-in line has part of the shaft covered, causing it to be perceived shorter than the fins-out line, which extends beyond the area of the shaft.

Hochberg^[4] stated that for every example of constancy in perceptual judgment, we can find a perceptual departure from objective reality. There are some visual illusions that all normal humans experience in their everyday lives. It is well known that illusions have their origins in humans' perceptual frames of reference that are stored in the brain after years of experience with the outer world. The present findings suggest that acquiring information about the mechanisms underlying perceptual distortions can improve the precision of perceptual judgments. Future research can be conducted with altered angles of fins, fins-in vs. fins-out shaft as the base line position, and with/without time-pres-

sure to test the interaction between knowledge and factors that may affect perceptual precision in relation to the illusion.

References:

- [1] Rock I. An Introduction to Perception. New York: MacMilan, 1984.
- [2] Andreas BG. Experimental Psychology. New York: John Wiley and Sons, 1972.
- [3] Goldstein BE. Sensation and Perception. Belmont: Wadsworth, 1999.
- [4] Hochberg JE. Perception. Englewood Cliffs: Prentice-Hall, 1964.
- [5] Gregory RL. Eye and Brain: The Psychology of Seeing. 3rd ed. New York: McGraw-Hill, 1978.
- [6] McGraw KO, Stanford J. The apparent distance of interior and exterior corners: a test of Gregory's misapplied size constancy explanation for the Müller-Lyer illusion. J Gen Psychol 1994, 121: 19-26.
- [7] Goodale MA, Milner AD. Separate visual pathways for perception and action. Trends Neurosci 1992, 15: 20-25.
- [8] Predebon J. Manual-aiming bias and the Müller-Lyer illusion: the roles of position and extent information. Exp Brain Res 2005, 163: 100-108.
- [9] Lavrysen A, Helsen WF, Elliott D, Buekers MJ, Feys P, Heremans E. The type of visual information mediates eye and hand movement bias when aiming to a Müller-Lyer illusion. Exp Brain Res 2006, 174: 544-554.
- [10] Solso RL. Cognitive Psychology. Boston: Allyn and Bacon, 1991.
- [11] Crafts LW. Recent Experiment in Psychology. 2nd ed. New York: McGraw-Hill, 1950.
- [12] Schiano DJ, Jordan K. Müller-Lyer decrement: practice or prolonged inspection? Perception 1990, 19: 307-316
- [13] Fraisse P. Manuel pratique de psychologie expérimentale. Paris: Presses universitaires de France, 1974.
- [14] Brosvic GM, Dihoff RE, Fama J. Age-related susceptibility to the Müller-Lyer and the horizontal-vertical illusions. Percept Mot Skills 2002, 94: 229-234.

练习与有关知识对视错觉的影响

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摘要: **目的** 缪勒-莱尔错觉(Müller-Lyer illusion)是一种视错觉,即一条水平线段两端加上向外的箭头(fins-out),那么它看起来要比带有向内箭头(fins-in)的线段长些。本研究的目的是比较练习和有关知识对缪勒-莱尔错觉受试者感知精确度的不同影响。**方法** 受试者为事先对缪勒-莱尔错觉不了解的大学生(共108人,其中对照组20人),他们被要求在缪勒-莱尔模型中调整一条可移动线段的长度,使其与另一条线段的长度相同。受试者要接受缪勒-莱尔递增测试和递减测试。测试共分三个阶段,每阶段20次(10次递增测试,10次递减测试)。在第三阶段测试开始前,实验组学习了缪勒-莱尔错觉的有关知识。**结果** 在实验组中,第三阶段测试的偏差明显小于前两阶段。**结论** 了解视错觉机制的有关知识对于帮助人们纠正视错觉很重要。

关键词: 缪勒-莱尔错觉; 视错觉; 感知