

The Influence of Visual Illusion on Visually Perceived System and Visually Guided Action System

Yu-Hung CHIEN*, Chien-Hsiung CHEN**

* *Graduate School of Design, National Taiwan University of Science and Technology, 43 Keelung Road, Section 4, Taipei, 106 TAIWAN, D9110104@mail.ntust.edu.tw*

** *Graduate School of Design, National Taiwan University of Science and Technology, 43 Keelung Road, Section 4, Taipei, 106 TAIWAN, cchen@mail.ntust.edu.tw*

Abstract: Visual illusions occur around us all the time, which present in nature and appear when you least expect it. It is well known that visual illusions can have a dramatic effect upon our visual perception of an object's size and position. However, whether visual illusions have a similar influence on visual guided action or not, it remains the subject of much debate. The purpose of this study is to explore whether the visual information used to identify and categorize an object would be similar to the visual information used to plan and control visually guided movements directed toward that object. The outcome of this study will be helpful for designers to understand our visual information system and apply that knowledge to the design practice. In order to achieve the purpose of this study mentioned above, three visual illusions as the experiment's apparatus are applied to examine the relative effect of visual illusions on both the visual perceived center of an object and the position of a grasp on that object when a balanced lift is required. The results of the experiment show that (1) Illusions influence both the perceived and the grasped estimates of the center position, but the grasp center is more veridical; (2) Judd-illusion, one of the three visual illusions, has a bigger degree of effect than two other illusions on both the perceived and the grasped estimates of the center position; (3) By providing the participants with a mean to guide their visual perception of these illusions, the errors from the estimation of the center position can be significantly reduced.

Keywords: Visual Illusion, Visually Perceived System, Visually Guided Action System.

1. Introduction

Visual illusions occur around us all the time, which present in nature and appear when we least expect it. For instance, have we ever placed a stick in water and wondered why the part in the water appeared to be bent? It is well known that visual illusions can have a dramatic effect upon our visual perception of an object's size and position. However, whether visual illusions have a similar influence on visual guided action or not, it remains the subject of much debate. The purpose of this study is to explore whether the visual information used to identify and categorize an object would be similar to the visual information used to plan and control visually guided movements directed toward that object.

Goodale and Milner [4] argue that visual information is processed in two functionally distinct systems that they identified anatomically as the dorsal and ventral cortical streams. The dorsal stream transforms visual information to guide motor acts, while the ventral stream creates a visual perception of the world. (See Figure 1)

There is a growing body of evidence suggesting that the aspects of visual information frequently used for visually guided action are distinctly different from those used for visual perception. For example, Bridgeman, Kirch and Sperling [1] demonstrate that observers accurately point to a static target, even though the target is visually perceived to be moving. Furthermore, when a static target is moved to a new location during a saccade,

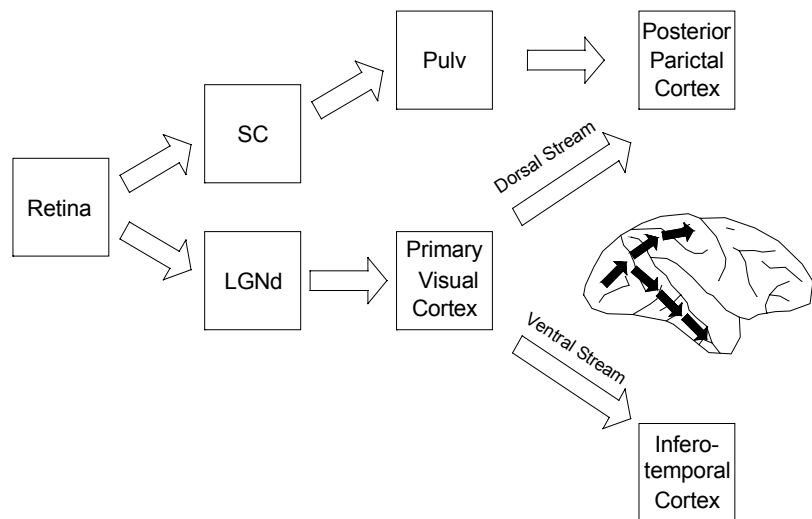


Fig. 1 the processing system of visual information

observers accurately guide their hand to that new location although they do not perceive the target’s movement [1, 3].

According to Ellis, Flanagan and Lederman [6], in their experiment research, they used Judd illusion and Ponzo illusion to demonstrate that visual illusions have shown to affect our visual perception but not the visual guided action. Thus, vision for perception is viewed to be dissociated from vision for action.

The studies mentioned above have showed that vision for perception is said to be dissociated from vision for action. Nonetheless, according to Franz, Bulthoff and Fahle [3], they show that the Ebbinghaus illusion affects grasping to the same extent as perception. They suggest that the same signals are responsible for the perceptual effects and for the motor effects of the Ebbinghaus illusion.

Visual illusions could affect designers’ approach to their design. For instance, according to Paul van Donkelaar [2], he has conducted an experiment looking at movement time (MT) for people performing pointing movements. MT for pointing movements is described by the Fitts’ Law, such that MT varies with target size and with the amplitude of the movement that must be made to reach the target. van Donkelaar [2] used the Ebbinghaus circles illusion in his experiment. The results of the experiment do not support the idea that only the ventral stream is fooled by illusions and vision for perception is said to be dissociated from vision for action. He concluded that his results “demonstrate that the misperception of certain object attributes can have a significant impact on certain aspects of motor output directed towards the object.”

Whether visual illusions have a similar influence on visual guided action or not, it remains the subject of much debate. Nonetheless, it provokes the possibility of innovational design concept by designers who understand human visual information system. Therefore, the outcome of this study will help designers to have more understanding of our visual information system and hopefully to apply that knowledge to their design practice.

2. The Experiment

This experiment examines the relative effect of a position illusion on both the visual perception of an object’s center and the grasp position chosen to lift the same steel bar. The background illusions chosen were Judd illusion, Zöllner illusion and Ponzo illusion.

Judd illusion was a variation of Müller-Lyer illusion by Judd [5] in 1899 in which the two arrowheads both point in the same direction (See Figure 2). Zöllner illusion was created by John Zöllner in 1860. In this illusion, the horizontal lines are parallel, but appear to be tilted at an angle (See Figure 3). Ponzo illusion is named after Mario Ponzo who first demonstrated it in 1913 (See Figure 4).

2.1 Participants

Fourteen (9 female, 5 male) right-handed interior designers, ranging in age from 26-50 years (M=31.9, SD=9.8), with normal or optically corrected-to-normal vision participated in this study.

2.2 Stimuli

A steel bar, 203×40×2 mm, weighting 300g was used in this Judd illusion experiment. Zöllner illusion and Ponzo illusion were centered and printed in landscape orientation on a white piece of 420×297 mm paper. Figure 5 depicts those three illusions background with the steel bar in place.

2.3 Procedure

This experiment consisted of two parts including “the task of visually perceived system” and “the task of visually guided action system.”

2.3.1 The task of visually perceived system

The papers with the printed Judd illusion, Zöllner illusion and Ponzo illusion were placed on a corner of the table. The direction of these three visual illusions was presented to all the participants showing on Figure 5.

The participants stood in front of the table at a spot that would allow them to easily lift the bar with their right hand. They remained in this position for the balance of the experiment. The data were collected by adopting an adjustment technique, in which the experimenter did the adjusting. A thin piece of tape was attached to a thin Plexiglas rod with the tape extending past the end of the rod. The experimenter then moved the rod down the length of the bar with the tape just above the top edge of the bar.

Each participant was asked to say when the tape’s position was in the center of the bar. They were encouraged to have the experimenter adjust the position of the tape by instructing him to move it left or right. At no time were the participants allowed to reach towards or to point at the bar. When the participants were satisfied with the tape’s position, the experimenter lowered the rod so that the tape stuck to the bar at that location. The bar was then removed and the location of the tape was recorded.

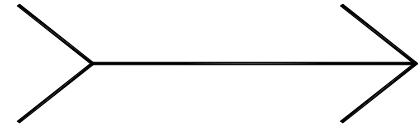


Fig. 2 Judd illusion

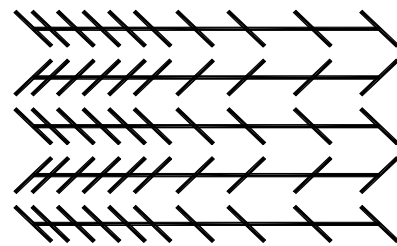


Fig. 3 Zöllner illusion

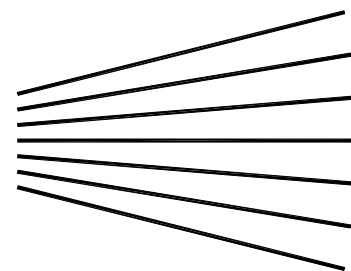


Fig.4 Ponzo illusion

2.3.2 The task of visually guided action system

A thin mark was inscribed on the center of the pad of the participant's index finger. A small piece of double-sided tape was scuffed on one side and this side was stuck on the inscribed mark. Each participant was asked to "lift the bar using only the thumb and index finger of your right hand so that it comes up off the table level or, in other words, so that it is balanced in your grip." After lifting, the bar was handed to the experimenter and the position of the tape that had now transferred to the bar was recorded.

3. Results and Discussion

3.1 Results of the task of visually perceived system

The participants visually judged the center of the bar on the background of Judd illusion. The result indicated a mean of 99.71mm (SD=3.29mm) from the left edge of the bar, which was located on the left of bar's center. After that, the participants visually judged the center of the bar on the background of Zöllner illusion. The result showed a mean of 102.04mm (SD=1.63mm) from the left edge of the bar, which was located on the right of bar's center. In the end, the participants visually judged the center of the bar on the background of Ponzo illusion and obtained a mean of 102.75mm (SD=1.37mm) from the left edge of the bar, which was located on the right of bar's center.

As revealed by *t*-tests, these three distances are significantly different from the true center of the bar (101.5mm) (i.e., Judd illusion-v, $t(13)=6.203$, $p<0.001$; Zöllner illusion-v, $t(13)=3.956$, $p<0.002$; Ponzo illusion-v, $t(13)=5.695$, $p<0.001$, respectively).

3.2 Results of the task of visually guided action system

The participants grasped the bar on the background of Judd illusion. The result indicated a mean of 99.25mm (SD=2.89mm) from the left edge of the bar, which was located on the left of bar's center. After that, the participants grasped the bar on the background of Zöllner illusion. The result showed a mean of 101.35mm (SD=2.71mm) from the left edge of the bar, which was located on the left of bar's center. Finally, the participants grasped the bar on the background of Ponzo illusion and obtained a mean of 101.54mm (SD=2.24mm) from the left edge of the bar, which was located on the left of bar's center.

As revealed by *t*-tests, these three distances are significantly different from the true center of the bar (101.5mm) (i.e., Judd illusion-G, $t(13)=6.313$, $p<0.001$; Zöllner illusion-G, $t(13)=3.362$, $p<0.005$; Ponzo illusion-G, $t(13)=5.667$, $p<0.001$).

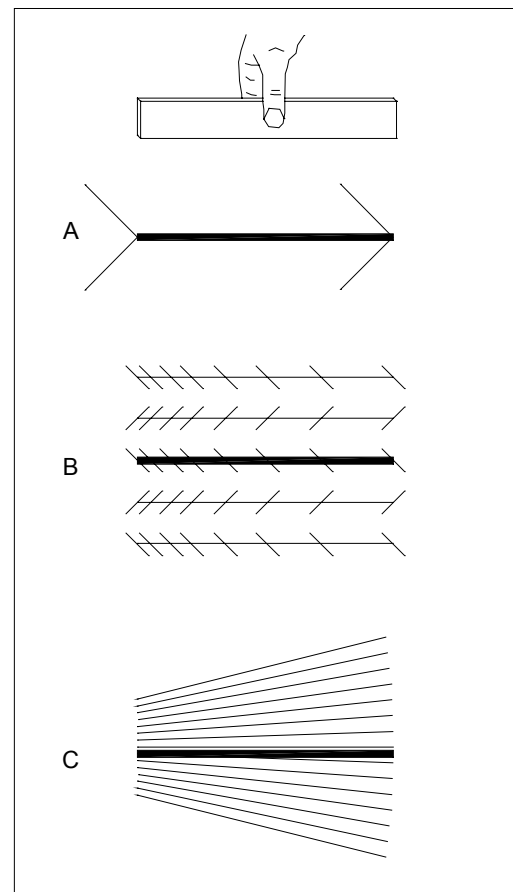


Fig. 5 Schematic depictions of A the steel bar and the Judd illusory background used in this experiment, B the Zöllner illusion background used in the experiment and C the Ponzo illusion background used in the experiment, with the steel bar in place.

3.3 Comparisons of These Two Systems

The results of the experiment show that illusions influence both the perceived and the grasped estimates of the center position, but there was no significant difference between both offsets by *t*-tests. Nonetheless, the grasp center is more veridical. Furthermore, both the perceived and the grasped estimates of the center position are offset from the true center in the opposite direction of the background illusion.

By comparing the results generated from the visually perceived systems, a one-way ANOVA indicated that there existed a statistical significant difference among these illusions ($F(2,39)=6.743$, $p<0.003$). The result from a post-hoc comparison (i.e., LSD) indicated that Judd-illusion has a bigger degree of effect than the other two illusions on the perceived estimates of the center position. In addition, by comparing the results generated from the visually guided action system, another one-way ANOVA indicated that there existed no statistical significant difference among the grasped estimates of the center position ($F(2,39) =2.709$, $p<0.079$). This means that visually guided action system can effectively reduce the error from estimation of center position.

4. Conclusion

The result of the experiment supported what Franz et al. [3] proposed, that is, visual illusion affects grasping to the same extent as perception. Nonetheless, by providing the participants with a mean to guide their visual perception of these illusions, the errors can be significantly reduced. This study is focused on discovering the phenomena of our visual information system. The outcome of this study will be helpful for researchers to find out why visual illusions affect our visual perceived system and visual guided motor system. Furthermore, designers can apply visual illusions to their design or redefine their design approach by understanding visual illusions. It will provoke the possibility of innovational design concept by designers who understand human visual information system. The outcome of this study will also be helpful for designers to understand our visual information system and apply that knowledge to the design practice.

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