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RESEARCH

Mechanisms of Nucleolar Protein Regulation During Zinc Deficiency in Yeast

REVIEW

The Causes of Pediatric Ischemic Stroke

Research

Investigation of Optical Illusions on the Aspects of Gender and Age

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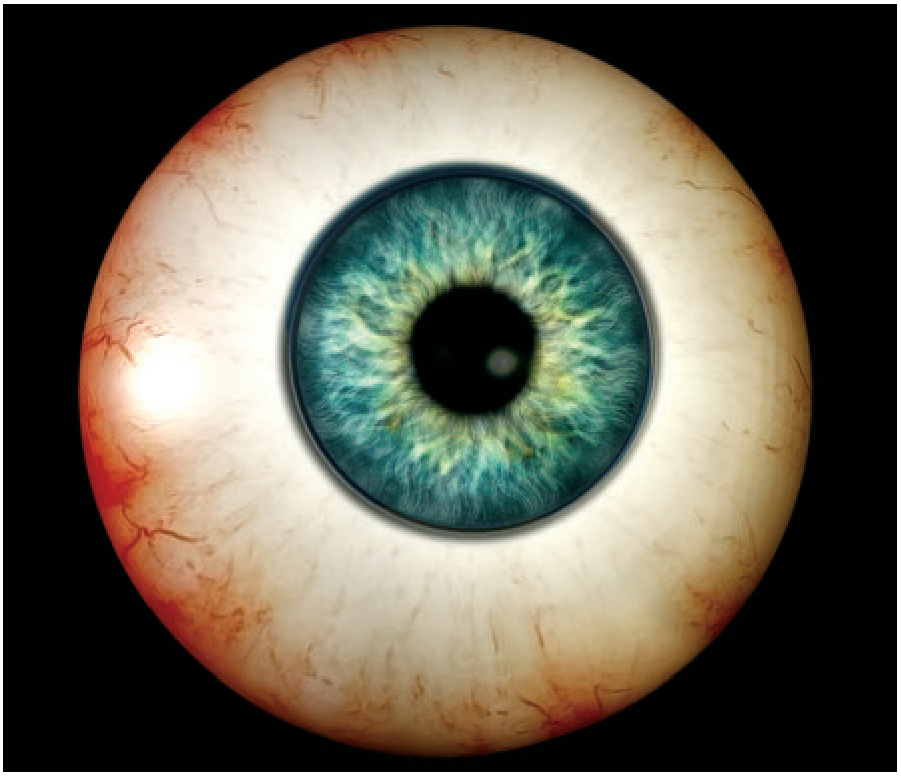

Optical illusions can reveal the remarkable vulnerabilities of human visual perception as well as the populations most susceptible to these perceptual tricks. An online survey attached with the link to the optical illusions was sent through e-mails to each responder. The purpose of the survey was to collect the responses of 2,000 UCLA faculty and students (undergraduate and graduate) to different types of optical illusions, such as those involving motion, color, appearance and shape. The results of the survey demonstrated that females tend to be more susceptible to color, motion, and appearance optical illusions than males. But interestingly, there was no difference in viewing optical illusions in older and younger participants. Collectively these findings suggest that psychological and physiological effect on optical illusion may differ depending on the gender but not necessarily the age.

INTRODUCTION

No one perceives one image exactly the same way as another person. A study done at the University College London showed a series of optical illusions to thirty healthy volunteers and noticed that the degree of susceptibility to the illusion was contingent on physiological differences in the brain. In one illusion named the Ponzo illusion, the volunteers were shown an image of two horizontal lines inside a tunnel, one that appeared in the foreground and closer to the observer than the other line. To most observers, the line that appeared farther away from the observer seemed longer than the line in the foreground, but in reality, both lines were of equal length. Using functional magnetic resonance imaging (fMRI), the researchers found that people with a larger primary visual cortex surface area perceived a smaller difference in length between the two lines, suggesting that physiological differences between individuals influence the unique effect of optical illusions on each person (Schwarzkopf et al., 2011).

Another study done at the Ben-Gurion University of Negev pointed out that people usually perceive the world in two visual systems hypothesis, vision for perception and vision for action (Ganel et al., 2008). Volunteers were shown the Ponzo illusion and showed significant psychological evidence to the level of susceptibility of optical illusions. According to Ganel et al., people with visual system that rely mostly on perception were more likely to see objects in the rich context of scenes. Therefore, they are more prone to be embedded and fooled by optical illusions. On the other hand, people with visual systems that rely mostly on action tend to show visual control on objects in the optical illusions and are less susceptible to optical illusions. Therefore, both physiological and psychological evidence are important in the study of optical illusions.

One type of optical illusion seen in sex-linked disease is colorblindness. According to a report from the Howards Hughes Medical Institute, seven percent of the male population, or around 10 million American men, and around 0.5 percent of the female population are red-green colorblind (Corney, 2007). In addition to colorblindness, optical illusions may occur through other mechanisms, such as size and shape distortion (Luckiesh, 1965). This study investigates whether gender and age affect other optical illusions involving motion, color, and shape to better understand the effect of human physiology and psychology on optical illusion.

MATERIALS AND METHODS

SOCR Optical Illusion Survey. The UCLA Statistics Online Computational Resources (SOCR) Optical Illusions Survey was sent to 2,000 randomly chosen UCLA faculty and students, both undergraduate and graduate. Each responder received an email attached with the information about the optical illusions survey. Participation by the recipients was voluntary. The controlled variables in this experi-

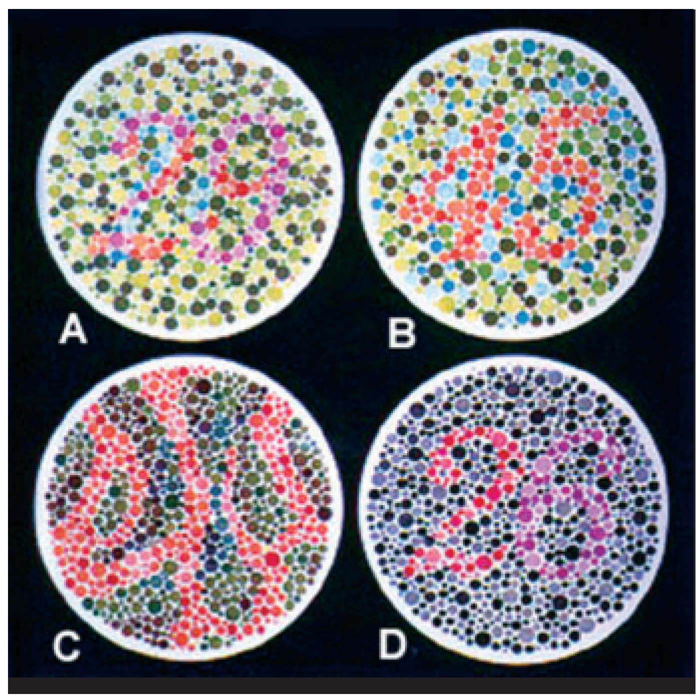

Figure 1. Color Blindness. This image from illustrates a sample test for colorblindness. A person with normal color vision sees 29 in circle A; 45 in circle B; no numbers in circle C; and 26 in circle D. A red-green colorblind person sees 70 in circle A; nothing in circle B; 5 in circle C; and nothing in circle D. A red color-blind person could sees 70 in A, nothing in B, 5 in C, and 6 in D. A green color-blind person sees 70 in A, nothing in B, 5 in C, and 2 in D.

ment are the people solicited to respond the survey. The survey solicited user responses on a number of optical illusions and collected anonymous subject demographic data, including gender and age. The median age of 30 was used to segregate the faculty responses from the student responses. The survey presented seven optical illusions involving different aspects of vision such as color, motion, and shape to the participants. The participants were exposed to the images for 30 seconds or less before answering any questions pertaining to the particular illusion.

The first image presented (Figure 1) tested for color blindness in the participant. The data in this sample was compared with the national average of colorblind incidence. Question 1 asked: "What numbers are seen in the picture shown (Figure 1)?"

The second image presented, known as the Pacman Illusion created by Jeremy Hinton, is a motion optical illusion (Figure 2). To create the illusion, the participant stares at the cross located at the center of the picture for around thirty seconds until they see a green dot in place of the "missing dot." The purple dots appear to disappear based on the movement of the green dot. In order to observe the changing color of the dots and directional difference of the moving dots, readers are encouraged to read the optical illusions survey online. Questions 2-4 were associated with this illusion and were as follows:

Question 2: Which direction do you see the disappearance of purple dots?

Question 3: Do the purple dots disappear based on the path of green dot?

Question 4: How long do you stare at the picture to see the green-dot?

The Hermann Grid created by Ludimar Hermann in 1870 is an optical illusion combining elements of color and motion (Figure 3). The image creates the illusion of flashing dots on a grid. Question 5, "do the white dots between the blue blocks turn into black?" was associated with this illusion.

The following questions were associated with an image that caused an afterimage effect (Figure 4). After participants stared at the image for 30 seconds and stared at a white area afterwards, an afterimage of the image should appear on the white surface because of fatigue of the retinas. The questions were as follows: "Stare at this picture for around 30 seconds. If you look away from the computer monitor and stare at the wall, do you see an

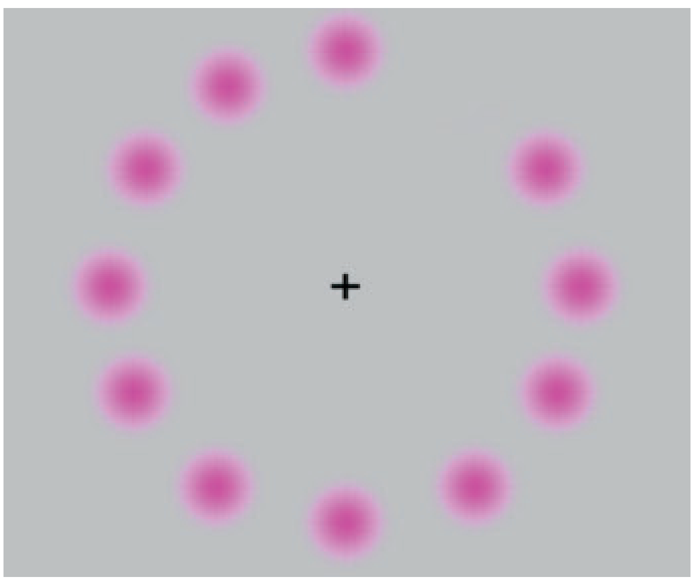

Figure 2. Pacman Illusion. The participant is asked to stare at the cross located at the center of the picture for around thirty seconds. A green dot should appear in place of the "missing dot" and the purple dots appear disappear based on the movement of the green dot.

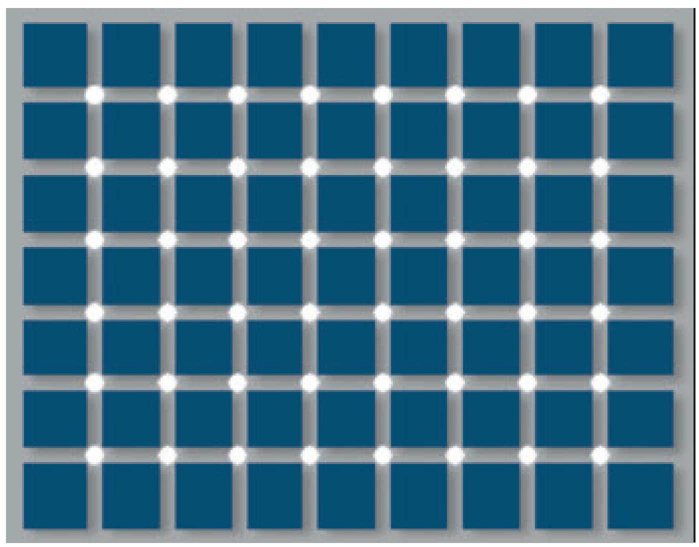

Figure 3. Hermann Grid. This picture is formed by 9 x 7 blue blocks on a grey background, and white circles in between each blocks. Subjects viewed the the picture around 10 seconds before answering the corresponding question in the survey. The optical illusion causes the dots on the grid to alternate between white and black.

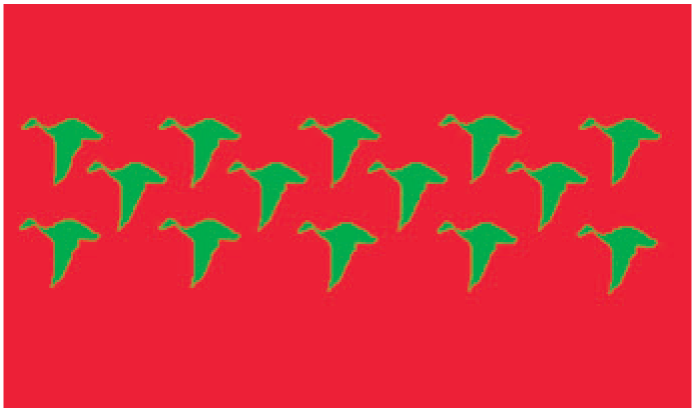

Figure 4. After Image. After staring at the image for 30 seconds, subjects shifted their view to a new environment, such as a neutral white space or wall, and were asked to count the number of birds seen on this new blank space.

after image on the wall?" and "How many birds did you see from the after image?"

Another optical illusion, Checker Shadow, created by Edward H. Adelson, creates a color illusion (Figure 5). The colors of surface A and surface B are identical, but A seems darker than B because it is surrounded by lighter blocks. Moreover, block B seems to lie under the shadow of the cylinder in the image, which, in the human mind, should dim the true brightness of block B.

False Color was also presented as an example of a color optical illusion (Figure 6). In this optical illusion, people often mistakenly judge the ten blocks in the first row of this picture to have the same color; the color of the bottom five blocks on the green background is the same as the color of the upper five blocks on the red background.

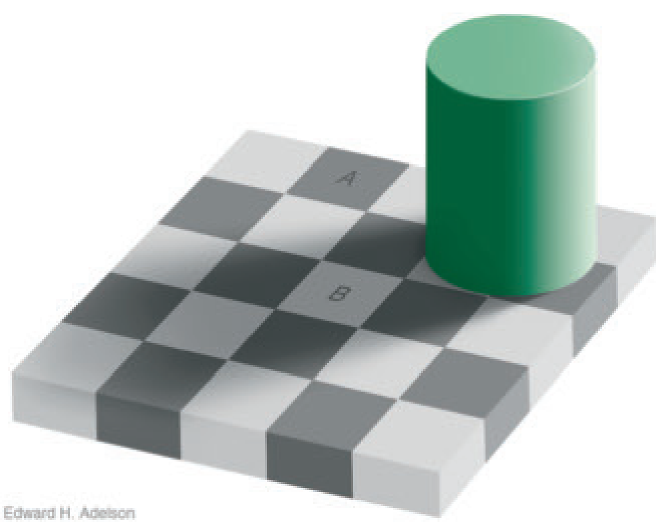

Figure 5. Checker Shadow. This color optical illusion focused on the color discipline. Subjects were asked to compare the color intensity of box A and box B.

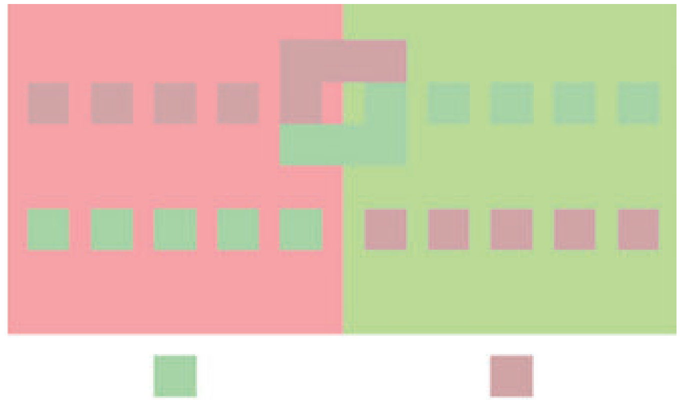

Figure 6. False Color. Subjects stared at the image for 10 seconds and compared the colors of boxes in the first and second row. Subjects often mistakenly interpret the color of the first row as light green, due to the background.

Disappearing dot was presented as a color and motion optical illusion (Figure 7). The result of this optical illusion is to observe the disappearance of a light blue dot at the center of the circle and maybe disappear eventually. The question associated with this optical illusion is to determine the extent at how each responder observe differently.

Statistical Analysis. To assess the statistical difference between two groups, two independent sample Wilcoxon Rank-Sum test was selected, be-

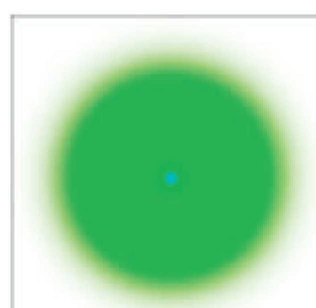

Figure 7. Disappearing Dot. Responders were asked to stare at the picture for 30 seconds to determine whether they could observe the light blue dot getting dimmer and eventually disappear.

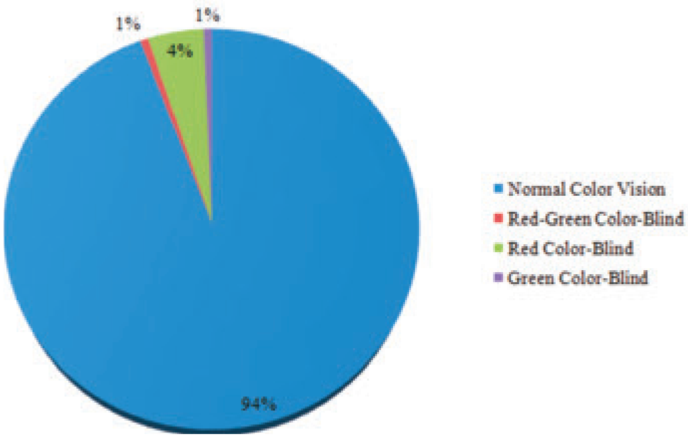

Figure 8. Gender effects on viewing optical illusions. The percentage of people affected in each optical illusion of the survey (n=158).

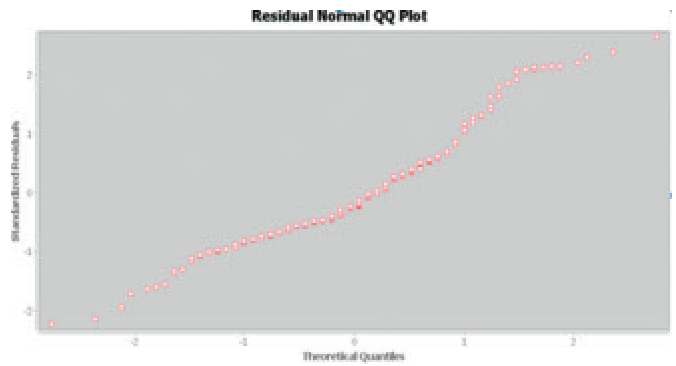

Figure 9. Age effects on viewing optical illusions. Survey respondents answered yes-or-no questions to demonstrate their susceptiblility to the corresponding optical illusion. This figure shows the percentage of people in different age affected in each optical illusion of the survey.

cause the normality of population parameters of the two independent samples was not assumed and the population sizes were not equal. One-way analysis of variance (ANOVA) was selected for the statistical difference among three or more groups.

RESULTS

Gender Effects. The response to the optical illusion tests by male participants and female participants were significantly different (P<0.05). In this sample of subjects, males have an approximately 8% color-blindness rate, while about 3% of females are colorblind (Figure 8). In the motion optical illusions (Pacman illusion and Hermann grid), a higher rate of females perceived these optical illusions based on the survey responses. For the afterimage illusion, the number of birds that were seen in the afterimage for males was binomially distributed; they tended to see either the most number or the least number of birds. In the color optical illusions Checker's Shadow and False Color, there were also a higher percentage of females that perceived the optical illusions.

Age Effects. Survey responders were separated into two different groups based on the sample size median age of thirty. The group over thirty years old had a higher percentage of colorblindness than the younger group by around 5% (P<0.05) (Figure 9). In the motion optical illusions (Pacman Illusion and Hermann Grid), both groups had similar percentages of people who perceived the optical illusion, suggesting that age has a minimal influence on the effect of motion optical illusions. In the afterimage experiment, the responses of both groups gave a bimodal distribution for the number of birds perceived in the afterimage. The older group had a higher percentage of people who were affected by the Checker's Shadow illusion, while there was a higher percentage of people in the younger group compared to the older group for the two other color illusions (False Color and Disappearing Dots). However, the high p-value of 0.116 of the age variance source, which is above 0.05, indicates the main effect is not as significant as gender. Therefore, responses grouped by age are generally equal.

DISCUSSION

Despite the initial prediction of this study that males and older people would be more susceptible to optical illusions, the results of this study showed that there was a higher percentage of females than males susceptible to the optical illusions in the survey, and that age had minimal effects on the responses. With the exception of the Disappearing Dot, the data shows that females are five to ten percent on average more susceptible to the optical illusions presented, including those involving color and motion (Figure 8). There is not a noticeable difference between the survey responses of the two age groups examined, one above thirty years old and one below thirty (Figure 9), which suggested that age has minimal effect on optical illusion susceptibility. One study examining the Ponzo illusion stated that females are significantly more susceptible to the Ponzo Illusion than males (Miller, 2001). Females tended to perceive the top horizontal line to be much longer than the bottom line. Furthermore, females had slower responses to the Embedded Figures Test (EFT), suggesting that females were more field dependent. This implies that the difference in reactions to the Ponzo Illusion between gender is due to the spatial strategy used by the two gender groups to solve the task (Miller 2001). The results of this study complement this hypothesis of a difference in spatial strategy; this difference could explain a higher susceptibility in females to optical illusions.

There are two important possible sources of errors that could have influenced these results. The first factor is the response error, which involves the attitude of responders to the survey. Because this survey was voluntary, the time that each subject spent on the survey was not controlled. These results could have arisen because females followed the instructions provided next to the optical illusions more closely and thus were more able to perceive the optical illusion. Collecting data through online survey was an effective way to gain a large amount of responses; however, the data could have been biased by the survey recipients simply not responding. Sending emails constantly throughout the quarter to can minimize such non-response bias of the data, which occurs when the collected data is not within the optimal range of responders.

While the reason for a male bias in colorblindness is genetic (Kelly, 1973), the greater susceptibility to optical illusions in females seems to be caused by a difference in task-solving strategy. The results of this study suggest that gender significantly affects optical illusion perception while age has minimal influence. The finding of this study strengthens the idea that males and females behave and solve questions differently. Potential gender bias in the perception of optical illusions prompts future studies on the difference in other behaviors between the two sexes.

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SOCR URL: http://www.socr.ucla.edu

Survey URL:

http://socr.ucla.edu/docs/surveys/SOCR_Survey_VisualIllusions_2010.html

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