Depth Explanation for the Effectiveness of the Müller-Lyer Illusion

Dan Reynolds
20473104
Assignment 2
Psych 306

Daniel Reynolds 20473104

Abstract

The depth explanation for the Müller-Lyer illusion proposes that the perceived difference in length of the lines is caused by the interpretation of the inward and outward going lines as the inside and outside corners of a building. The inside corner is perceived as further away from the observer than the outside corner, resulting in a line scaling effect. This explanation is examined in this study by comparing the effectiveness of arrow line endings that produce a corner depth effect to square detached brackets which do not produce such an effect. Four university students participated in 25 trials each for both types of line endings. The study found that the participants were nearly 100 percent accurate on average in calculating the length of the lines with the detached square brackets and were 10 percent less accurate with the arrow line endings, supporting the depth explanation of the illusion.

Daniel Reynolds 20473104

Depth Explanation for the Effectiveness of the Muller-Lyer Illusion

The Müller-Lyer illusion examines how the perceived length of equal length lines can differ depending on the angling of the arrows at the end of each line. Psychologist Richard Gregory suggested that features of a 2-dimensional picture can alter an observer's perceived size of objects, a perception effect that he refers to as “depth cue scaling” (Gregory, 1968). He suggests that a line with inward-going arrows is perceived as outside corner of a building, creating a negative depth cue scaling, while the line with outward-going arrows is perceived as the far inside corner of a room, creating a positive depth cue scaling. This scaling effect causes the brain to perceive the outside corner as closer than the inside corner, creating the illusion that the line with the inward-facing arrows is shorter than the outward-going version. Researchers ran trials of the Müller-Lyer experiment in the 1960s with members of an African group called the Zulus, who lived in a “circular culture” of round buildings and who did not perceive the inward-going or outward-going arrows as corners of a building (Chandler, 2014). Without any perception of inside or outside corners, the Zulu performed more accurately in the experiment than Western participants, suggesting that the depth effect is responsible for creating the illusion.

This study uses two different versions of the Müller-Lyer illusion. The first uses inward and outward-going arrows that create a depth cue scaling effect in participants from a non-circular culture. The second uses inward and outward-going detached square brackets instead of arrows. The detached square brackets are not perceived as corners and do not generate the described depth effect. The purpose of this study is to determine how the depth effect influences the effectiveness of the Müller-Lyer experiment. The study has participants adjust the dependent variable, the length of a line with inward-going arrows, until they perceive it as equal to the length of a provided line with outward-going arrows. The independent variable, the shape at the end of each line, is then replaced with detached angle brackets and the experiment is repeated. It is expected that participants will more accurately match the length of the adjustable line and the control line in the inward and outward-going detached square brackets version of the experiment than the arrow version, supporting the hypothesis that the arrow line endings create a depth cue scaling effect. This result would confirm research from previous studies that the depth effect is responsible for the inaccuracy of Western participants in the Müller-Lyer experiment.

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Method

Participants

The study requires participants from a non-circular culture that would experience the perceived depth effect from the inward and outward-going arrows. Four university students from a Western culture were selected to perform the experiment.

Materials

A computer is required to run the PsyCog: Exploration in Perception and Cognition CD. A text application is required to measure and analyze the results of the experiment. No other materials are required.

Procedure

Participants are presented with a computer interface consisting of a pair of lines with inward and outward-going arrows at their respective ends. The length of one line defined as the “control line” remains constant, while the participants are able to modify the other line, called the “adjustable line”. The length of the control line remains constant between each trial, while the length of the adjustable line is randomized at the start of each trial. The participants are required to use a button in the computer interface to modify the length of the adjustable line until they perceive the length of both lines to be equal. The percentage of the length of the adjustable line compared to the control line is recorded. The participants are not shown this percentage and receive no feedback on their performance in order to minimize potential learning effects. This activity is repeated for 25 consecutive trials without any breaks. The participants are given a brief pause while the conditions of the experiment are changed. The independent variable is changed and participants repeat the experiment with inward and outward-going detached brackets for another 25 trials. Participants conduct the experiment independently and individually and do not observe eachother's results.

Results

The arrows version of the experiment had a lower control line percentage than the detached brackets version when averaged over the 100 trials across the four participants. The participants on average perceived the adjustable line to be equal to the perceived line when it was on average approximately 86

percent of the actual length of the control line. The accuracy of the participants in the second version of the experiment with the detached lines was notably higher and the point at which they perceived the lines to be equal was on average approximately 97 percent of the actual control line.

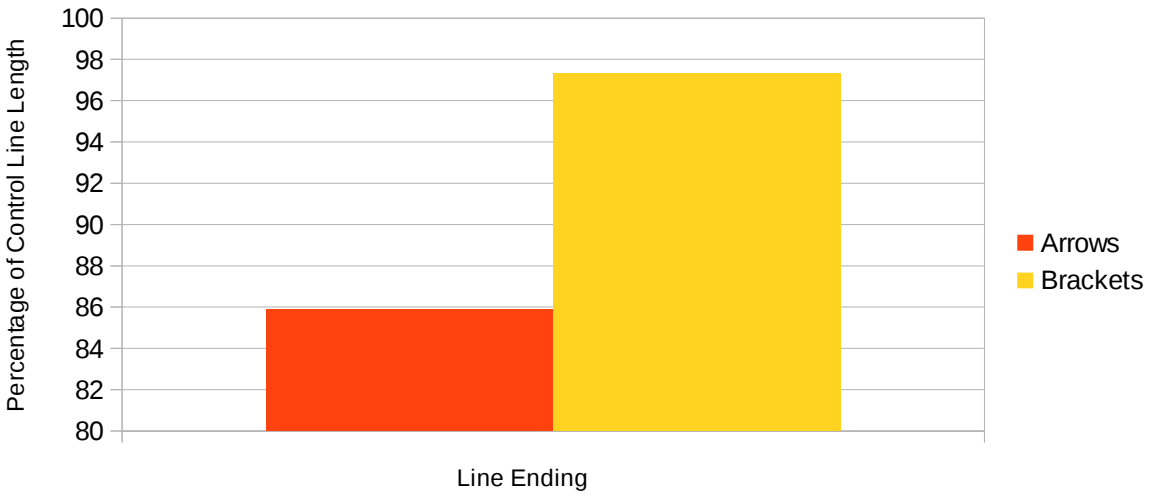

Figure 1. Average Performance of Arrow vs Detached Bracket Endings

The average performance per trial in each of the two versions of the experiment shows the arrow version of the experiment consistently underestimating the length of the adjustable line relative to the control with small variations in length. The detached brackets version has an average adjustable line length on average equal to the control line and is completely accurate in several of the trials.

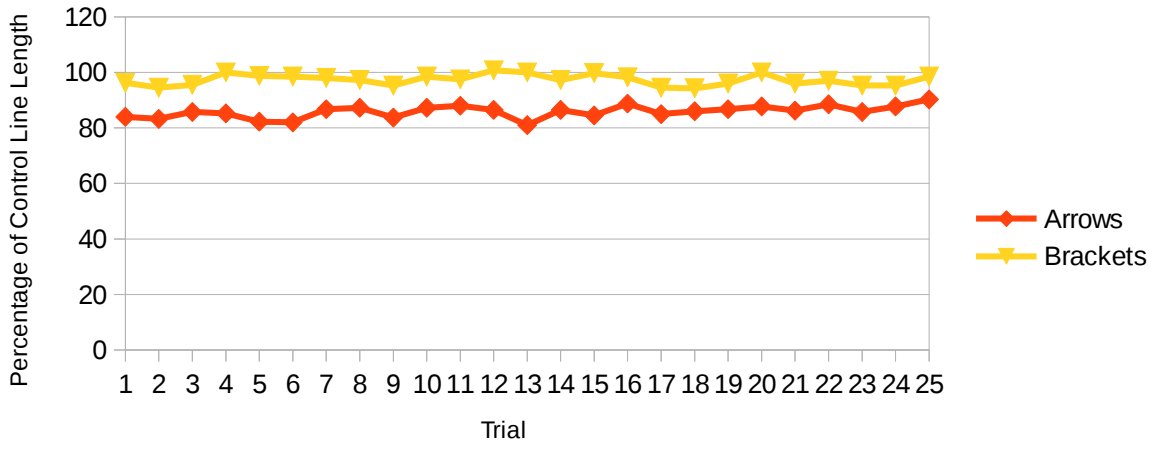

Figure 2: Average Trial Performance of Arrow vs Detached Brackets

Discussion

The result of the study confirms the hypothesis that the accuracy of matching the adjustable line to the control line in the detached brackets version was expected to be higher than in the arrow version. These results conclude that on average the detached brackets version consistently performs more accurately than the arrow version of the experiment, with accuracy approaching one-hundred percent. The theory that the Müller-Lyer illusion is created by depth cue scaling when inward and outward-going arrows are used at the end of each line is supported by the results. The arrow version of the experiment which does not have the same depth cue scaling effect on Western participants consistently performed approximately ten percent more accurately than the detached brackets version. These results align with the research by Gregory that concluded that depth cue scaling can influence the perceived scale of 2-dimensional images. It confirms the role of this scaling effect in the Müller-Lyer illusion and provides further evidence for the depth expanation. It agrees with past research and strengthens the hypothesis that there is a depth effect causing the lines with arrow endings to be perceived as different lengths.

References

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Gregory, R. L. (1968). Perceptual Illusions and Brain Models. *Proceedings of the Royal Society of London. Series B, Biological Sciences. 171*, 279-296.