Chris Angeloni

Experimental Methods in Perception

9/22/14

**Muller-Lyer Illusion: Examining Effects of Depth and Figure Length**

INTRODUCTION

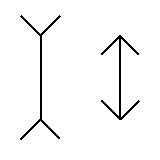
The Muller-Lyer illusion is a famous visual phenomenon that manipulates the perceived lengths of lines adjoining two directional arrows. In the classic example, two lines of identical length connect arrows of two directional types; one set of arrows pointing inwards and the other set pointing outwards (Fig. 1). When viewing these different line types, the line with inward pointing arrows appears larger than the line with outward arrows, despite them being identical in length. The exact cause of this illusion is unknown, but there are two popular explanations. The first claim posits that the illusion is driven by depth cues - the arrows resemble corners and the concave corner appears farther away, so the visual system perceives this line as larger relative to a convex corner of equal size. The second claim posits that this effect is due to overall figure length being confounded in the inward versus outward arrow manipulation - the overall length of the figure with inward-pointing arrows is larger, and this increased size may drive the percept that the line is longer.

Figure 1. Classic Muller-Lyer illusion.

The current study aimed to test these two models through manipulation of overall figure length and angle steepness. We predicted that manipulating angle steepness would increase the magnitude of the illusion if depth is the main cue underlying the illusion (i.e. steeper angles will cause lines to appear closer or farther away, increasing the perceived difference in depth). Furthermore, we predicted that keeping the length of the figure constant across different arrow directions by selectively manipulating line length, arrow angle, and arrow length would cause a reduction in the Muller-Lyer illusion, assuming that overall figure length is the determining cue.

METHODS

*Participants.* 17 undergraduate and graduate students were recruited from the Psychology and Engineering departments at the University of Pennsylvania. They were offered candy as compensation for their participation in this IRB-unapproved study.

*Apparatus.* All stimuli were generated using Matlab R2014a and displayed on an LCD monitor positioned roughly at eye level, about half a meter from the participant.

*Stimuli.* Line stimuli consisted of white lines and arrow heads displayed on a black background. The stimulus parameters were carefully chosen to yield several combinations of matching figure lengths across several comparative conditions, namely, matching figure length between inward and outward arrows, between inward arrows of different angles, and between outward arrows of different angles (MAYBE INSERT FIG HERE). All parameters were set in pixel values.

To match figure length between inward and outward arrows, it was necessary to adjust the physical line length to account for differences in overall length. To do this, we used line lengths of 100, 140 and 180. Furthermore, we adjusted arrow angle and length to enable us to match figure lengths. We used angles of 120 and 150 degrees and corresponding lengths of 40 and 40/31/2 (~23) pixels. Stimuli with inward facing arrows with either angle-arrow length pair of 120 degrees and 40 pixels or 150 degrees and ~23 pixels yielded total overall figure lengths of 140, 180 and 220. Inward facing arrow conditions with these specifications were later matched to outward facing arrows of the lengths 140 and 180 (there were no conditions in which outward facing arrow lines could be a total length of 220).

The parameters chosen also allowed us to compare within arrow direction conditions to assess the effects of angle steepness on line estimates. The comparison set for inward facing arrows consisted of lines of lengths 100, 140 and 180 when arrow angles were 120 degrees with a length of 40 relative to lines of the same length with arrow angles of 150 degrees with arrow lengths ~23. Because outward facing arrows do not add to their overall figure lengths, it was possible to directly compare outward arrow angles across all arrow lengths. It is noteworthy that some comparison conditions are represented with greater frequency in the data, due to the counterbalancing of all the particular stimulus parameters. This could potentially be a source of systematic bias in our comparisons.

We also included a random angular jitter in half of the blocks for each participant (counter-balanced across participants), but did not examine jitter in this analysis.

*Task.* Participants were first given verbal instructions about the task and informed that they would be viewing lines with directional arrows and were to give their best estimate of line length in comparison to a standard line. The standard was displayed at the beginning of the experiment and was 140 pixels in length. However, it was classified to the participants as being a length of 100 units, so all estimates were made given that basis. For each trial, participants viewed a line stimulus for 1000ms, after which they provided a response by typing their estimated length. Participants also had the option to revisit the stimulus, revisit the standard or quit the experiment. All stimulus parameters were counterbalanced (3x2x2 design yielding 24 conditions) and each participant ran in 4 blocks, yielding 96 total trials.

RESULTS