Perceptive fields and the hermann grid illusion

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Measuring Perceptive fields using the Hermann Grid Illusion

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Abstract

This study looks at how displacement of the fovea changes how the Hermann Grid illusion is shown at different bar widths. The first hypothesis was that the bar width at which the illusion was maximal would increase with increased eccentricity. The second hypothesis was the bar width at which the illusion would increase the higher eccentricity. The study was carried out on 228 participants and after the study was completed it was seen that the first hypothesis was confirmed, and while the means showed a positive correlation in the second hyposthesis, there was not a significant difference between two of the levels of the IV.

Introduction

There are a broad spectrum of topics that psychology delves into, from how the brain works to how people interact with the world and those around them. Many psychologist study how the brain perceives the world and how it can be fooled whilst been given the same raw data everyone else has. However, this study is going to be centralized around the eyes, and how they can be giving the brain false information before it even gets there. This experiment will focus on the measurement of perceptive fields at altered distances from the fovea. To test this, altered bar widths will be used within a Hermann Grid Illusion.

A Hermann Grid Illusion is a black background that is covered by intersecting horizontal and vertical white line, giving the illusion of even black squares (Schiller and Carvey, 2005). This phenomenon was first attributed to simultaneous contrast, which was described by Hermann as being " The apparent brightness of each point on the grid depends on the amount of black which exists in a certain area around it (1870. As cited in Spillmann, 1994). From this, Hermann stipulates that when there are larger white bars, peripheral contrast is less as there is less black to contrast. This is explained as " Its brightness will thus be less enhanced by contrast and must therefore appear darker." (1870. As cited in Spillmann, 1994)

However, it wasn't until many years later that there was a new explanation for the phenomenon. A theory within the human visual system called receptive-field organization. This theory was brought to light by Baumgartner. His theory was that the illusion was due to the fact that " brightness signalling on-center cells stimulated by the intersection receive about twice as much lateral inhibition as cells stimulated by the bars." (Spillmann, 1994). Lateral inhibitions will then cause the intersections to appear darker. Lateral inhibition is when a neuron is overly excited, which reduces the activity of neighbouring cells. When applying Lateral inhibition to the Hermann Grid illusion, lateral inhibition occurs when the outer ganglion cells are over-stimulated, causing under stimulation of the center ganglion cells, making the intersection seem darker.

Width is a very important consideration when discussing the Hermann Grid illusion as a whole. Braumgartner also discussed how the diameter of the receptive field could be measured by using the width of the bar. When the illusion was strongest correlated with the diameter of the receptive field center (1960. As cited in Spillmann, 1994) Spillmann then goes onto describe how to measure the size of a receptive field. “ To determine the size of a perceptive-field center, the observation distance (and thus the visual angle of the inducing stimulus) is varied until the illusion is maximal. For a threshold measurement, it is assumed that the critical bar width at which the illusory spots are strongest corresponds to the size of the perceptive-field center.” (1994). This can also be adapted to measure the size of the periphery, rather than the center of the perceptive field. This can be done by displacing the fixation point (Spillmann, 1964. As cited in Spillmann 1994). Because of this, the Hermann grid illusion can be used to measure both the center and the surround of the perceptive field.

There are going to be two hypothesis considered when undertaking this experiment. These will discuss how the bar width interacts with the size of the perceptive field centers as well as how the bar width interacts with the whole perceptive field. The first hypothesis being discussed in this experiment is that the bar-width at which the illusion is maximal should increase with increasing distance from the fovea, this being due to the size of the perceptive field centers. The second hypothesis being discussed is that the bar width where the illusion disappears should increase as the distance from the fovea increases, this time due to the size of the whole perceptive field, including center and surround.

Method

Participants

The participants for this experiment were 228 QUT students enrolled into the unit PYB204 – Perception and Cognition. By being part of the unit, participants were deemed to be eligible and those who were present the day of the experiment had the chance to participate. No other selection or exclusion criteria was applied to those who could participate in the experiment. Of the 228 participants, 180 were female and 48 male, and ranged in age between 18 and 61 with a mean age of 23. 82

Design

In this experiment, the Independent variable (IV) was the displacement from the fovea. There are 3 degrees of displacement used in this experiment, which are; 0°, 5° and 10°. Participants were to complete all 3 levels of the IV, which were randomized as a control variable. The first DV is the bar width where the illusion is maximal using a method of adjustment, while the second DV is the bar width at which the illusion disappears. This uses a staircase method using a step size of 0. 04° with 6 reversals. From this, it can be extrapolated that each participant looked at the Hermann grid illusion six times, three for the first DV and three times for the second DV. Other control measures used include having an equal amount of intersections in each grid as well as the fact that half of the participants viewed their displaced grid from the left and the other half on the right.

Apparatus

Stimuli was rendered on a 21. 5” monitor, using 1400 x 900 screen resolution. No working distance correction was given and participants were instructed to wear whatever spectacles they used for computer work, if any.

Participants viewed a 3 x 3 grid subtending 6. 6° with the central point of the grid displaced at either 5°, 10° or 15° from the center of fixation. Participants were provided a visual target (a plus “+” sign) to fixate upon, which was located in the center of the screen.

Procedure

Prior to the experiment, particpants were directed to a computer, with their head 30cm away from the monitor. During the test, six different test were conducted. The two hypothesis were conducted sequentially, the first three tests considering the first hypothesis and the last three tests considering the second hypothesis. The first three tests required participants to evaluate at what width the illusion was most apparent. The second three tests required the participants to locate when the illusion was minimal at each level of the IV. These tests were conducted in computer labs with roughly 10-30 people in each session and all sessions happening over the course of one week. Groups were conducted at different times of the day.

Results

The results from each of these experiments were collated and processed and descriptive data was collected to provide some understanding as to how each of the tests were affected by the bar width. A table of these statistics is provided below.

Means and Standard Deviation of Maximal Illusion and Illusion Threshold

Variable	Mea	Standard	N

	n	Deviation	
Max_Illusion0	. 54	. 37	228
Max_Illusion5	. 68	. 38	228
Max_Illusion10	. 83	. 44	228
Threshold0	. 91	. 47	228
Threshold5	1. 16	. 47	228
Threshold10	1. 19	. 51	228

As evidenced in Table 1, it shows that the mean increased for each level of the IV, it was reported that the lowest mean was when there was no displacement from the fovea (Mean = . 54, SD = . 37). The next highest being the average amount of displacement, 5°. (Mean = . 68, SD = . 38) and the largest displacement (10°) showed the highest mean of all the trials in the first set of trials. (Mean = . 83, SD = . 44). This shows that there is a positive correlation between the displacement of the fovea, and the bar width at which the illusion is maximal. This is also seen in the second set of trials. Where there was no displacement of the fovea, there was the lowest mean for bar width. (Mean = . 91, SD = . 47), the second test shows the second highest displacement and the average mean. (Mean = 1. 16, SD = . 47) and the largest Displacement from the fovea (10°) shows the largest mean (Mean = 1. 19, SD = . 51)

While means were used to show some correlation, t-tests were also completed to see whether or not the data would be statistically relevant. All but one of the t-tests completed showed that there were significant differences between the levels of the IV. When considering the differences between threshold 5 and threshold 10, it showed that there was not a significant difference between the two levels of the IV. ($t(228) = -1.472$ $p > .05$)

Discussion

When considering results from these experiments, the first hypothesis was confirmed. As the displacement from the fovea increased, so did the bar width that the illusion was maximal. 0° had the lowest mean with . 54, 5° was second with a mean of . 68 and 10° had the largest mean width with . 83. These studies are in line with previous studies of the phenomenon and are indicative of previous results by Spillmann and Random-Hogg (1980).

However, when considering the threshold DV, the hypothesis was not completely confirmed. When considering the mean widths, there was a positive correlation throughout, with the smallest mean being assigned to no displacement with a mean of . 91, the second highest mean of 1. 16 going to the 5° displacement of the fovea and finally the largest mean width being attributed to the largest displacement of the fovea, 10° with a mean of 1. 19. However, when conducting t-tests to consider the significance of the results, it was found that there was not a significant difference between the results of the 5° of displacement and the 10° of displacement. While the means are in line with current research, more testing could show more statistically significant results.

Some of the limitations of this study can be the eyesight of the participants. Participants in the past have reported not being able to see all levels of the IV, which could give skewed results as some participants could only take part in part of the experiment. One of the ways to combat this is to add selection criteria on to the experiment to make sure that all participants can see all parts of the IV.

One of the ways that this future studies could improve upon this experiment is to complete the experiment with more advanced technology when it is available, so that researchers will be able to get a greater idea of how the eye and perceptive fields work within the eye.

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