Affect of shape and color on visual Recognition

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ABSTRACT

Color and shape are two very noticeable attributes of the world around us. Subconsciously, human beings identify the shape and color(s) of everything in our present environment. Do either of these attributes have an effect on our decision-making process? Are we attracted to one color over the others or one shape over another? Does the human eye prefer one combination of shape and color or does it vary per individual? These are some of the questions this paper will try to answer. The primary goal of this paper is to study how shape and color influence visual recognition. We have taken 8 subjects and first expose them to a grid of black and white shapes. Each subject count the number of squares within the grid. The subjects will then be shown a different grid full of shapes with random colors. They will be asked to conduct the same actions as they were with the first grid. Every run will be timed. We will compare the differences in time and accuracy between the runs.

KEYWORDS

Visual attention , visual guidance , gazepoint

1 INTRODUCTION

Our study focuses on the guidance and attention of visual variables – 2D shape and colors. In this study, we will use eye tracking to analyse the visual guidance from shape and colors. The use of road signs play a very important role in our daily driving . Let us take the example of stop sign . In USA the stop sign was standardised in 1922 by the American Association of state highway officials (AASHO). They selected a octagon in yellow color, was there any specific reason for this selection ? The shape octagon was selected because of its rare usage at that point in time and yellow because of its reflective property. Currently the stop sign shape has not been changes but the color has been changed to red because of its association with traffic lights. Whereas in European countries the stop sign is circular and red in color. This lead us to think how the different combination of shape and color affect out visual guidance. Is our visual guidance attracted more to any color and shape ? is there any relation between shapes of different color and shape to visual guidance and attention? If not, why not just place all the signs in black and white in similar shape to save cost.

1.1 Hypothesis

The purpose of this study is to see how shape and color of the object affect our recognition ability. We hypothesize that on being asked to select a colored shape in 6*4 grid the participants showed less efficiency and greater reaction mean time then on made to select same shape in black or white. Using this we will also see the affect of color and shape on variables that affect our visual attention and guidance. We will capture finish time, time to first fixation, and accuracy of the participants.

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2 BACKGROUND

After the adoption of Bertin's [1] seven visual principle in cartography, the number of studies on the different aspects of visual variable increased considerably. Eye tracking has been defined as a objective, precise and quantitative way to see how perceptive the participants are to certain information[2]. It has been widely used to answer question's such as "why certain variables have greater visual attention"

Garlandini et al [3] applied the eye tracking technology to evaluate the visual guidance of the four most commonly used visual variables - size, color, hue and orientation. They found size to be the most effective and efficient of the visual variable but this was done under flicker condition.Flicker condition does not have much usage in other visualization.

Visual perception is a reaction of the human visual system to the physical stimuli[4]. MacEachren's[5] states that there are two visual stages. In the first stage the pixel to pixel contrast of a retinal image in a process is described whereas in the second one it is stated that a person uses this information from first stage to form edges, regions and shapes. From this it can be said that the color is easier to process that shapes.

Some of the previous studies have shown that color is a important factor while provide visual guidance in 2D object searches. They have also shown that shape is weaker than color while providing guidance from the same 2D tasks. Wolfe et. al. based on his experiments of 1D sizes, shows that size is the most important factor guiding visual attention.

In this study, we are going to focus on visual attention and guidance due to variable color and shape in 2D

3 METHODOLOGY

3.1 Apparatus

During the process of research, a Dell P2213 22" LED LCD monitor (1680x1050) was used. Eye tracking movements were recorded using a GP3 Gazepoint 60Hz sampling rate eye tracker with a visual angle accuracy of 0.5-1 degrees. The device was calibrated using a 5-point calibration method. Gazepoint Analysis software was used to collect and analyze data.

3.2 Subjects

The study consisted of 8 Clemson University undergraduate students ranging from ages 20-27. 1 participant had corrected vision while the remaining 7 did not. 7 participants were male and 1 was female. Subjects were chosen by members of the research team rather than being volunteers

3.3 Stimuli

Subjects were exposed to 20 random images with 24 shapes in a 6x4 grid pattern consisting of triangles, diamonds, squares, and circles. Of the 20, 10 grids had randomly colored shapes colored with either RGB green, RGB red, RGB blue, RGB yellow, or RGB purple. The other 10 grids had black shapes. All 20 grids consisted of a white background. Each grid had an aspect ratio of 16:9 and was centered on the screen with black borders along each side. There were an additional 2 colored grids and 2 black grids for practice. Participant instructions were given on-screen using the Gazepoint Analysis software text feature prior to each set of 10 grids.

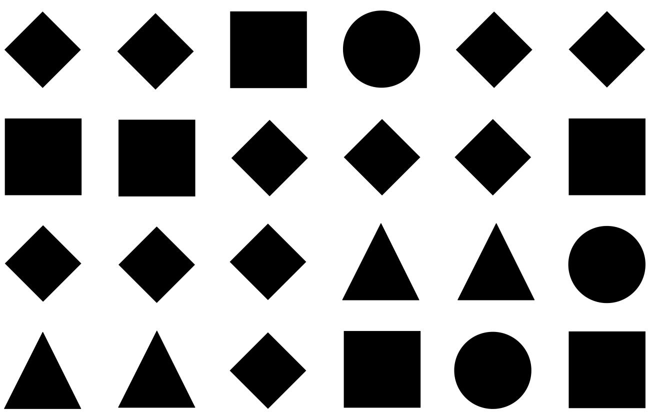

Figure 1: Image with 24 B/W shapes

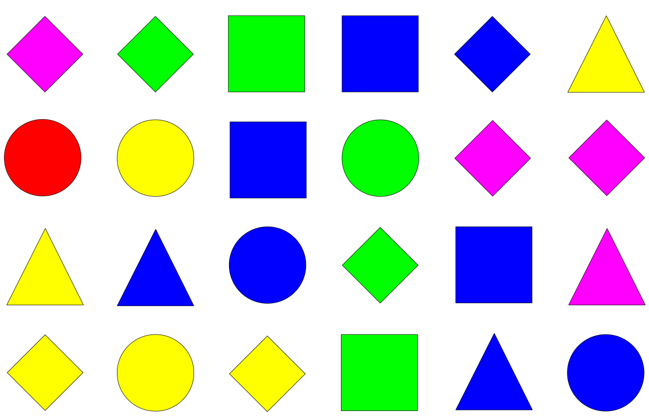

Figure 2: Image with 24 colored shapes

3.4 Experimental Design

The experiment carried out was a within-subject experiment. Participants were asked to count the number or squares in a grid of 24 random shapes described above. Each participant was greeted by a research team member when entering the experiment room, seated, then given the opportunity to ask any initial questions they might have. They were then read an informational letter from the Institutional Review Board which included risks involved with the experiment, potential benefits, confidentiality information, principle researcher contact information, information regarding voluntary participation, and a reminder that they are able to opt-out at any time during or after the experiment. After consent was acquired, subjects were asked a few pre-experiment questions relating to eyesight and corrected vision. Subjects were then read a set of general instructions detailing the basics of the experiment, what will be asked of them, and the purpose of the experiment, then given another opportunity to ask questions. Subjects were seated about 20" from the computer monitor/eye tracker and asked to calibrate the Gazepoint eye tracker using the Gazepoint Analysis software. After the initial calibration, participants read a more detailed set of on-screen instructions which guided them through the actions they would be performing and inform them of how to provide feedback (e.g. to press the space bar after the successful completion of each task)

3.5 Procedure

During each trial, participants were asked to count the instances of squares on each grid as fast as possible. They were to only count squares across all 24 (4 practice, 20 real) grids. Half the participants were shown the color grids first, while the other half were shown black and white first. The color-first participants were given the 2 practice colored grids first, in random order, to grasp the concept of the experiment before viewing the remaining 10 colored grids prepared in a predetermined random order. Each grid remained on the screen indefinitely until the participant pressed the space bar to indicate they had finished counting. Between each grid there was a blank image in order to prepare participants for the next grid. After the 10 colored grids, there were a set of on-screen refresher instructions for the black and white grids up next. Participants were given another set of 2 practice grids, in random order, followed by the 10 remaining black and white grids prepared in a predetermined random order. The procedure was reversed for the black-and-white-first participants. After the completion of all 20 trials and 4 test trials, participants were given a debriefing survey about their experience during the study followed be another opportunity to ask questions.

3.6 Analysis

Study analysis will be done on speed and accuracy of counting and shape chosen. Speed and accuracy metrics will be compared between colored and black and white grids to determine statistical differences and implications these differences (or lack thereof) provide on shape recognition and how that differs with color.

4 RESULTS

8 participants were selected for this experiment. All the Participants were from Clemson university. 37.5 % were graduate students where as 62.5% were undergraduate students. None of the participants were color blind. 7 Participants were male whereas 1 was female. The age range of the participants was 20-27 with the average age being 26.71 year. After the experiment the participants were asked that between black and white and color, in which did they found the counting of the squares easier. 87.5 % (7 out of 8) of participants said that they found the colored one easier.

Time was the first measure for our proposed hypothesis. The time taken by the participants to find squares in colored images is less as compared to the time taken by the participants to find squares in black and white images. The average time taken by the Participants in colored images is 80.27s whereas the average time taken in black and white images is 84.02. The bar graph in fig.3. shows the time comparison of the time taken by the participants.

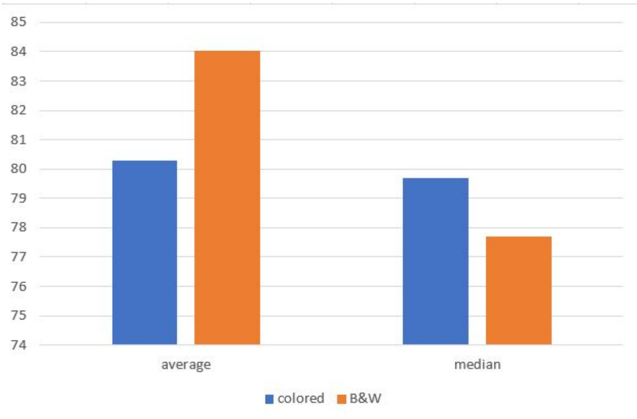

Figure 3: Bar graph for time taken

The Second measure for the hypothesis proposed by us is accuracy. This was measured by asking the participant to count and say aloud the number of squares. The participants showed higher accuracy with the colored images then the black and white images. The average of accuracy on black and white images is 92.5 % whereas the average of accuracy on the colored images was 93.75 %. The bar graph Show in fig.4. show the comparison of accuracy on black and white and colored images.

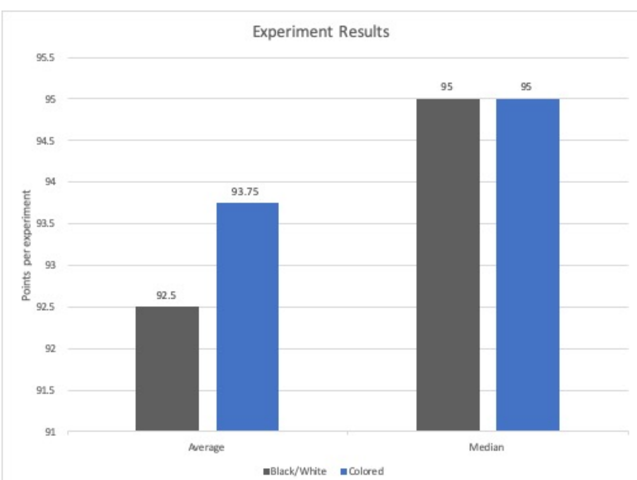

Figure 4: Bar Graph for accuracy

The table.1 shows the value obtained on applying ANOVA to the Accuracy and Time taken data. The Table contains the P-value and F-stat obtained on applying the ANOVA to the Participant data for black and white images.

BW	Accuracy	Time
F-stat	3.428	0.5
P-value	0.1135	0.5

Similarly we applied the ANOVA to the data for colored images and obtained the information given below in table.

BW	Accuracy	Time
F-stat	0.2	1.3369
P-value	0.6704	0.2915

The comparison of these value suggest that our hypothesis holds true.

fig.5. , fig.6. and fig.7. shows some sample fixation, gaze map and heat map with the Images.

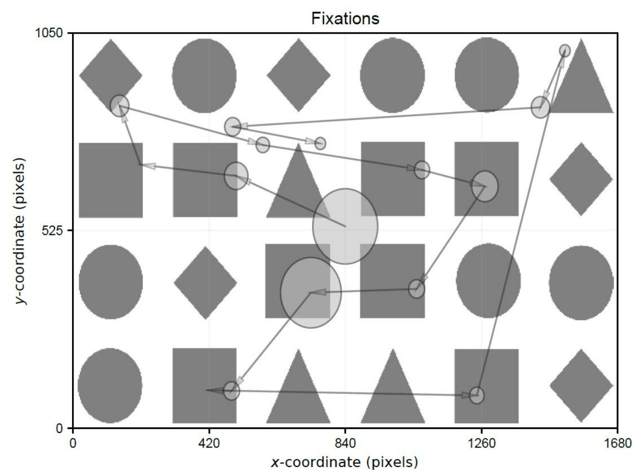

Figure 5: Fixation on B/W Image

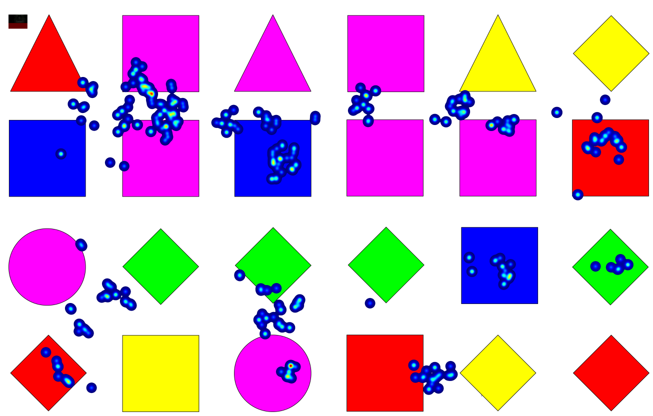

Figure 6: Heat map on Colored Image

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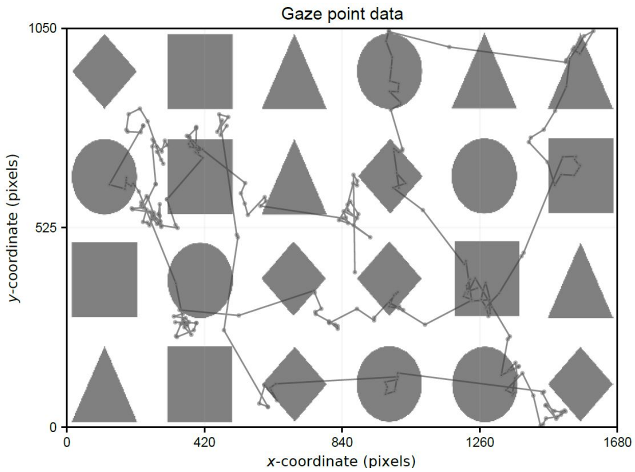

Figure 7: Gaze map on B/W Image

5 DISCUSSION

Due to data loss, we were only able to gather data from eight participants. We hypothesized participants would be faster when counting colored squares and our data supports our claim. The shape grids used during the experiment were random in terms of color, type, and placement of shape, which limits the implications our data has on shape recognition and the effect color or placement has. This does give us the possibility of expanding our experiment and controlling color, type, and position of shapes within a grid to test different aspects of shape recognition – allowing us to supplement our current results and learn more about eye tracking, shapes, colors, and how they all relate, however.

We also hypothesized participants would be more accurate when counting colored shapes and our data supports that claim as well. While only marginally higher, participants were more accurate when asked to count the number of colored squares versus the number black squares. This data, however, is potentially statistically insignificant, as the median accuracy between colored squares and black squares is the same.

While our data supports our hypothesis that colored shapes are more recognizable than black shapes, it is perfectly possible our data is unknowingly dependent on a randomized aspect of our experiment. As previously mentioned, there are many possible opportunities to experiment and further our knowledge about shape recognition and its relation to color. Many of these future experiments would be very similar to this one; by controlling one variable at a time, multiple experiments could be analyzed wholly to paint a larger picture of the current shape recognition information which may give us an insight into how we interact with shapes in our everyday lives. This has the possibility to affect multiple facets of our lives, including, but not limited to road signs and markers, advertisement design, and consumer good design. The ethics of this are unknown currently

6 CONCLUSION

This experiment has provided us a small amount of insight as to how we visually recognize different shapes and colors in our surrounding environment. Although the results of our research have proved our hypothesis to be true, the margins were very small, and we did not foresee the data resulting from this experiment to be so close. Due to this, we are not able to draw any decisive conclusions with respect to colors, shapes, and our visual recognition abilities. As a group, we believe the similar results between black white and colored image accuracy and competition times is a result of way we designed our image slides. In order to obtain more conclusive data, in a future experiment, we would create more slides, with a higher quantity of smaller shapes, increasing the difficulty of the test. This would produce an intensified version of the study we conducted and more likely would have created a better environment to analyze our visual recognition ability when determining shapes and colors. In addition to this, we were only able to conduct this experiment on small group of individuals. With a larger subject pool, paired with a more difficult test, this experimented would have more likely produced more useful and interesting data. As we conclude our research, we are left with more questions to be answered and a slightly better understanding of how we may be able to distinguish the correlation between color, shape and a human beings' visual recognition capacity.

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