The Influence of Visual versus Written Word Distinction in Virtual Interface Selection

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1 ABSTRACT

As more and more tasks have become dependent on the interactions of humans with computers, interfacing between the two has increasingly become the dominant way most of us spend our time, both professionally and recreationally. As such, a well or poorly designed HMI (Human-Machine Interface) can be the difference between a pleasant and efficient experience or a frustrating and time consuming one [3]. Even so, we have all experienced what it is like to waste time fumbling through what should be a simple task because our only way of communicating with the tool we need was created unintuitively for the average user. This is not due to a lack of care on the part of the designers, but an absence of concrete design principles for them to follow. In this study, we establish a connection between the use of visual cues such as shapes to aid in the visual search of displayed information and an efficient user experience. We established that users could more easily pick out a prompt from a grid if that prompt was a shape instead of plain text.

2 INTRODUCTION

The focus of our study is to establish the difference in efficiency experienced by the end user of a HMI when information is represented in a display by shapes and plain text. Through eye tracking technology we are able to monitor participants as they attempt to find various words associated with shapes and various two dimensional shapes both organized in a grid format. Through the data we collected, we will attempt to show that locating specific prompts from a field of similar objects can more easily be done when the prompt is a shape instead of text.

3 BACKGROUND

Questions are often asked regarding the method of view for users attempting to interact with software design user interfaces as to the preferred views required to most effectively locate desired objects as quickly as possible. Quasi-real conditions of natural environments for testing user interfaces can include many benefits such as encouraging active participation of software project managers and product owners as well as helping to understand the needs of users of applications in development [1]. Understanding the relationship between the different visual aspects presented to end users of an application and the ways that they react to interface design can create better experiences and significantly increase the efficiency of accomplishing tasks. Studies that involve task-oriented interface design have been done that show additional benefits such as reducing mental strain with the Rating Scale of Mental Effort (RSME) [2] as well as increasing levels of productivity. Our goal is to illustrate some changes in HMI design that are required to show these benefits and the level of increased efficiency that results.

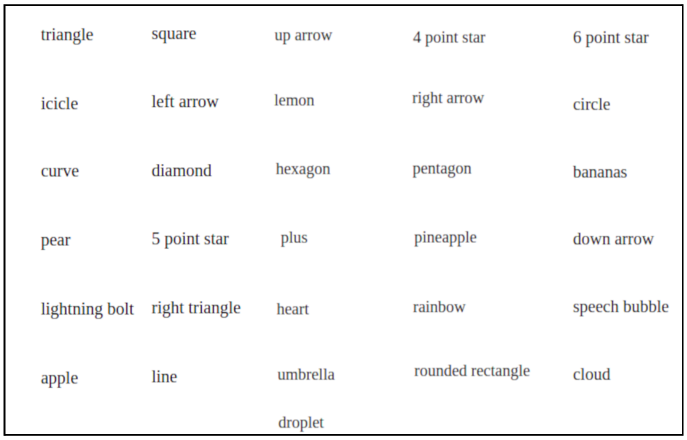

Figure 1: Grid of data with test stimuli

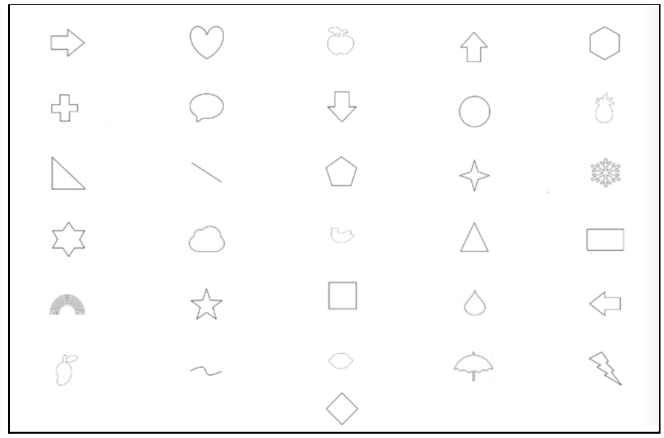

Figure 2: Grid of data with visual stimuli (shapes)

4 EXPERIMENTAL DESIGN

4.1 Apparatus

In this study, we gathered data through the use of an eye tracker. The specific model used was the Gazepoint GP3 eye tracking system which boasts an accuracy within 1 degree at a sampling rate of 60Hz. Our participants were required to sit in a position so that their eyes were at least 25 cm from the eye tracker, but no more than 40 cm away. The eye tracker uses 5 point calibration to ensure accuracy. Our stimuli were displayed on a 1680x1050, 22 inch Dell monitor.

4.2 Stimuli

For stimuli, we used two images. The first was a grid of words representing shapes from which the participants were directed to find a specific word. The second was a grid of shapes from which the participants were directed to find a specific shape.

4.3 Subjects

The subjects for our study will be 10 participants who are in some way involved with the University of Clemson. They are all within the ages of 20 and 54 with a diversity of eye sights and occupations. All participants have proficient knowledge of the English language and have normal color vision. There is no restriction on the subjects of the study based on any specific sex, gender, race, social status, or any other metric besides being associated with the University of Clemson.

4.4 Experimental Design

The experiment is based on giving participants a prompt which will then be shown along with other similar objects in a large grid. All prompts were based on a variety of shapes. Each participant was given two randomly selected prompts from a list created by the researchers. For one prompt, the participants were given a word that represents a shape. They were then required to find that word from a grid of similar words. For the other prompt, participants were shown a randomly selected shape which they were then required to find from a grid of similar shapes. While searching for their prompts, participants' eye movements were tracked and recorded. The independent variable for this experiment was the type of prompt given to the participants, shapes or text. The dependent variables were the differences in time and eye movement required to find each prompt.

4.5 Procedure

Participants were first given a consent form to read and sign before we conducted the experiment. After the participants consented, they were asked to sit up straight at a position and distance from the computer such that their eyes could be easily located by the eye tracker. Once in position, the experiment was started by the subject completing a calibration test for the eye tracker. The participants were then shown one of two prompts. They were shown text on a blank background that either informed them that they would be shown a grid of words or shapes. They were also prompted to find a shape or a word that would be hidden somewhere within the grid. The prompts were randomly selected for each participant using a python function that produced a random number within 0 and 30 which was then used to pull a value from an array where our list of prompts was being stored. They were also instructed to press the spacebar once they had found their random prompt within the grid. At which point they would be asked to repeat the exercise with either a grid of words or shapes depending on whichever they had not already done. Our eye tracker collected data for both exercises by observing the direction of each pupil and storing the corresponding point of gaze with "X" and "Y" coordinates.

4.6 Hypotheses

We hypothesize that a HMI will be more efficient to the end user if it shows images in the form of shapes to the end user to aid with visual searching when compared to participants only selecting from written words, and that the participants will have to look through less items before finding the visual image as opposed to the words.

5 RESULTS

5.1 Time Taken for Completion

Using the indicators for "start" and "stop" that are output whenever each participant finds the item that they were tasked with finding, the time in seconds to several decimal places is recorded every time the eye tracker updates which is every 60 frames (as the eye tracker is 60hz). Using the times recorded every update, along with the "start" and "stop" times, we computed the time taken for each participant to find the object that was requested of them; as timeToComplete = stopTime - startTime. After taking the averages of all the times that we had for each person, what we found is that in order to locate the item based on shapes and outlines, it took on average about 74.37% of the time that was required to locate the items based on words or text.

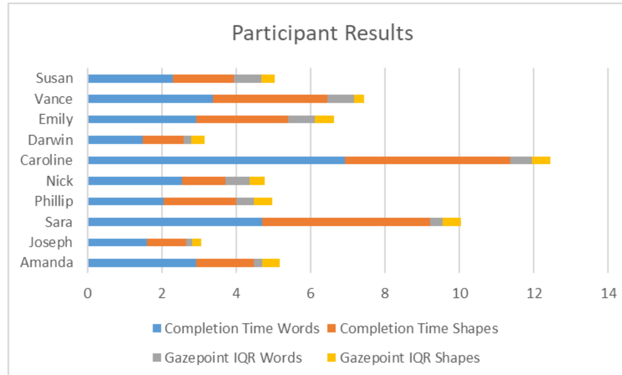

Figure 3: Summary of participant results (time in seconds)

5.2 Gazepoint Coordinate IQR

In order to effectively analyze the Gazepoint data that we retrieved from the eye tracker, we used the left eye X and Y values that the eye tracker records from each participant, and recorded the data as coordinates during the appropriate respective times for each of the two tasks that were being accomplished. We used the spread of coordinates for each participant to see how much looking around the screen they had to do before they found the item they were searching for. We did this by finding the interquartile range of the data from the coordinates and averaging together the interquartile ranges of the X and Y data, which gave us the middle 50% of the data, by subtracting the 75th and 25th percentile. We used this as a numerical representation of the amount of darting across the screen that each participant had to do, with a lower number generally being better. We found that time taken for completion didn't necessarily have any direct impact on the Gazepoint IQR value results. So just because someone took less time to find an item, that didn't have an impact on how much of the items on the screen they had to look over before they completed the task. However, we did find a general trend in age, with IQR steadily increasing as the participants got older, with a few outliers for the data, as evident in figure 4.

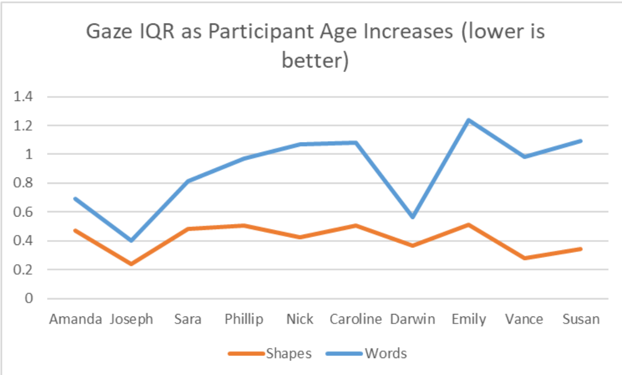

Figure 4: Positive trend in Gazepoint IQR

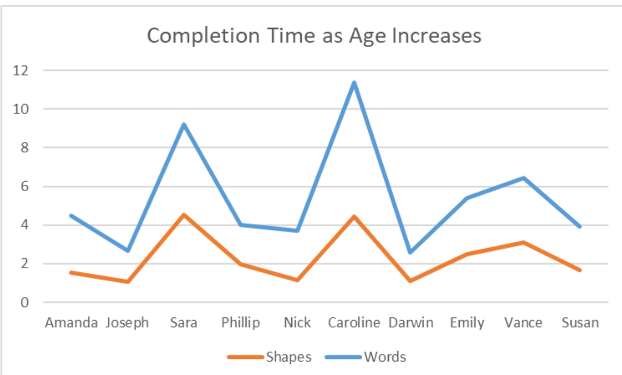

Figure 5: No trends in completion time (in seconds)

5.3 Additional Demographic Factors

The participants in this study were weighted towards younger individuals and those who wear corrective lenses. Eight out of ten participants were under the age of twenty-five and seven out of ten wore some form of corrective lenses while participating. Both of these factors could skew our results slightly in support of our hypothesis. We know that children as young as three years old have relatively high awareness of company logos but tend to associate them with the product type and not the name of the company [4]. Given this information, and the relatively young average age of our participants, we can assume that our data is in some way skewed toward the hypothesis. Similarly, our study's bias towards those with corrective lenses could influence our results because it tends to be easier to spot shapes than words when vision is impared.

From the time taken for completion and the Gazepoint IQR data, along with the demographic information that was gathered from each participant, we were able to search for other trends that cropped up in the experiment. In addition to the increase in Gazepoint IQR as age increases, we also found that the males in the study took on average 55.92% of the time to locate the written word item and on average 57.05% of the time to locate the shape item as evident in figure 6.

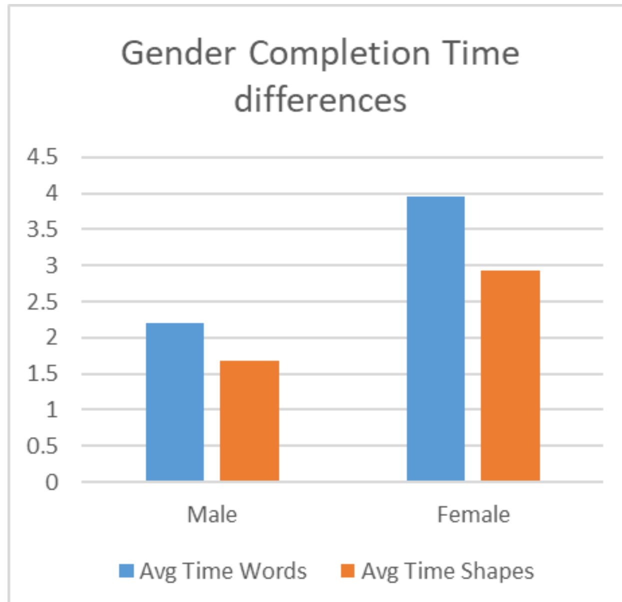

Figure 6: Completion time trends based on gender (in seconds)

6 DISCUSSION

An assumption can be made directly from the Gazepoint IQR data that since the Gazepoint IQR results increased with age, that younger people are generally better at deciphering things around an image in their periphery. This data would explain why older people tend to move their head around screens more often in order to focus on smaller portions of the screen when they are trying to find things on digital displays, as well as why they also like to have larger images to view. This also shows that fitting lots of elements (both visual and textual) on a single screen is easier for younger people to decipher and interpret and that locating these items gets steadily harder as age increases.

The data also shows an additional trend that he hadn't expected to find in that males seem to be objectively faster at locating visual information with both images and text even when all other demographic factors remain largely the same. Why this occurs is definitely cause for a further, more comprehensive study.

Image recall and association between imagery and text that exists in the brain is definitely something that user interface designers should choose to leverage, as our study shows that finding information is easier with imagery, and people tend to appreciate virtual interfaces that allow them to accomplish tasks as fast as possible without flooding them with too much information at once in an unorganized manner; imagery is a great way to solve this problem.

7 CONCLUSION

Through this experiment, we were able to show that there is significant correlation between the use of shapes in place of text when displayed in a grid format and the ease with which participants found them when prompted. Although the difference is pronounced, it is not as stark as we had expected. It is possible that had the participants been given multiple prompts of the same kind instead of only one of each, a more concrete difference would have presented itself. In that case, we would expect participants to gain more familiarity with the format and establish a more accurate memory of both stimuli. If the difference in difficulty between the two types of prompts increased, then it would lend greater credibility to our hypothesis. In future experiments, we would suggest that format be followed to further our understanding of how users can more efficiently interact with human machine interfaces.

8 REFERENCES

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