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Female Performance Advantage When Using a Standard Interface Design

INTRODUCTION

Computers have become common in every aspect of daily life. As production costs, sizes, and weights continue to fall we can be sure that computers will become even more ingrained in our everyday lives. The way which we interact with computer software has remained rather static. We use a digital display that displays a graphic user interface (GUI) which is peppered with interactive icons and buttons. As our computer applications become more complicated we add additional ways to interact with the system. As more controls are added to a system the time required to complete a task and learn the new features increases. In this paper we will show that there is a difference in how users preform when presented with a feature rich environment. In particular we are interested in determining if there exists a significant difference in how men and women perform. In order to show this difference exists we had both men and women participate in an experiment designed to examine an individuals effectiveness at searching a cluttered and motionless display.

The goal of this research is to show that typical button and menu GUIs favor one sex over the other. Ideally, future work will be able to modify interface designs so that this limitation is reduced or even eliminated. This would result in an increase in overall productivity when using software.

In order to correctly frame our question for this experiment we must look at the accepted differences that have been shown to exist between men and women. The first key point is to realize that there are differences between men and women; these differences do not translate into the dominance of one sex over the other. Rather, these differences are simply differences, they are psychological and perhaps neurological differences that affect the way that men and women process external stimuli. One suggestion is that these differences evolved due to the way that labor tasks were divided during the hunter-gatherer phase of human development [3]. In this paper we will use evolutionary psychology to explain these differences. Next we will discuss some key differences, between men and women, that are important for this paper.

Cognitive Differences

When compared directly, men are typically much better than women with most kinds of targeting abilities, such as throwing and catching missile objects, such as a football [5]. Conversely women tend to be much faster than men when performing a series of movements especially using the fingers, this is referred to as fine motor skill. This advantage is present even though men tend to be faster than women in pure speed movements that are related to fine motor skill tasks [5]. In her book, Kimura suggests that this difference between speed for fine motor movements and the completion of a

series of fine motor task suggests that women are able to coordinate these movements more effectively than men.

Spatial Differences

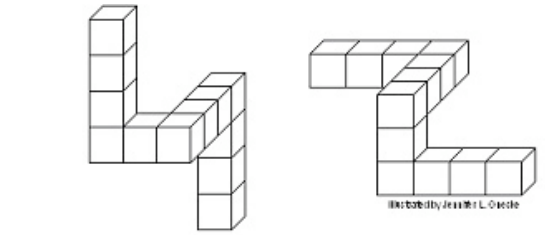

Figure 1: Based on Shepard & Metzlar's 'Mental Rotation Task'

Figure 2: Mental Rotation Task Based on Canonical Orientations

Figure 1: Mental rotation task example [10]

Spatial ability encompasses a broad range of abilities. The biggest gender difference appears in the ability known as mental rotation (see Figure 1). This task generally involves being able to observe 2 objects, in either 2 or 3 dimensions, and determining if the second image is the same as the first; only rotated. In this task men are often an entire standard deviation above women in their performance ability [5]. Another important but perhaps unrelated difference has been found in the way that men and women navigate both virtual worlds and the real world. Women tend to navigate much better when using landmarks as points of reference for travel. Men, conversely tend to use euclidian coordinates more effectively than landmarks, though they are still able to navigate effectively using landmarks [4][5][6][1][7]. Women do appear to out perform men in tasks that require object location memory. Eals et al. found that in certain cases, women significantly out-performed men in an object location memory task [5][3]. A task used to test object location memory normally provides the participants with some form of array of objects. The participant then either knowingly or unknowingly commits these objects and their relative location to memory. They are then asked to pick objects from a list that were not present or find the object that has moved or disappeared. Women tend to be significantly better than men at this task[3][9]. It should be noted that when the objects in these tasks are uncommon the difference can become insignificant [3]. It is suggested that the reason for this is that women tend to assign a label to objects in order to remember them. If it is difficult to assign a unique label to an object then this advantage is limited [5].

Figure 2: Identical picture test. (From Ekstrom et al., 1976. Copyright 1962, 1975 by Educational Testing Services. [5]

Perceptions Differences

For this experiment there is one key perceptual difference between men and women. Women are usually superior to men in the skill known as 'perceptual speed'. The identical

picture task, as can be seen in figure 2, involves the matching of a single image with another image presented within an adjacent array. This task is made up of several behavioral task the most important, for this experiment, being visual scanning. It has been suggested that women excel at this task due to their ability verbalize the visual stimuli [5]. While true this affect does not seem to account for the entire female advantage.

Based on these cognitive, spatial, and perceptual differences it is expected that we will be able to show that women out-perform men in our experimental tasks. This is due to women's superior abilities in perceptual speed and object location memory.

In the following section we will examine work that has been done in other areas. After which we will look at the experimental design, setup, and software. In the final section we will examine the experimental software in detail including documentation and use, as well as its currently known limitations.

RELATED WORK

Evolutionary Psychology

There are many subdivisions of psychological thinking which attempt to explain common psychological phenomenon. Evolutionary Psychology explains human development based on evolutionary theory. For this project there is one theory of particular interest because it can be used to explain the fundamental differences between men and women that we are interested in. The hunter-gatherer theory presented by Eals et al.[3] suggests that the spatial sex differences developed in humans are due to a division of labor tasks. Specifically the female advantage in object location memory was developed as result of the gatherer habits of the ancient humans. This theory is echoed by Kimura in her book [5]. Men were typically the hunters in these societies and as such they developed a different set of spatial abilities.

Navigation of Virtual Space

Until recently [2] it had been accepted that there was male advantage in the navigation of virtual worlds [1][6]. Mary Czerwinski's et al. novel approach has shown that a key factor for women in navigating virtual spaces is the size of the field of view. When the field of view in a virtual environment increases the navigation task time was significantly improved. Specifically women were able to improve their performance in the navigation task so they were similar to the performance levels of men. In both virtual and physical spaces there is a difference in the way that men and women navigate. Women tend to use landmark directions in order to navigate a space. Conversely, men focus on euclidean directions. Research has suggested that this difference is due to sexually dimorphic strategies [8].

This area of study is not relevant to this current paper since we are not looking at navigation tasks. The research is important, though, to show that with novel display techniques we have been successful in the reduction of spatial gender bias. It also shows

that there are sexual dimorphic differences in strategy development. While not directly relevant to the topic of this paper it is an interesting result.

EXPERIMENTAL DESIGN

Method

This experiment consists of two separate methods. Both tasks are functionally the same with the key difference being one task uses the numbers from 1-50 as labels and the other task uses unique star images as labels. The goal is to limit the apparent female advantage in spatial location caused by their ability to better verbalize the stimuli [9][5].

Design & Tasks

The experiment consists of two distinct screen setups and two labeling techniques (see figure 3 and 4). Both screens feature a 5 x 10 grid with the labels positioned randomly on the buttons within the grid, for a total labeled button count of 50. The second labeling technique (figure 4) has the buttons displayed as images. Each image is unique variation of a star image.

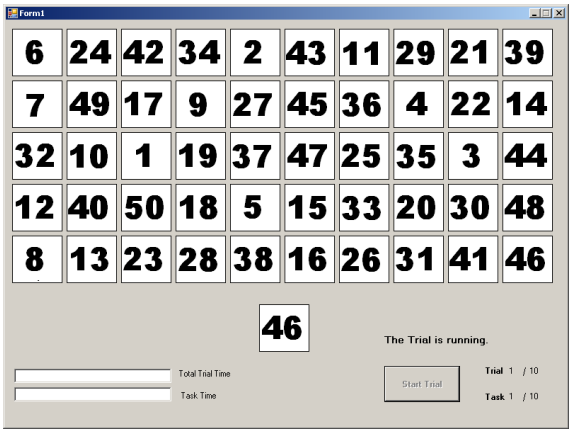

Figure 3: Experimental software with numbers as labels

The current task setup has the user perform 10 trials. Trials 1-5 have the buttons labeled with numbers. Trials 6-10 label the buttons with star images. Each trial has the user perform 10 matching tasks where an image is displayed and they click the matching image from the grid. This is a key parameter for this study, and therefore is carefully controlled. The trials and their corresponding tasks were randomly generated and stored in an xml document. This ensures that the trials are not unique between users. Currently the order of the trials is static based on the order that they are read from the xml document

but this would be adjusted when the experiment is actually run.

To begin a trial the participant clicks the 'start trial' button. Next the first image to match will become visible and a timer will start. Each trial and task is timed, with the trial time beginning from when the 'start trial' button is click until the last match is made. Each time a match is made the time between the last and the current match is recorded.

The tasks are also randomly generated and stored in the trial xml file. They remain constant through all participants.

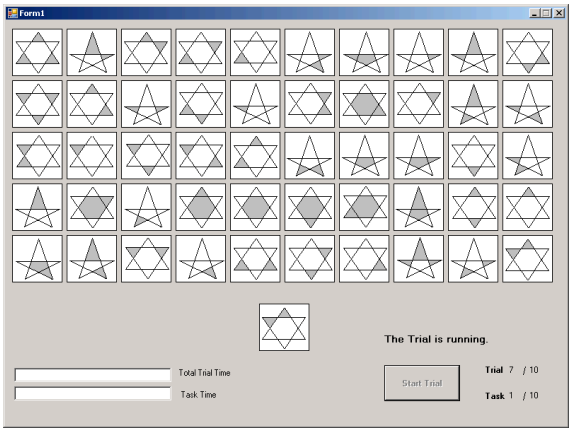

Figure 4: Experimental software with unique stars as labels

Experimental Software

There were two pieces of software developed for this experiment. The task specific software was developed using the Microsoft's C# language. The application displays a window that is 800x600 pixels in size.

The second piece of software generates a random set of 10 Trials that can be used for the experiment. Running this application again will override the previous xml document. For this reason it should not be run in the same directory as the main experimental software as it will override the current xml trial document.

hypothesis

Based on the psychological differences between men and women: (H1) I believe that we will find a significant difference in task completion time, favoring women. This will be due to women's superior abilities in object location memory and perceptual speed. From this result I will infer that typical button and menu GUIs are used more effectively by female users.

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