Exploring color preference through eye tracking

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Keywords: Color preference, eye tracking, fixation.

ABSTRACT

Most color preference studies use subjective rating methods, such as survey and paired-comparison procedures. They all depend on subjects' subjective answers. In order to get objective color preference data, this study utilized an eye-tracking experimental method to explore the possible relationships between color preferences and characteristics of scan-path. A web-based experimental method using eight NCS colors applied to 7 categories of objects was used as the stimulus to identify and analyze the relationship between color preference and eye movements of 103 college students. Results show that there are correlations between color preferences and eye movement patterns. A Multi Variable Analysis (MANOVA) shows that fixation duration, fixation counts, and return of fixations are significantly different between most favorite colors and least favorite colors. Generally speaking, people spent longer time, and there were more fixations and fixation counts on their preferred colors. Observers paid more attention to textured colors than non-textured colors.

1. INTRODUCTION

Color is a powerful tool to attract a subject's attention, to bring out the desire to consume, and to make communication more efficient (Lee & Barnes, 1990). The voluminous literature on color preferences has produced a rich knowledge database over the past years.

In the past century, most color researchers adopted the questionnaire investigation method (Saito, 1996). There are varieties of survey methods to study color preferences, but most of them use subjective approaches. Besides the above-mentioned subjective methods, psychologists have also found that visual behavior may demonstrate a person's degree of preference. For example, the more one prefers something, the more one's pupils dilate (Hess & Polt, 1960). In addition, one looks at a preferred object over and over (Adams, 1987; Shimojo *et al*, 2003). These visual clues seem more objective than previously used survey measurements, and cannot be easily falsified. In order to objectively identify the color preference of study participants, an eye track observation method was used to explore the feasibility of deriving color preferences through identifying fixations and information related to them.

As substantiated by literature on this subject, eye tracked scanpath strongly suggests the locus of inherent attention (Henderson & Hollingworth, 1999). Eye position is also an on-line monitor for a person's cognitive process. But there are many factors which can cause a viewer to be attentive. These factors can be divided into two categories: (1) conspicuous external stimuli (i.e., luminance, color contrast, spatial layout, presentation time), and (2) the subject's internal processes (i.e., knowledge, experience, curiosity, liking, or other complicated reasoning Salvucci & Anderson, 1998).

In order to distinguish these causes of variance in scan path, we can orthogonally manipulate the object and color categories, and also counterbalance each color position within a subject. After viewing all stimuli with presentation times of 5 seconds, we ask the subjects to rate colors in order of preference. In this way, we can derive the relationship between preference order and characteristics of scan path.

2. METHOD

Eye movement recording

Apparatus. The video-based, pupil/corneal reflection eye tracking apparatus used was an infra-red eye movement recording system (EyeLink II) manufactured by SR Research Ltd, Canada. The subjects were seated facing a calibrated 21 inch Barco display monitor (30 cm high and 40 cm wide) which was 60 cm away. The visual angle of the whole screen is 36.8 degrees wide, 28.1 degrees high. The visual angle of each single stimulus is 6 degrees wide and 6 degrees high. The monitor has a vertical scan frequency of 85Hz, and a resolution of 800 * 600 pixels. Subjects wore a headset containing a camera which monitored and recorded their eye movements and fixation locations. The study was conducted in a laboratory with fixed luminance control**.** (figure 1)

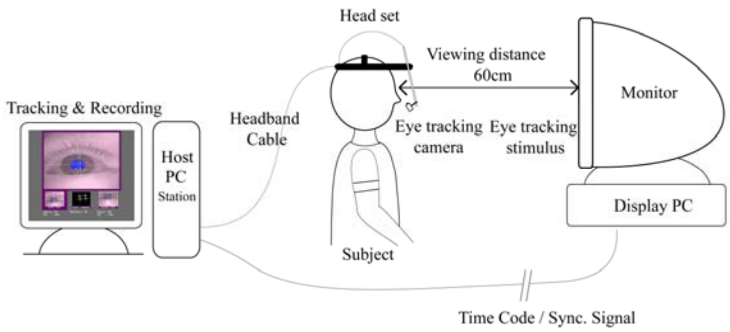

Figure 1: Set up of the experiment.

Figure 2: Images set as stimuli for the experiment (from top left to bottom right, T-shirt, moped, backpack, floppy disk, chair, mug)

Stimuli. The instruments used for data collection in the research were 7 kinds of objects. There were color chips, and images of mugs, T-shirts, chairs, mopeds, floppy disks and backpacks (figure 2). Each object was represented 8 times in 8 different NCS colors (figure 3). The 8 colors were R, Y50R, Y, G50Y, G, B50G, B and R50B. There are 8 blocks (cells) in each display frame, and each cell contains 1 image of the object with a color applied on it (figure 4). Each stimulus was displayed for 5 seconds, then a mask popped up for 1 second to avoid carry over and after-image effects. A series of random shifting occurred after the masking to counterbalance the layout arrangement, thus preventing the same color from always showing up in a fixed location.

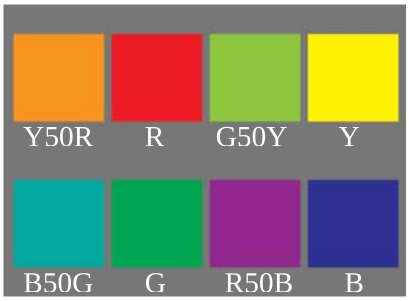

Figure 3: NCS color set as stimulus for experiment.

Subjects. The subjects were 103 undergraduates (68 females) from the College of Journalism and Communications at Chinese Culture University. Those with less than perfect vision had had their vision corrected using glasses or contact lenses, so that all subjects were able to see normally. All of the subjects had normal color vision according to the Ishihara color vision test.

Procedure. After subjects reported to the laboratory and passed the color vision test, they read the instructions of the experiment and practiced participating in it. A process to calibrate and validate the eye tracker was performed by having each subject fix the location of 9 points on the calibration screen. Once the calibration was done, the subject started to view each of the displayed frames.

Figure 4: NCS color set as mopeds for experiment.

Data collection. The various color instruments mentioned above were used to measure color preference and eye movement. The serial order in which the images were projected was randomized by the computer so that the image color order changed every 5 seconds. This order change occurred 8 times, with a one second break between changes. Throughout the 56 displays, totaling about 340 seconds of image observation time, the subject's eye movements were constantly monitored and data were recorded using the apparatus shown in Fig. 1.

Preference ranking

Stimuli. The same display frames used for recording eye movement were also used as the basic component for preference ranking. There was a blank space beneath each of the colored object images for subjects to fill in their ranking orders from 1-8 using the computer keyboard. (figure 5)

Procedure. After all display images had been viewed and the eye tracking procedure had been completed, subjects looked at a display frame on the computer screen having fixed color sequences of each kind of image, and ranked their image color preferences from 1 to 8. Each subject's color preferences in order from highest to lowest for each object category were then collected. The ranking information was stored in a database for further statistical analysis.

Figure 5: Set up of color preference in rank order.

3. RESULTS

Eye Fixations

A One-Way Multi Variable Analysis (MANOVA) was performed to confirm whether the eye movements are affected by color preferences. The results showed there are significant differences among 8 colors in 7 categories about the mean fixation duration ($F_{(7, 5768)}$=51.309, p<0.001). Subjects tend to look at their favorite color longer (figure 6). Significant differences are also found in mean fixation counts ($F_{(7, 5768)}$=9.890, p<0.001). Subjects pay more attention to their preferred color images (figure 7). The comparison of the return of fixations shows another significant difference ($F_{(7, 5768)}$=83.034, p<0.001). It shows that the subjects were attracted by their favorite colors more than their non-favorites (figure 8).

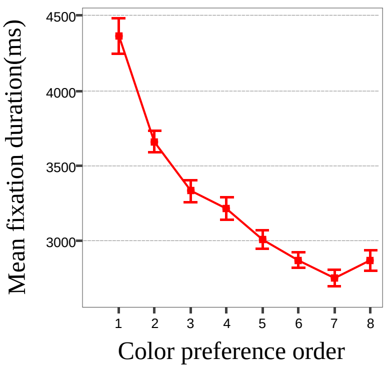

Figure 6: Fixation durations as a function of color preference in order.

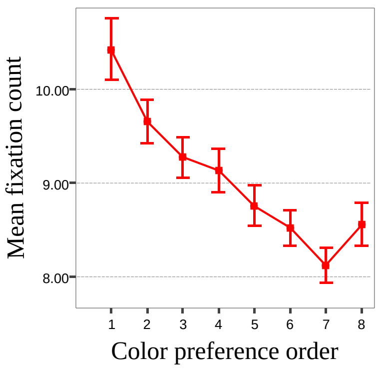

Figure 7: Fixation counts as a function of color preference in order.

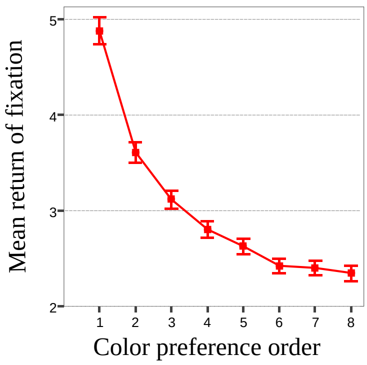

Figure 8: Return of fixations as a function of color preference in order.

Preference ranking

Based on subjects' choices about their preferred color among 8 colors from each of the 7 categories, figure 8 shows the subjects' color preferences by ranking orders. Blue is the most popular color among the 8, while red T-shirts and mopeds, and orange backpacks are also welcomed.

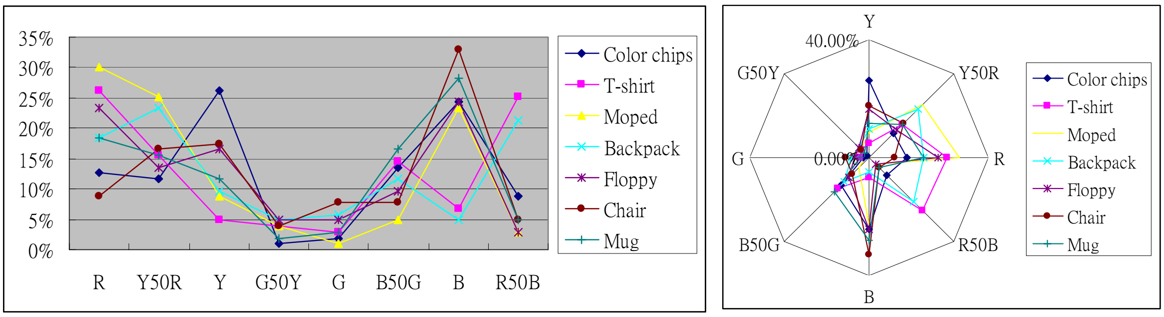

Figure 9: Color preference in rank order. (Each point is based on data from 103 subjects.)

4. CONCLUSIONS

The study was trying to figure out what the relationships are between color preferences and eye movement. We found fixation counts, fixation duration, and return of fixations to be associated with colour preference ranking orders. This means that people's eye movement information does indicate their color preference. Generally speaking, subjects spent more time on red (R) and orange (Y50R) colours, while paying less attention to purple (R50B) and chartreuse (G50Y).

Results also showed significant differences in eye movement between color chips and other colored objects. Stimuli with texture attract more attention than those without texture. This means that color chips attract less attention than images such as mopeds, backpacks, and chairs, etc.

Utilization of the eye tracking system could prevent inconsistent conclusions among studies of color preference. Consider this example: Taft (1996) found no difference between color chips and colored real objects on a semantic scale. Thus, he suggested that one can determine preferences using color chips rather than colored real objects. On the other hand, Lee (2001) found significant differences between chips and objects through an extensive survey using a semantic differential scale.

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