The Impact of Background Color on Reading Speed and Attention

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Abstract: How to design a physical space which maximizes people's attention is a valuable undertaking, as its answer can improve people's productivity at school or workplace. In this study, how background color changes people's concentration while reading is explored. Twenty-four participants were recruited and asked to complete reading comprehension questions with different background color. Eye-tracker was used to record participants' eye movements, thereby their reading speed and attention. Results show that participants were most concentrated when the background color is red and least concentrated when the background color is black, which agrees with implications of previous research.

1. Introduction

Attention is how people concentrate on a particular object (Allport, 1989) [1]. When individual concentrates, they give up the opportunity to notice other details in their surroundings. Therefore, the "selective" property of attention makes it valuable and worthy to be explored (Muho, 2011) [5].

Psychologists have long been exploring how environment shapes people's attention. For example, children in a classroom with shy teachers would show more concentration problems than children with high-achieved teachers (Werthamer-Larsson,1991) [8]. Tennessen (1995) [7] discovered that university students would direct attention better when facing a window with natural views. Furthermore, Fisher (2014) [3] found that decorations on walls would distract children.

Nevertheless, few studies have explored how environment color affects people, while researchers found that environment color had an impact on animals. For example, Zebrafish would feel more anxious being in a black, blue, beige, red tanks than in transparent or white tanks (Abreu et al., 2020) [2]. Coloring type of images also influenced people's attention, where images with initially salient colors had greater imact on people's attention (Frey, 2008) [4].

This study explored the relationship between attention and background color. How to design a physical space which maximizes people's attention is a valuable undertaking, as its answer can improve people's productivity at school or workplace.

2. Methods

2.1 Participants

Twenty-four random participants were invited to Tims Coffee on 6088 Humin Rd, Minhang, Shanghai. Our of twenty-four participants, four participants were exclueded due to their failure to follow the procedure, twenty (60% female, *Mean age* = 25.8, *SD* = 9.36) of them provided accurate data. All participants were divided into four groups. We set different background colors (red, white, black and beige) for each group by placing a shelf on table and covering it with tablecloths of different colors.

2.2 Stimulus

We used a three-paragraph passage was used as the stimulus. It is an excerpt from Long Distance by Alejandro Zambra, translated into Mandarin. This passage was chosen due to its clear timeline and transference in places. In this way, we were able to create questions with fixed answers. We set four questions for the passage. The answers could be found in the passage directly. The stimuli were presented on a 15.6 inch screen with a 1920×1020 dots per inch.

2.3 Measure

Eye-tracking An aSee eye-tracker (aSee A6; 7 Invensun Technology, Beijing, China) was used to capture eye-movements of participants at 60cm distance. Participants were told to keep their heads motionless to ensure the accuracy of experiments. The eye tracker provided completion time by recording fixation duration. Fixation count was also reported to study the concentration level. Greater rate of fixation count / completion time meant a higher concentration level.

2.4 Procedure

Participants took the test independently. First, they would report their gender and age on a form after signing the consent form. Before they started the test, they would perform a calibration test on the eye-tracker. Participants would then follow the instructions on the screen to finish the reading comprehension test. There were four questions in total, and they were asked to locate answers in the text as quickly as possible and to stare at them on the screen when reporting the answers.

Here is an exemplary question of how the test performs. A question appeared before the passage:
When does Portillo calls the author?
After that, the reading passage appeared on the screen (part):
... He would call me very early, at six or seven in the morning, so I could give him a report on what had happened the previous night, which was pretty much pointless, because nothing ever happened, or almost nothing...
Participants would search for answers. If they reported orally *six or seven in the morning*, they could move to the next question. This step was repeated four times until four questions were correctly answered. In the end, each participant got a doughnut from Tims Coffee as a reward for providing us data.

3. Results

Descriptive analysis Average completion time is the average amount of time a participant took to report an answer. The group under black background (*M* = 26.03s, *SD* = 15.53s) have the longest

average completion time and the red group has the shortest one (M = 16.46s, SD = 5.97s). White group (M = 20.63s, SD = 7.54s) and beige group (M = 19.01s, SD = 9.45s) have comparable average completion time.

Fixation count is the number of times a participant looked at an area around answer. Red group (M = 5.89s, SD = 2.01s) has the highest average fixation count. In comparison, black group (M = 4.15s, SD = 2.05s) has a higher average fixation count than that of White group (M = 5.71s, SD = 1.65s) and beige group (M = 3.64s, SD = 1.67s).

The ratio of average fixation count to average completion time was analyzed. Red group (0.36) has the greatest ratio and white group had a moderate ratio (0.28). Black (0.16) and beige (0.19) groups had comparative ratios.

Table 1 The Average Completion Time and Average Fixation Count of Different Groups

Measures *Mean* (*SD*)	Red	Black	White	Beige
Average completion Time	16.46 (5.97)	26.03 (15.53)	20.63 (7.54)	19.01 (9.45)
Average Fixation Count	5.89 (2.01)	4.15 (2.05)	5.71 (1.65)	3.64 (1.67)
Average Fixation Count / Average completion Time	0.36	0.16	0.28	0.19

T-test Results The completion time of the red group was significantly different from that of white group (t (5) = 2.54, p < .05) and black group (t (5) = 4.62, p < .005). The black group had significantly different completion time than that of the white group (t (5) = 2.51, p < .05) and beige group (t (5) = 3.14, p < .05).

As for the number of fixation count, that of red group and of beige group (t (5) = 2.62, p < .05) and that of white group and of beige group (t (5) = 2.40, p < .05) were significantly different.

4. Discussion

The purpose of this study is to investigate the effects of background color on reading speed and attention. Differences in completion time and fixation count in four groups with four background colors (white, red, beige, black) were analyzed, and it was demonstrated that environment color had an impact on both reading speed and attention.

In terms of the completion time, people with red tablecloth had the greatest ratio of fixation count to completion time, because they reported answers in shortest time span with the highest average fixation count. We can conclude that red group had the fastest reading speed due to the most frequent reading in shortest time. Previous study reported a positive correlation between attention and reading speed (Shimoda, 1993) [6], we can further concluded the red group had the greatest concentration. This finding resonated with a previous finding that red hue in the environment had the least distraction to people (Yeshurun, 2004) [9].

In contrast, the black group is found to be the least attentive: it took them the longest time to locate answers and they had the lowest average fixation count. The ratio of fixation count to completion time (0.16) is the smallest among four groups. It is concluded that a black background makes people read with lowest speed and least attention. However, the effects of black background were not significant according to t-tests.

This study has rooms of improvement, including limited sample size, the presence of varying cofounding factors (e.g. noise level), and insufficient space coverage of tablecloth, which could be addressed during further experimentations.

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