Effects of Color on Heart Rate

ABSTRACT

It was investigated whether the color red increases a person's heart rate when compared with white. Pulse was measured in a convenience sample of 27 undergraduate students. Each participant had to copy two similar paragraphs onto each paper, with their pulses measured before and after. Random assignment was used as the order of the red and white sheets of paper was randomized using a coin flip. The changes in heart rate were then compared using a simulation-based and theory-based method. The change in heart rate after the activity with red paper was significantly higher than the change after the activity with the white paper in both the simulation-based ($p = 0.004$) and theory-based tests ($p = 0.0093$). Causation can be inferred, but the results cannot be generalized to the population due to the nonrandom nature of the sample.

Background and significance

Colors have long been hypothesized to affect human behavior and various studies have explored this idea. In an experiment performed by Wilson, twenty undergraduate students were used and it was found that red resulted in higher levels of arousal than subjects exposed to green (Wilson, 1966). In another study examining the effects of color on responses to a computer game where people exposed to blue continued to improve in successive games, but the red group's performance decreased as time went on, suggesting a higher level of alertness at the beginning of the game with an increased heart rate compared to the blue group (Wolfson & Case, 2000). However, another study performing tests in a green room, orange room, and white room reported no significant difference in performance or arousal (Etnier & Hardy, 1997), indicating there might be a response due to red specifically.

This experiment tests the hypothesis that looking at a red sheet of paper increases the heart rate of undergraduate students more than a white sheet of paper.

Method

Participants

Twenty-seven undergraduate students volunteered to participate in the study. Prior to participation, they were not notified of the goal of the experiment.

Experimental Design

The explanatory variable was the color of the paper which was categorical and the response variable was heart rate (pulse) which was quantitative.

Procedure

A base heart rate measurement was taken for each participant by placing two fingers on the base of the wrist and counting for fifteen seconds, then multiplying this by 4 to get the number of beats per minute. Participants sat at a table and and first looked at a white (or red) piece of paper and copied down a section of a news article onto the paper. The news articles were selected for their lack of hotly controversial topics so as to avoid causing too much extraneous stress (Ponti et al., 2017). The piece of paper containing the excerpt of the news article was the same color as the piece of paper they copied onto. The excerpt was divided into two sections of three sentences each. Heart rate was measured again, repeating the same process and they were asked three questions to separate the time between part one and part two of the experiment. The questions were: When did you wake up this morning?, What did you eat for breakfast?, and What classes did you have this morning?. The same procedure was repeated with opposite color of paper (red if white had been used, white if red had been used). The order of the colors was determined randomly beforehand using a coin flip.

Data Analysis

Data were input into Excel where the differences between the before and after pulse for each color of paper were computed. After these values were obtained, the Matched Pairs applet was used to run a paired, one-sided simulation-based test to compare the differences in the before and after heart rate measurements for red and white paper. Because the sample size was n=27

and the data not too skewed, a theory-based test was run using the Theory-Based Inference applet with a 95% confidence level after the data were checked to see if it was not too skewed.

Results

The data collected were the differences between the before and after pulse for **each** color of paper. They were plotted as paired data (two differences representing the two colors for each person) in a simulation-based test (Figure 1). The simulation based data provided a p-value of 0.004 when testing the hypothesis that red paper will have more of an effect on heart rate than white paper. The theory based data provided a p-value of 0.0093 and a 95% confidence interval of (0.6001,5.9919).

Simulation-Based Test

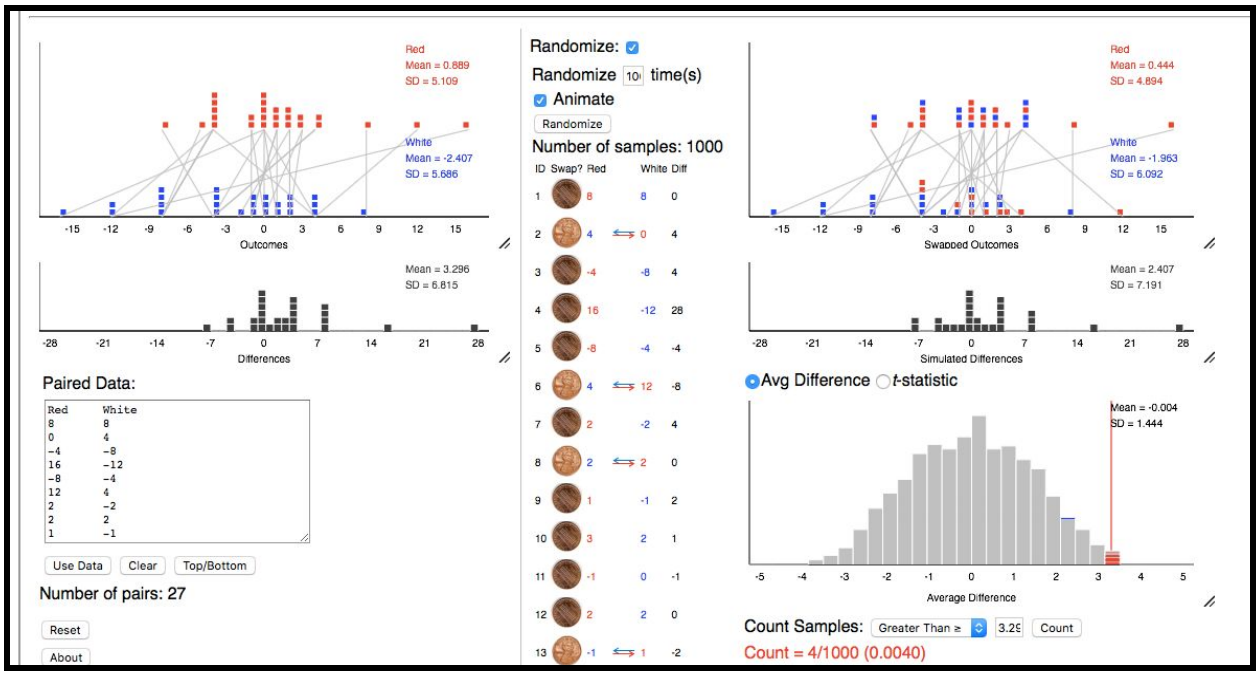

Figure 1. Paired Data Analysis of Heart Rate in Two Conditions. The pulse differences within each subject were determined for white and red paper and plotted as paired data. The mean difference was 3.296 with a standard deviation of 6.815.

Conclusions

There is strong evidence to reject the null hypothesis that there is no difference in the long run mean change in heart rate for white paper vs. red paper (simulation-based p=0.004, theory-based p=0.0082). We are 95% confident that the long run mean difference in change in heart rate of red vs. white paper lies in the interval (0.6534, 5.9386). Since the interval does not contain 0, this further supports a significant result. Since the order of treatments was randomly assigned, it can be concluded that the red paper caused the observed increase in heart rate. However, these data cannot be generalized to the entire population of the college since the sample was a convenience sample and not a random sample.

The study has limitations in that the data was taken mostly from a convenience sample of people from a very limited age range and socioeconomic status. If there was more time, a larger, more random sample could be acquired at the campus dining hall. Also, other colors such as blue or green could be added in the future to further prove effects of red. A potential problem in this experiment is that participants were not tested or asked if they were colorblind which would lead to insignificant results. In the future, this would be something to account for. Overall, the effect of red paper on heart rate was significantly different from white paper.

References

Etnier, J., & Hardy, C. (1997). The effects of environmental color. *Journal of Sport Behavior, 20*(3), 299-312.

Ponti, M., Belanger, S., Grimes, R., Heard, J., Johnson, M., Moreau, E., . . . Digital Health Task Force. (2017). Screen time and young children: Promoting health and development in a digital world. *Paediatrics & Child Health, 22*(8), 461-468.

Wilson, G. D. (1966). Arousal properties of red versus green. *Perceptual and Motor Skills*, 23, 268-289

Wolfson, S., & Case, G. (2000). The effects of sound and colour on responses to a computer game. *Interacting with Computers, 13*(2), 183-192.