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Evidence for Gender Bias in Color Perception: Men recognize colors faster

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Abstract

The paper proposes a divided visual field experiment for studying possible gender bias in chromatic sensitivity, A novel experimental methodology is presented using virtual reality headset for delivering visual stimuli. The use of virtual reality headset enables us to present distinct visual stimuli to the two visual hemispheres, also giving freedom on the choice of stimuli presentation time and reducing the chances of error. Two separate android applications have been developed for the experiment. The first android application is used for presenting the same or different visual stimuli to the two eyes of the subject. The second android application is used for recording the responses. Each test subject goes through sixty trials in the experiment, where each trial consists of displaying the target color for a brief period of time followed by a black screen and then distinct colors are displayed separately to each visual field for a very brief period of time. The experiment has been conducted on 16 individuals (8 male and 8 female). A significant result is observed that males have a faster reaction time than females. ANOVA analysis on the data revealed a p-value of 0.0376, thus indicating statistical significance.

Keywords: divided visual fields, gender bias, color recognition

Introduction

Lateralization of the human brain is the phenomenon in which certain cognitive processes are more specialized on one side of the brain than the other. This phenomenon has been a field of study for researchers perennially. Various studies have tried to show the advantage of one hemisphere of the brain over the other in performing certain tasks. Hugdahl (2003) showed the presence of left hemispherical advantage in listening tasks. Syllables were presented to both the ears and the subjects were made to respond to target syllables, when they were heard in a specific ear. This showed a right ear advantage, implying a left hemispherical advantage. Coming to the field of vision, studies conducted in (Young et al., 1985) and (Prete et ail., 2015) confirm the left visual field or the right cerebral hemispherical advantage in the task of recognition of familiar or unfamiliar faces, when presented unilaterally. With respect to the task of recognition of colors, the study in (Nelson M.L, 1905) suggested that there was no superiority in any cerebral hemisphere in this task. However, this study showed that women were better at recognizing colors than men, when the colors were unilaterally presented. This study, however, did not include observations about reaction times.

The study presented in this paper aims to validate the experiment by Nelson M.L in 1905 and to find the dependence of reaction time on independent variables such as visual field to which the stimuli is presented and the gender of the participant. In our experimental setup, a VR headset is used to isolate the two visual fields completely. This is cost-effective (under $10) and efficient, since expensive eye trackers are not needed, and the stimulus can be presented for any specified time interval, since wandering of the eyes is not an issue anymore.

Distinct colors are flashed to the two eyes and the participants are asked to identify the target color. Their reaction times are recorded and analyzed using ANOVA.

Experiment

Selection of the Participants

Sixteen people consisting of 8 males and 8 females are included in this study. They are all predominantly right-handed as determined by the Edinburgh right-handed inventory test. All the participants had a score of more than 80. The participants are also given the Ishihara test to check whether they are colorblind or not. The selected participants passed both the tests.

Experimental Setup

The participant is seated comfortably and made to wear a VR headset. Two android applications have been developed. The mobile phone with the first app, which presents the stimulus to the eyes of the participants, is placed inside the VR. The other app, which is the response capture system, is given to the participant's right hand.

Stimuli Presentation App

The app is designed in such a way that, when placed into the VR, the left visual field is completely isolated from the right visual field. This is achieved using a black narrow screen between the two visual fields. The experiment consists of 60 trials per person. In each trial, a target color is presented to both the eyes for 2 seconds. This is then followed by a black screen for 3 seconds to remove any effects due to persistence of vision. This is followed by a flash, consisting of different colors in the two eyes. One of these colors may or may not be the target color. The duration of the flash is 50 ms. Three colors are used in the experiment, namely red, green, and blue. The target color is randomized in each trial. Each of the three colors is used as the target color for 20 trials. The target color flashes only 30 times out of the 60 trials, which is also randomized. Due to the randomness of the experiment, the participant cannot predict what the target color would be or whether it would flash or not and hence all the biases are removed from the experiment. If the participant sees the target color flash, s/he needs to press a button using their right thumb which is part of the response capture app. Whenever the target color flashes, the time stamp and the visual field (right or left) in which it is flashed are recorded.

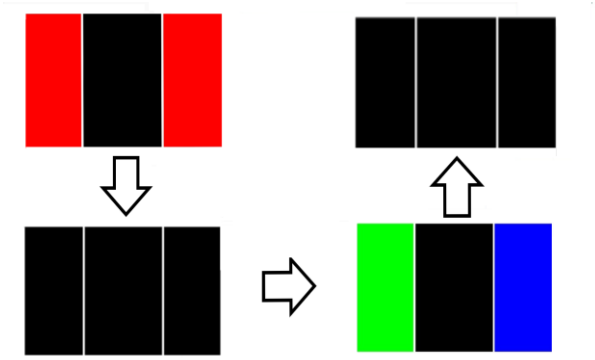

Figure 1: The top left screen, which indicates the target color, is flashed for 2 seconds. Then black screens are flashed for 3 seconds, followed by the bottom right screen, which flashes two different colors for 50 ms.

Response Capture App

This app creates a single button covering the entire screen of the mobile phone for ease of use. If the button is pressed, the device vibrates, letting the participant know that the button-press has been recognized; this avoids double clicking of the button. The timestamp is also recorded as to when the button is clicked. To synchronize the timestamps between the two devices, the TrueTimeRx library is used. This library requests a time seed from an NTP server and this seed is cached in the device. The library compensates for the round-trip time involved in getting the seed from the server. The seed needs to be requested only once after booting the device, since it is cached; it needs to be requested again, only if the device is rebooted. Thus, subsequent network requests are avoided. The library requests multiple NTP servers at once and filters out the best response received.

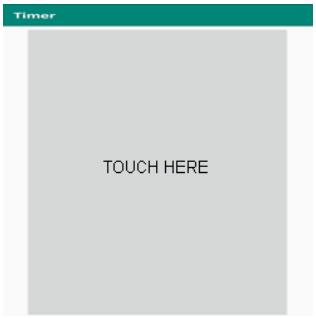

Figure 2: The UI of the response capture app

Data Analysis

To the timestamps in the response capture app, the corresponding entries in the stimulus presentation app are matched. The reaction time is calculated as (Timestamp in response capture app – Timestamp in stimulus presentation app). For each of the thirty flashes, this is calculated and using these values, the mean reaction time of a participant is calculated. Since the stimuli presented are the 3 basic colors (red, green and blue), participants rarely missed or miss-clicked. The maximum number of flashes missed by a participant is at most one; So, the accuracy is not a useful metric in the experiment and hence is not considered.

Results

This experiment has been performed to see whether there is any significant laterality in recognizing colors with respect to the reaction time. The results are analyzed using two-way ANOVA, by taking gender and visual fields as independent variables and mean reaction time as the dependent variable. From this, we obtain $F(1,30) = 1.597$ and $p = 0.2127$. Since $p > 0.05$, the result is not statistically significant. However, looking at the individual interactions, it is seen that the effect of gender is significant. One-way ANOVA is then performed by taking gender as the independent variable and mean reaction time as the dependent variable. Now, $F(1, 30) = 4.733$, $p = 0.0376$. This result is statistically significant, since $p < 0.05$. The mean reaction time for male subjects is observed to be 633.6 ms, whereas for females, it is 714.3 ms.

Figure 3: A participant undergoing the experiment.

Discussion

Based on the results obtained, we see that there is no laterality related to the recognition of colors. This observation agrees with the 1905 experiment. However, there is a gender advantage observed. As indicated by the results of the limited experiments conducted, it appears that men in general can recognize colors faster than females.

There is a finite possibility that the observed gender difference occurred due to the small sample size. Experiments need to be repeated on a much larger number of subjects to conclude that there is a gender difference. The other minor possibility is that the chosen group of male subjects have faster response times in general for any task.

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