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**Retraction: Influence of lighting and noise on visual color assessment in textiles** (*IOP Conf. Series: Materials Science and Engineering* **872** 012033)

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- (1) Sánchez Godínez, S., Vázquez López, J., Gutiérrez Rosa, P., & Hernández Arellano, J. (2019). INFLUENCIA DE LA ILUMINACIÓN Y RUIDO EN LA EVALUACIÓN VISUAL DE COLOR EN TEXTILES. *Pistas Educativas*, 133(JULIO 2019), 615-624. Retrieved from <http://www.itcelaya.edu.mx/ojs/index.php/pistas/article/view/2114/1609>

# Influence of lighting and noise on visual color assessment in textiles

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**Abstract.** Color is a human perception of the light reflected by an object. It is an appreciation that depends on the way the human's eyes detect the reflected light and the way the brain processes it. However, for industry, it is an attribute of product appearance and its observation allows the detection of certain anomalies and defects [1]. Therefore, color is a characteristic that allows to judge an object by creating conditions for its acceptance or rejection [2]. In this research, a laboratory experiment was carried out to analyze different factors involved in visual color evaluations in textiles. A complete factorial experiment design was carried out in which the analyzed factors were lighting, noise, color and participants.

**Keyword(s):** Visual assessment, Color discrimination, Textile color, Visual ergonomics

## 1. Introduction.

Colors are perceptual concepts used by the brain to distinguish between different received stimuli [3]. In [4], color is defined as: "the attribute of light that uniquely corresponds to a sensation for each spectral distribution. This sensation is connected by the intensity and duration of the stimulus, the state of adaptation of the observer, the area of the retina affected and the luminous and chromatic contrast with which it is received".

Visual observation for color assessment is generally inadequate for several reasons: eyestrain, difficulty in achieving uniform illumination and an appropriate environment, among others [5]. For visual color assessment, it is recommended to use a lighting booth where lighting conditions are controlled and aspects such as illuminant, color of booth walls, observation geometry, avoidance of other lights, among others, are taken into account [6].

Color measurement has been gaining importance due to industrial development. Therefore, in a wide range of industrial sectors, the quantification and control of color is of significant importance since it is a quality characteristic [7]. If the environmental factors in the work areas are properly regulated, they will increase the overall performance of the process [8]. Therefore, the objective of this study is to analyze if some factors such as lighting, noise, among others, have an influence on visual color evaluations in textiles, since in small and medium sized companies these evaluations are not performed in the adequate conditions due to lack of knowledge or low budget to make changes in the work areas [9] [10]. For this reason, the study

analyzes the main factors that influence visual color evaluations in textiles and propose improvements, either by making optimal use of the company's facilities or by requiring a low-cost investment.

## 2. Methods

In order to determine the factors that affect visual color evaluations in textiles, laboratory level experimentation was conducted using a complete factorial experiment design with a total of 1852 runs conducted at random, in which the factors evaluated were [11][12]: lighting, noise, color to be evaluated and the participants. All the variables with each of the experienced levels are presented in Table 1.

**Table 1.** Table of study variables.

| Independent variable           | Levels                          | Code | Dependent variable | Unit of measurement |
|--------------------------------|---------------------------------|------|--------------------|---------------------|
| Lighting                       | Warm light 460 Lux              | I1   | Result             | 1=success           |
|                                | Warm light 195 Lux              | I2   |                    | 0=error             |
|                                | Warm light 60 Lux               | I3   |                    |                     |
|                                | White light 940 Lux             | I4   |                    |                     |
| Noise                          | 58 dB                           | R1   |                    |                     |
|                                | 95 dB                           | R2   |                    |                     |
| Color                          | brown color<br>$\Delta E= 0.44$ | A    |                    |                     |
|                                | color blue<br>$\Delta E= 1.2$   | B    |                    |                     |
|                                | color pink<br>$\Delta E= 5.20$  | C    |                    |                     |
|                                | green color<br>$\Delta E= 7.35$ | D    |                    |                     |
| Participant                    | 100                             | P    |                    |                     |
| * $\Delta E$ =Color difference |                                 |      |                    |                     |

The experimentation consisted of 4 different levels of lighting, for which the type of light and its intensity was changed. For testing the influence of noise, the experiments were carried out with normal classroom noise, and for level 2, the participants were subjected to industrial noise during the tests. Different colors of fabrics were evaluated with 4 levels of difficulty, and the result of the evaluations (binary variable) was recorded as "1" if the participant chose the correct answer and "0" if the answer was incorrect [13][14].

A convenience sample of 100 students who had time availability to come to the lab and participate in all the sessions of the experiment was selected.

Before starting the assessments, information was collected from each participant (Table 2): age, sex, lens use and height by eye. An ErgoMeasure model anthropometer from ErgoTechMx was used to measure eye height and students were asked not to wear heels [15].

**Table 2.** Information requested from each participant.

| Participant | Sex   | Age | Lenses | Eye height |
|-------------|-------|-----|--------|------------|
| P1          | Man   | 22  | No     | 1757       |
| P2          | Woman | 20  | Yes    | 1536       |
| P3          | Woman | 19  | No     | 1385       |
| P4          | Man   | 22  | Yes    | 1669       |
| P5          | Man   | 23  | No     | 1647       |

|      |       |    |     |      |
|------|-------|----|-----|------|
| P6   | Man   | 22 | No  | 1636 |
| P7   | Man   | 24 | No  | 1557 |
| P8   | Man   | 26 | No  | 1669 |
| P9   | Man   | 22 | No  | 1701 |
| P10  | Man   | 23 | No  | 1695 |
| P11  | Woman | 19 | No  | 1574 |
| P12  | Woman | 20 | Yes | 1436 |
| .    | .     | .  | .   | .    |
| .    | .     | .  | .   | .    |
| .    | .     | .  | .   | .    |
| P98  | Man   | 21 | No  | 1695 |
| P99  | Man   | 20 | No  | 1514 |
| P100 | Man   | 22 | No  | 1675 |

A station for visual color evaluation was used, consisting of a table with a grey background, with a height of 80 cm, on which the lighting system was placed at a height of 130 cm. A dimmer was used to change the intensity of the lighting for achieving the 4 levels that were evaluated. At one side of the evaluation table, the speakers were placed to reproduce industrial noise. An Extech Instruments model 407732 digital sound level meter was used to regulate the noise levels to be evaluated.

To carry out the experiment, the "2 of 5 test" was applied, which consists of placing 5 samples of the same color, of which, 2 show no difference in color between them and the other 3 are exactly the same between them. The objective of this test is for the participant to be able to identify the pair of equal fabrics. The fabrics used were measured with a colorimeter and were chosen depending on the delta color (color difference) required to prepare the different plates to be evaluated. Figure 1 shows the 4 plates evaluated in the experiment.



**Figure 1.** Plates prepared with the fabrics to perform the evaluations 2 of 5.

The procedure to be followed during the study was explained in detail to the participants and following the randomization of the design of experiments, the runs were started. After preparing the measurement station with the levels of each factor depending on the run to be made, each participant was called to the evaluation area. With the help of the sound meter, the noise levels established for the experiment were adjusted. In the same way, the bulbs were changed (warm light or white light) and with the luxmeter of 20000 Lux, Lutron Electronic model YK-10LX the intensity of illumination was measured to adjust the intensity levels required for each run of the experiment [16]. The participant stood in front of the evaluation area to perform the "2 of 5" test, as shown in Figure 2.



**Figure 2.** Visual color evaluation area.

The plate with the fabric samples to be evaluated was placed on the table and the participant had to choose, within a maximum of 20 seconds, the pair that was the correct answer for him. This procedure was repeated for the 4 plates consecutively. The total time in evaluating the 4 plates showed an average of 40 seconds.

### 3. Results

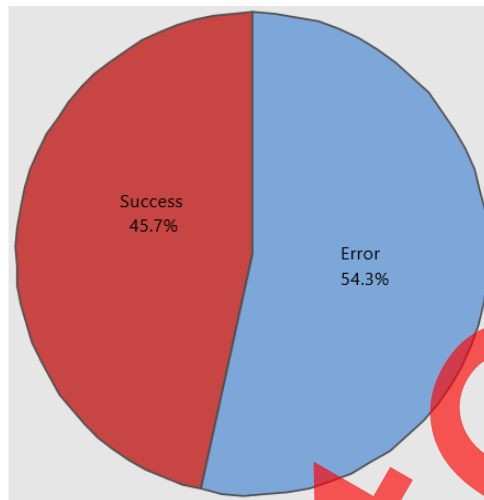
The result of the experiment is a binary variable. Therefore, for the analysis of the data, a binary logistic regression was performed using Minitab 18 software. Table 3 presents the results obtained in the binary logistic regression, in which the factors: lighting, noise, color and participants were captured.

**Table 3.** Binary logistic regression results.

| Source      | GL  | Adjustment dev. | Half an adjustment. | p-value |
|-------------|-----|-----------------|---------------------|---------|
| Regression  | 22  | 321.215         | 11.258              | 0.0000  |
|             |     | Factors         |                     |         |
| Participant | 16  | 38.521          | 3.254               | 0.0015  |
| Lighting    | 4   | 9.365           | 3.0012              | 0.0452  |
| Color       | 4   | 200.35          | 66.3258             | 0.0000  |
| Error       | 520 | 501.25          | 0.9925              |         |
| Total       | 520 | 775.32          |                     |         |

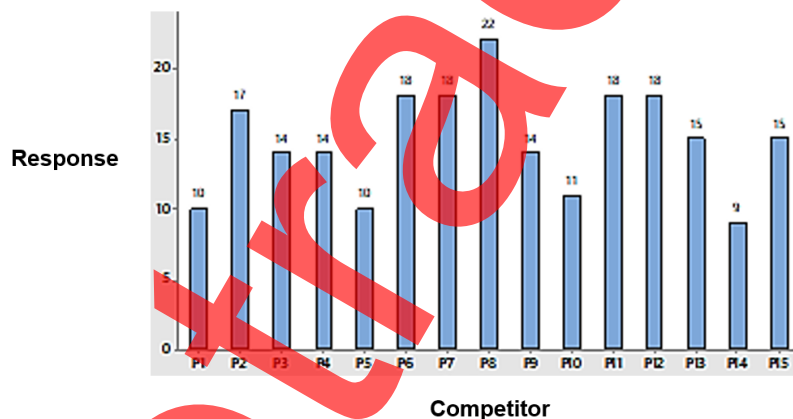
As shown in Table 3, lighting, color and participants are factors that were statistically significant for this experiment, with the noise factor being outside the model. Figure 3 presents a graph with the total successes and errors of the participants.

Figure 3 shows that most of the color evaluations made by the participants were incorrect and that only 45.7% of these were correct.



**Figure 3.** Percentage of success and errors in visual color evaluations.

Each participant made a total of 32 evaluations and Figure 4 shows a bar graph showing the number of successes each of the participants got. Participant 8 was the one who got the most successes while participant 14 got the least successes, and both participants are men.



**Figure 4.** Total number of correct evaluations obtained by each of the participants.

Figure 5 shows graphs of each of the factors that statistically influence visual color evaluations in textiles. It can be noted that the participants do not present a defined pattern. In the case of lighting, it can be noted that the greater the intensity of the light, the greater the success; and for the color factor evaluated, better results were obtained with the plates that had the greatest color difference between the correct and incorrect fabrics.



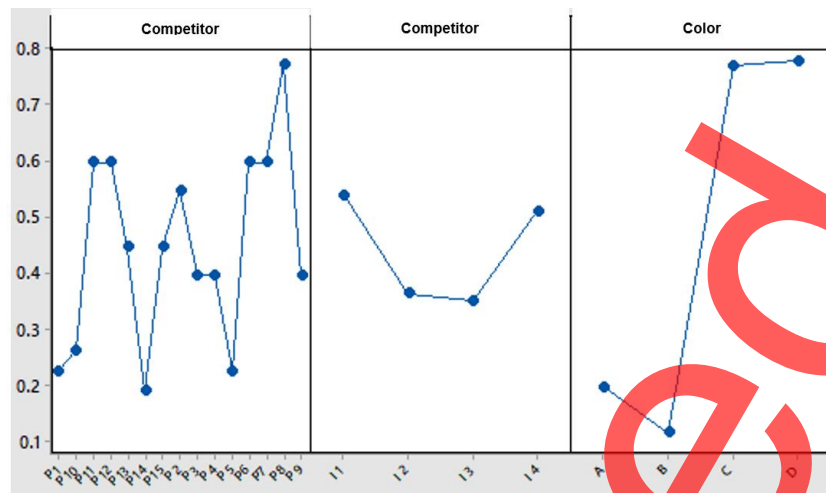


Figure 5. Main effects graph.

#### 4. Discussion

With the experimentation carried out in this study, it was found that the participants turned out to be a statistically significant factor in the visual assessment of color in textiles, since each person has a different capacity for color discrimination. Therefore, it was concluded that the people who will carry out color assessment activities need to be examined beforehand to know if they are suitable for such activity and subsequently be trained to do the work in the best way. Another main factor is lighting, where from the two types of light (warm light and white light) that were evaluated, it was found that there were better results with white light but not much difference with the evaluations made with the higher intensity of warm light. The last statistically significant factor is color, since there is greater difficulty in choosing the correct samples when the color difference between them is small. It was also observed that, although plate A with brown samples has a lower  $\Delta E$  than plate B with blue samples, it obtained a greater number of correct evaluations, so it can be concluded that the participants are less able to discriminate blue shades.

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