RESEARCH ON THE IMPACT OF LIGHT SOURCE SPECTRUM ON COLOR VISION

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ABSTRACT

This paper studies the impact of light source spectrum on color vision using indoor simulation experiments. Under the same condition of illuminance, a test participant observed different color pictures under light sources in black boxes respectively. The impact is studied by the distance that a test participant distinguishes the color brightness difference in each picture. It has been found that there's impact of light source spectrum on distinguishing the brightness difference of some colors. And color rendering index can be an important factor in the distinguishing process.

1. INTRODUCTION

Vision is the most important sense, and visual performance can be affected by the environment. In addition to the brightness factor, there may be some other impact of light source on human visual function [1]. There are many kinds of light sources, different light source spectrum result in different color temperature, color rendering index and other factors, which may also cause some impact on color vision. By learning previous studies, we didn't get a unified conclusion of the impact of light source spectrum on color vision [2] [3]. This paper presents experiment studying the impact of light source spectrum on distinguishing the brightness difference of some colors.

2. TEST METHOD

The experiment was carried out indoors. Black boxes were used for the experiment, and each box was 1.5m high with a square cross section of 0.5*0.5 m^2. Each light source was set at the top of each box, and picture was placed at the bottom of the box so that it was illuminated by the light source. Under the same condition of vertical illuminance on the picture, a test participant observed different color pictures under light sources in black boxes respectively. There's color brightness difference in each picture.

For each of the light source, let the participant walk towards the box, and measure the distance between participant's eyes and the picture at which the color brightness difference in the picture

was distinguished. Results of the distinguishing process under different light sources can be reflected by measured distances. A greater distance implies better lighting for distinguishing. Figure 1 shows one of the boxes in the experiment.

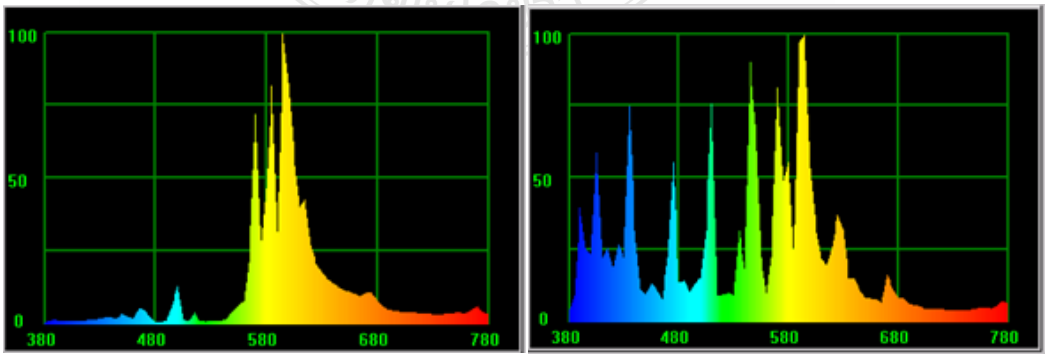
Figure 1. Black Box

2.1 Light Sources

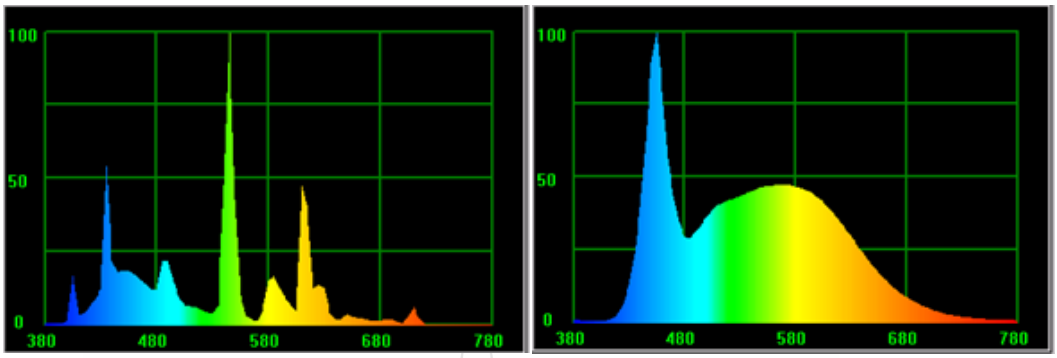
Four kinds of typical light sources are selected for the experiment. They are high pressure sodium lamp(HPS), quartz metal halide lamp(MH), compact fluorescent light(CFL) and LED. The lighting characteristics are shown in Table 1 and Figure 2.

Table 1: Basic Parameters of Light Sources

Light Source	Color Rendering Index(CRI)	Correlated Color Temperature(CCT)	Chromaticity Coordinates
HPS	26	1815K	x=0.5468 y=0.4079
MH	65	4044K	x=0.0632 y=0.3830
CFL	81	6644K	x=0.3158 y=0.0574
LED	86	6481K	x=0.7832 y=0.0498



HPS MH



CFL LED

Figure 2. Light Source Spectral Power Distributions

The power and some other parameters of the lights are very different. We use transparent light shielding plates and other methods to control the vertical illuminance on pictures to the same. In this experiment, appropriate illuminance of 60 lx was chosen, much more than the illuminance of the indoor environment.

2.2 Experiment Settings

In this experiment, the test participants of similar age and background are chosen. No one of the participants has color blindness or other eye diseases. Eventually the number of participants is 12, including 6 men and 6 women, aged between 22 to 25 years old. Within-subjects design was used and we took measures to diminish the influence of the experimental sequence on the experiment. We also give the participants some time to adapt to the changed environment.

Each picture was mainly in blue, yellow, red or green, and there's color brightness difference in each picture, thus constitute some pattern. We can easily distinguish the color brightness difference in daylight, but the difficulty will increase to varying degrees under different light sources respectively. Each picture was illuminated by each light source, and participants observed each of the matchups. Measure the distance at which the color brightness difference in the picture was distinguished. Then we decide whether light source spectrum has impact on the distinguishing process or not of each kind of color by measured distances.

3. RESULTS

The mean value and standard deviation of the critical distance measured are shown in Table 2.

Table 2: Mean value and standard deviation of the distances measured

Color	Blue				Yellow			
Light Source	HPS	MH	CFL	LED	HPS	MH	CFL	LED
Mean Value(m)	1.545	2.018	2.233	2.634	1.359	1.965	2.159	2.364
Standard Deviation	0.598	0.429	0.436	0.730	0.364	0.646	0.690	0.684
Color	Red				Green			
Light Source	HPS	MH	CFL	LED	HPS	MH	CFL	LED
Mean Value(m)	1.284	2.010	2.431	2.466	1.804	1.982	2.261	2.220
Standard Deviation	0.346	0.570	0.191	0.379	0.616	0.492	0.282	0.453

By statistical data analysis, there's a significant effect of light source ($p<0.05$) on the distinguishing distance when observing blue, yellow and red pictures. But there's no significant effect of light source ($p>0.05$) on the distinguishing distance when observing green picture. The selection of light sources in the experiment may have effect on the results. In consideration of all the four colors and the mean values of distance, HPS is the most unfavorable light source for distinguishing color brightness differences, and LED is the most favorable one, CFL is better than MH.

4. CONCLUSIONS

This paper studies the impact of light source spectrum on color vision. Color brightness difference distinguishing is the method used in this experiment. It has been found that there's impact of light source spectrum on distinguishing the brightness difference of some colors. In this experiment, those colors are blue, yellow and red. And color rendering index can be an important factor in the distinguishing process. Generally speaking, the measured distance is positively correlated with color rendering index, and it may be an important factor in the distinguishing process. In our opinion, in addition to the illuminance, light source spectrum also has some impact on color vision.

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