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RELATIONSHIP BETWEEN COLOR APPEARANCE MODE AND COLOR APPEARANCE SHIFT

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ABSTRACT

This research investigates the effect of color appearance mode on color appearance shift, 11 Munsell patches with eight different hues and three different levels of gray were used as test stimuli. Each individual patch was shown, in a test room, to a subject sitting in subject room. The subject was asked to look at the test stimulus through a small window that is filled by the test stimulus. Thirty six illuminance combinations of the subject room and the test room were prepared, so that the subject perceived three different color appearance modes: the object color mode, unnatural object color mode and light source color mode. The subject described the color appearance of the test stimuli using the elementary color naming method and the color appearance mode for each condition. The results showed that the amount of whiteness increased while both the chromaticness and the blackness decreased with the increase of test room illuminance. However, the hue did not change when the color appearance modes changed.

INTRODUCTION

The color appearance is result of visual perception. Different interpretations of color are due to different visual perception, which depends on age and other factors. Attributes of color perception, use for explaining the color of objects, are: brightness, hue and colorfulness [1]. The color appearance of objects depends on three components: the interaction of light sources, object and the human visual system [2].

The color appearance mode can be changed when the illuminance of environmental changes. Increasing illuminance changes the color appearance from object color mode to unnatural object color mode and to the light source color mode.[3] In the study of the color appearance mode some researchers investigated the relationship between color appearance mode and color preference. Their results showed that the perceived chromaticness, whiteness and blackness play a role for the determination of color preference for different color appearance modes [4][5].

Our experiment investigated the relationship between color appearance mode and color appearance shift.

EXPERIMENT

Apparatus and laboratory conditions

The laboratory was separated into two rooms there were the subject room and the test room as shown in Figure 1.

The subject room was $1 \times 1.5 \times 2.4 \text{ m}^3$ ($W \times L \times H$). The wall inside was covered with white wallpaper. At the ceiling, there was a daylight fluorescent lamp (FL_S) which could be

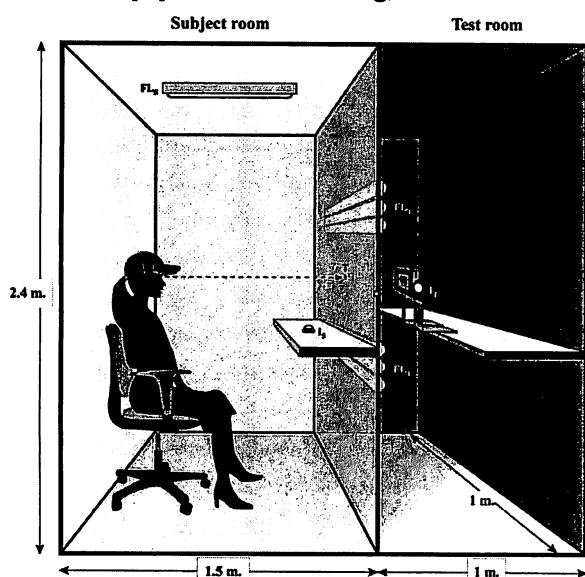


Figure 1. Laboratory and position of apparatus
 FL_S : a daylight fluorescent lamp of the subject room
 FL_T : 6 daylight fluorescent lamps of the test room
 I_S : the illuminance meter of the subject room
 I_T : the illuminance meter of the test room
 T : the $2 \times 2 \text{ cm}^2$ aperture square

adjusted to six-level intensity: 0, 0.5, 3, 15, 80 and 240 lx. The room illuminance was measured by a Konica Minolta CL-200 illuminance meter (I_S) that was put down on the shelf that was lower than $2 \times 2 \text{ cm}^2$ aperture square (T) to a visual angle of 1° from the subject at a distance of 1.1 meter as shown in Figure 2. A picture frame, a clock, key rings, artificial flowers, a shopping basket, cans, dolls, a flowerpot, a Rubic's Cube and books were decorated into this room to simulate a normal room of the subject as shown in Figure 3.

Table 1: 11 Munsell patches that choose from the Munsell color notation

Hue	Value/Chroma	Hue	Value/Chroma
5R	6/14	5BG	5/8
5YR	7/12	10B	6/10
5Y	8.5/12	5P	3/8
5GY	8/10	N	2/, 5/, 8/
5G	6/10		

The test room was $1 \times 1 \times 2.4 \text{ m}^3$ ($W \times L \times H$). Inside this room there were 11 Munsell patches which were eight different hues and three different levels of gray used as test stimuli, as show in Table 1. The six daylight fluorescent lamps (FL_T) adjustable at six intensity levels: 80, 120, 250, 500, 1000 and 2400 lx were attached to the wall. The room illuminance was measured by a Konica Minolta CL-200 illuminance meter (I_T) that was near the test patch.

Thirty six illuminance conditions (six subject room illuminance levels and six test room illuminance levels) were controlled by the experimenter.

Subject

Five subjects with normal color visual acuity were selected: SN (female, 24 years old), PY (female, 24 years old), NP (male, 27 years old), OB (female, 28 years old) and PC (female, 36 years old).

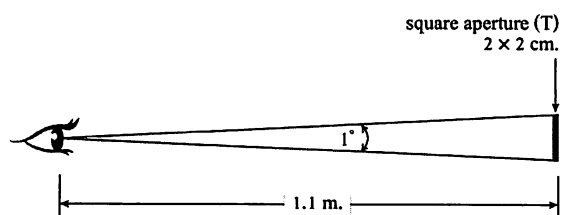


Figure 2. A visual angle of 1° from the subject at a distance of 1.1 meter

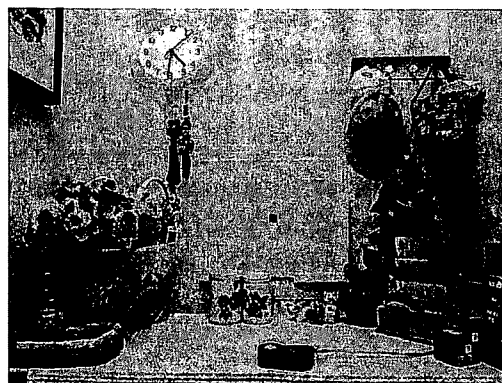


Figure 3. The position of many objects inside the subject room

Procedure

The experimental procedure was divided in two parts: the elementary color naming method and the color appearance mode.

1. The elementary color naming method

The illuminance condition was chosen by the experimenter from 36 prepared conditions. The subject adapted to the test room for two minutes and was told not fix the eyes on the test stimulus, but to look around the room at fixed times. When each individual test patch was shown in a test room, to a subject sitting in a subject room, the subject was asked to estimate the amount of chromaticness, whiteness and blackness in the test stimulus. If the test stimulus show the amount of chromaticness, the subject was asked to estimate the amount of hues: red, yellow, green and blue. One or two hues: red-yellow, red-blue, green-yellow and green-blue, were named and proportionated to the total of 100.

2. The color appearance mode

After finishing the elementary color naming, the subject was asked to judge the color appearance modes of the test stimulus: the object color mode, unnatural object color mode and light source color mode.

Afterwards, the next illuminance condition was selected and the subject adapted to the illumination of the room again. The selection of the condition was in a random order. Within each session, 11 Munsell patches were randomly presented under 36 illuminance conditions. Each subject repeat five sessions per condition.

RESULTS

Chromaticness, whiteness and blackness of test stimuli

The averaged data of chromaticness, whiteness and blackness of chromatic test patches 10B 6/10 are shown in Figure 4. The results of six illuminance of the subject room are shown in six plots.

The border illuminance of the test room between two color appearance modes is shown in the plots by vertical dot line if any. Under some conditions the subjects perceived only one color appearance mode (the condition of 0 lx the subject room). At the border line, there is only rapid change of chromaticness, whiteness and blackness when the illuminance of subject room is 240 lx.

Chromaticness and blackness decreased when the illuminance of test room increased from 80 to 2400 lx.

Whiteness increased when the test room illuminance increased from 80 to 2400 lx

All chromatic test patches: 5R 6/14, 5YR 7/12, 5Y 8.5/12, 5GY 8/10, 5G 6/10, 5BG 5/8 and 5P 3/8 shown the same pattern of results as 10B 6/10.

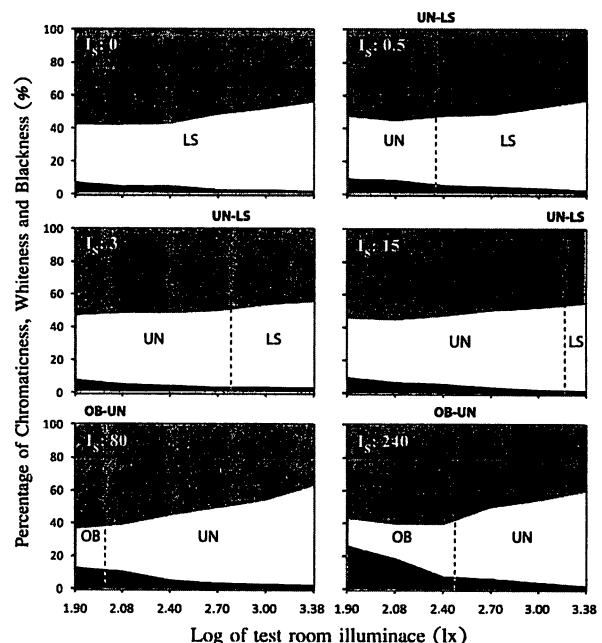


Figure 4. Percentage of Chromaticness (■), Whiteness (□) and Blackness (■) of the Munsell patch 10B 6/10.