Poster paper PA05

TIME COURSE OF CHROMATIC ADAPTATION STUDIED BY COLOR APPEARANCE OF ACHROMATIC PATCH

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ABSTRACT
The aim of this research was to investigate the time course of chromatic adaptation in a 3D space. The two room technique was used to carry out the experiment. A subject looked at an achromatic test patch placed in the test room through a small window opened on a separating wall between the test room and the subject room. The subject room was illuminated white and changed to a red light. The window was opened for certain duration from that changing point to control the adaptation time and a subject reported the color of the test patch by the elementary color naming at the end of the duration. The color appearance changed rapidly at short adaptation time and eventually stopped. The color appearance change reached 90 % of the entire change at 33 seconds in the averaged of five subjects.

INTRODUCTION
Chromatic adaptation is an important mechanism of color vision. When we look at a white object under daylight it appears white but when we move the white object to a room illuminated with red light we still perceive the white object as white because the eyes adapt to the red illumination [1]. The adaptation takes place almost instantly. Many researchers have investigated the time courses of the chromatic adaptation by using a 2D display as an adapting field. They found that the chromatic adaptation was achieved more than 90% at 60 seconds and completed at 120 seconds [2]. Fairchild and Reniff [3] used achromatic appearance method for test patches of various chromaticities presented on a computer-controlled CRT display. The result implied that two stages of adaptation existed; the first rapid few seconds and the second slow approximately 1 min.
In the real world we always perceive and see color in 3D space and we believe it necessary to investigate the chromatic adaptation by using a 3D space as pointed out by Ikeda et al. [4] and Pungrassamee et al. [5]. In the present research we used a real room which was illuminated by colored light and measured time course of the chromatic adaptation.

APPARATUS AND PROCEDURE
The experimental room had a size of 120 cm wide, 310 cm long and 200 cm high. The room was divided to two rooms, subject room and test room as shown in Fig. 1. There was opened a small window W of the size 5x5 cm on the separating wall at the subject eye level when he/she sat on a chair. In the test room side a shutter Sh was placed on the window to control the exposure of the test patch to the subject. The visual angle of the window W was 1.3^{o} x 1.3^{o} when it was viewed at the distance 215 cm. A test patch T of Munsell Value N6 was put at the test room on the shelf.

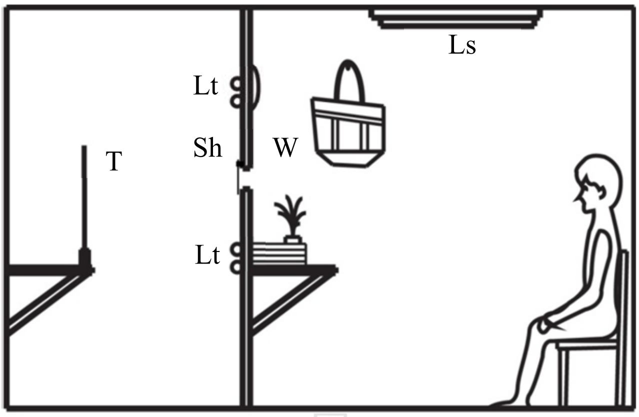

Fig. 1 Scheme of experimental room.

When the subject looked at T through the window W it appeared to be pasted on the window and he/she recognized it as an object in the subject room. The subject room was illuminated by five fluorescent lamps Ls of the daylight type at the ceiling. The central lamp was covered by a red film to give red light of chromaticity x = 0.509 and y = 0.301 when measured at the front white wall by a color luminometer. The illumination of the red light was kept at 87 lx on the front shelf of the subject room. White illumination was provided for the subject room by using four fluorescent lamps on the ceiling and it gave 576 lx. The test room was illuminated by the fluorescent lamps Lt of the same type as the subject room. The vertical plane illuminance at the test patch T was 25 lx to give its appearance an object color mode to the subject.

The subject's task was to judge the color of the test patch by means of the elementary color naming method, that is, the amounts of chromaticness, whiteness, blackness, and hues for the chromaticness in percentage. The subject entered the subject room lit with the white light and sat down on a chair for a minute or so. The shutter Sh of the window was closed. Then the experimenter switched the white light to the red light and opened the shutter. At a certain adaptation time for the red light the shutter was closed and the subject was asked to report the color of the test patch at just before the shutter was closed by his/her memory. After the subject response the red light was changed to the white light and the subject adapted to the white light for about 10 sec or longer depending on the readiness of the subject. Again the white light was changed to the red light for the measurement of the time course of the color adaptation. The time course of the color appearance of the test patch was thus investigated, which should tell the time course of the chromatic adaptation to the red illumination. Adaptation time from 1 s to 30 s was investigated at every second in the order starting from 1 s. The color appearance at 60 s was also measured to represent a long time for adaptation. When 31 judgments were conducted one session was over. Five sessions were carried out for each subject. Five subjects with the normal color vision as tested by the 100 hues test participated in the experiment.

RESULTS

In Fig. 2 results of hue appearance are shown for all the five subjects by polar diagram of which outer circle represents 100% of chromaticness. Five responses were averaged at each adaptation time in each subject. All the subjects perceived test patch of N6 as bluish green. The outermost point was obtained at 60 s, long enough to adapt to the red illumination. Ikeda et al. [6] did a similar experiment but for the steady adaptation of 8 different colors. Present hue appearance at 60 s confirms their results. The innermost points in Fig. 2 were obtained at 1 s and we see that the amount of chromaticness, which is shown by the distance from the center, increased as the adaptation time increased.

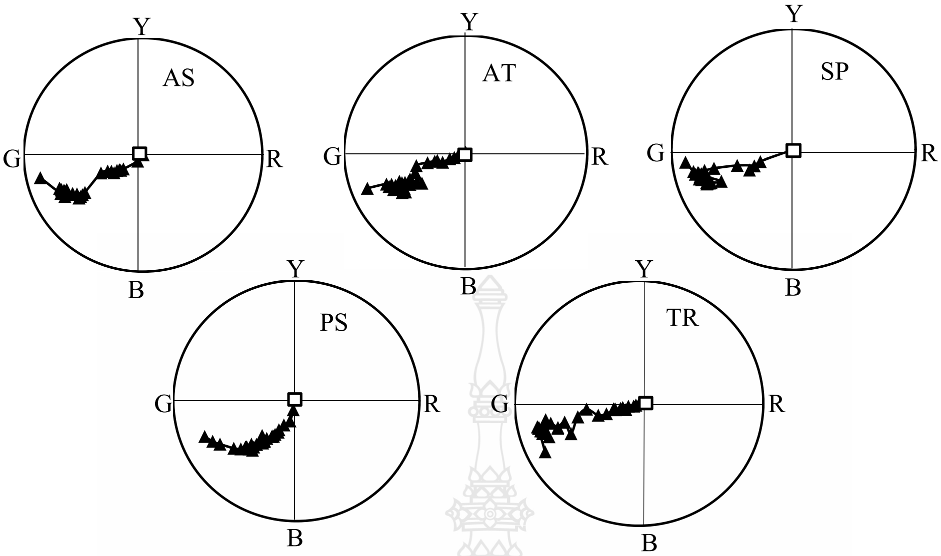

Fig. 2 Color appearance change for adaptation time shown for five subjects.

To see the increase more clearly the amount of chromaticness is plotted for the adaptation time as shown in Fig. 3 for five subjects. The abscissa shows the adaptation time from 1 to 30 s, and at 60 s and the ordinate the percentage of chromaticness. There are five curves in each figure to represent five sessions. Five curves from a subject are almost same to show consistent response of each subject. But there is difference among subjects. The subject SP shows a very rapid adaptation while the subject PS a rather slow adaptation.

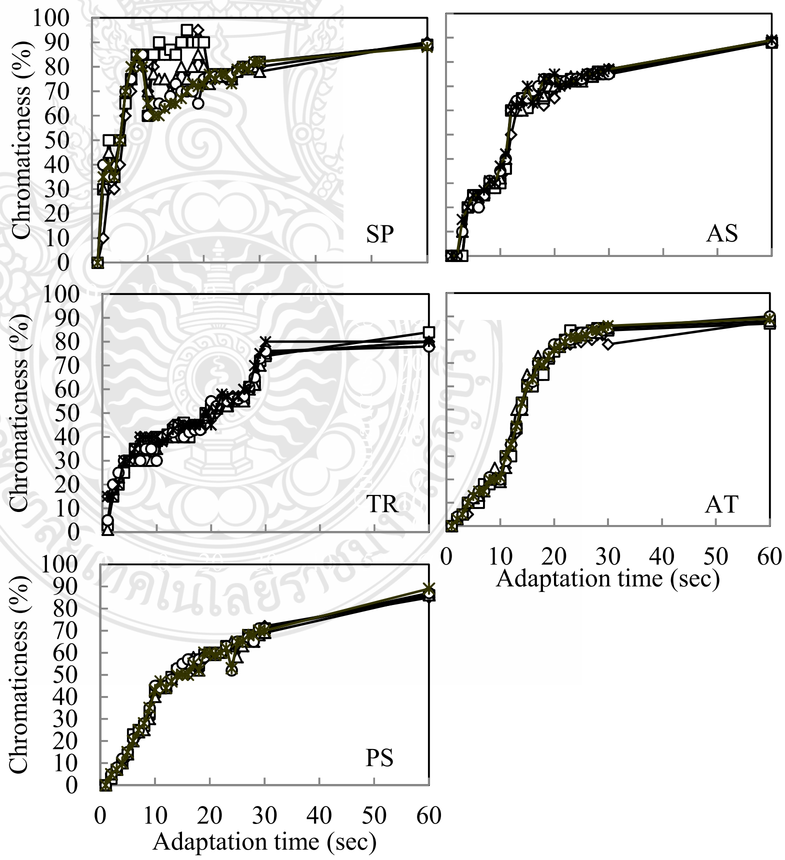

Fig. 3 Chromaticness change for adaptation time shown for five subjects.

The average of five subjects was taken at each adaptation time and is shown in Fig. 4. The chromaticness increased rapidly in the beginning of the adaptation and then more gradually in the latter time. If we assume the chromaticness at 60 s shows the completely adapted state of the eyes the adaptation time of 11 s was needed to recover to 50 %. The adaptation time for 90 % recovery was 33 s. This is much shorter than 120 s obtained by Fairchild and Reniff [3].

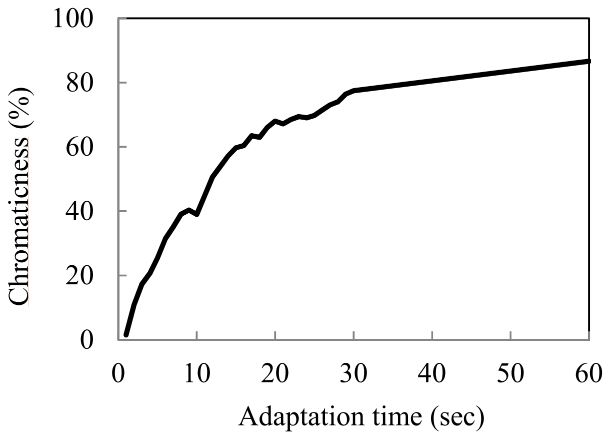

Fig. 4 Averaged chromatic change of five subjects for adaptation time.

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