CHAPTER V

CONCLUSION AND DISCUSSION

The color constancy is a very important property of the visual system and there have been proposed many theories to explain how the human visual system achieves the color constancy. Ikeda et al. (6) proposed a new theory called the recognized visual space of illumination RVSI which emphasized the action of the brain in perceiving color. The theory says that the brain recognizes the existence of a space and understands about the illumination in the space. Then the brain adapts to the illumination and discounts the effect of the illumination in terms of color and intensity. The discounting of the color gives the color constancy and the discounting of the intensity gives the lightness constancy. This proposal was clearly proved by Pungerassmee et al. (1) They judged the color appearance of test patches placed in a test room and observed through a window from the subject room. Whenever the window was enlarged to the size so that a subject could see objects in the test room and recognize the existence of the test room, the color appearance returned to the original color to show the color constancy.

In their case the subject room was illuminated by colored light and the test room by white light. We simply wondered if the same result would be obtained for the reversed situation of room illumination. Namely the subject room is illuminated by white light and the test room by colored light.

Our results confirmed the finding of Pungerassamee et al. but partly. We found in some cases the color appearance of test patches did not return to their original color, which implies that the color constancy does not hold. Our results will be summarized as below.

1) The finding of Pungerassamee et al. was confirmed when the test room was illuminated by yellow light. The color appearance of test patches returned to their original color whenever subjects recognized the existence of the test room by seeing objects in the room. The color constancy took place for any saturation of the yellow

illumination varying from saturation near white to that on the spectral locus in the xy chromaticity diagram. Only exception was for the test patch 5B5/3. With the yellow illumination of the highest saturation its color appearance did not return to its original blue color but was green.

2) The color constancy severely failed to hold for the red illumination. Only for the lowest saturation of the red illumination the color constancy took place. For increasing the saturation the color constancy gradually became poor and for the red illumination of the highest saturation the color appearance of test patches was far from their original color and it was just red. No discounting of the effect of the red illumination was achieved even by our brain.

Why did the color constancy hold in the yellow illumination and not in the red illumination? It is known that the psychological saturation of yellow color is not high even the spectral light of about 570 nm. The fact of the low saturation indicates yellow light is relatively close to neutral light. On the contrary, the psychological saturation of red illumination is very high. Figure 5-1 shows contour lines of same psychological saturation and of same psychological hue calculated by Stiles based on Stiles' line element theory. (9) On the diagram the illumination lights that we used are plotted by taking data from Fig. 3-5. Note that the most saturated yellow illumination Y25+W0 has the psychological saturation similar to the red illumination R12+W13. By looking at Fig. 4-11 we understand that the degree of the color constancy of these two conditions is not too different. With the red illumination the color constancy is poor for the green test patch but it is quite good for other patches. With the yellow illumination the color constancy is very poor for the blue test patch but it is quite good for other patches. Degree of the color constancy, we may say, is about the same. So we can conclude

3) Degree of the color constancy is determined by the psychological saturation of the illumination.

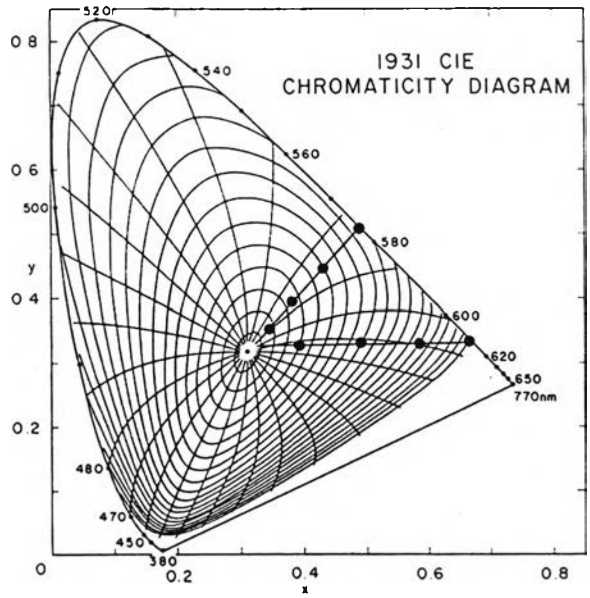

Fig. 5-1 1931 CIE chromaticity diagram with resemble lines of constant hue and saturation

In order to see the effects of window sizes on the color appearance of the test patches we replotted the results of Fig. 4-9 and Fig. 4-10 in different way as shown in Fig. 5-2 and Fig. 5-3. Figure 5-2 shows the color appearance of the test patches under red illumination and Fig. 5-3 under yellow illumination. The results are average of five subjects. Sections correspond to illumination condition. Results of different window size are shown by different symbols, squares for W1, triangles for W2, diamonds for W3, exes for W4 and circles for W5. Chromaticity coordinates of four colored test patches are connected by solid lines to form a quadrangle.

We understand that when the window was small as W1 and W2 the subject could see only the test patch within the window and the test patch was seen as an object placed in the subject room. Its color appearance was therefore determined in relation to the recognition axis of the RVSI constructed for the subject room. Then its color appearance shifted into the direction of the illumination in different degree according to the saturation of colored light. In this case we may say that the saturation of the colored light had much influence on the color appearance of the test patch. This interpretation is clearly demonstrated in Fig. 5-2. All four points of W1 and W2 are shifted toward red illumination with R5+W20 and the quadrangle shrinked to the red direction. The shrinkage became severe for high saturation of red illumination. When the subject looked at the test patch through W3 he/she could see some objects in the test room beside the test patch. Then the color appearance of the test patch shifted to return to the original color. Quadrangle of W5 is about the same as that of original color with R5+W20 illumination. This shows that as soon as the subject could recognize the existence of the test room the new RVSI for the test room was constructed and the color appearance of the test patch was determined based on the new RVSI. We see that quadrangles clearly separated into two groups; one, a group of the color appearance of the test patches as seen through W1 and W2 and the other group, the color appearance of the test patches as seen through W3, W4 and W5. The former group the color appearance of all test patches shifted to the direction of the illumination more than that of the latter group. This because of the illumination in the test room more affected to the color appearance of the test patches with W1 and W2 than with W3, W4 and W5.

With yellow illumination there was not much effect of window size on the color appearance of the test patch as seen in Fig. 5-3. But we can also see the separation to two groups; quadrangle of W1 and W2 on one side and those of W3, W4 and W5 on the other side.

An application of our results may be mentioned. Color illumination is sometimes used in show windows to attract people walking outside. If the owner of the shop intends to give correct color information to them, he/she should avoid the colored illumination of very high saturation.

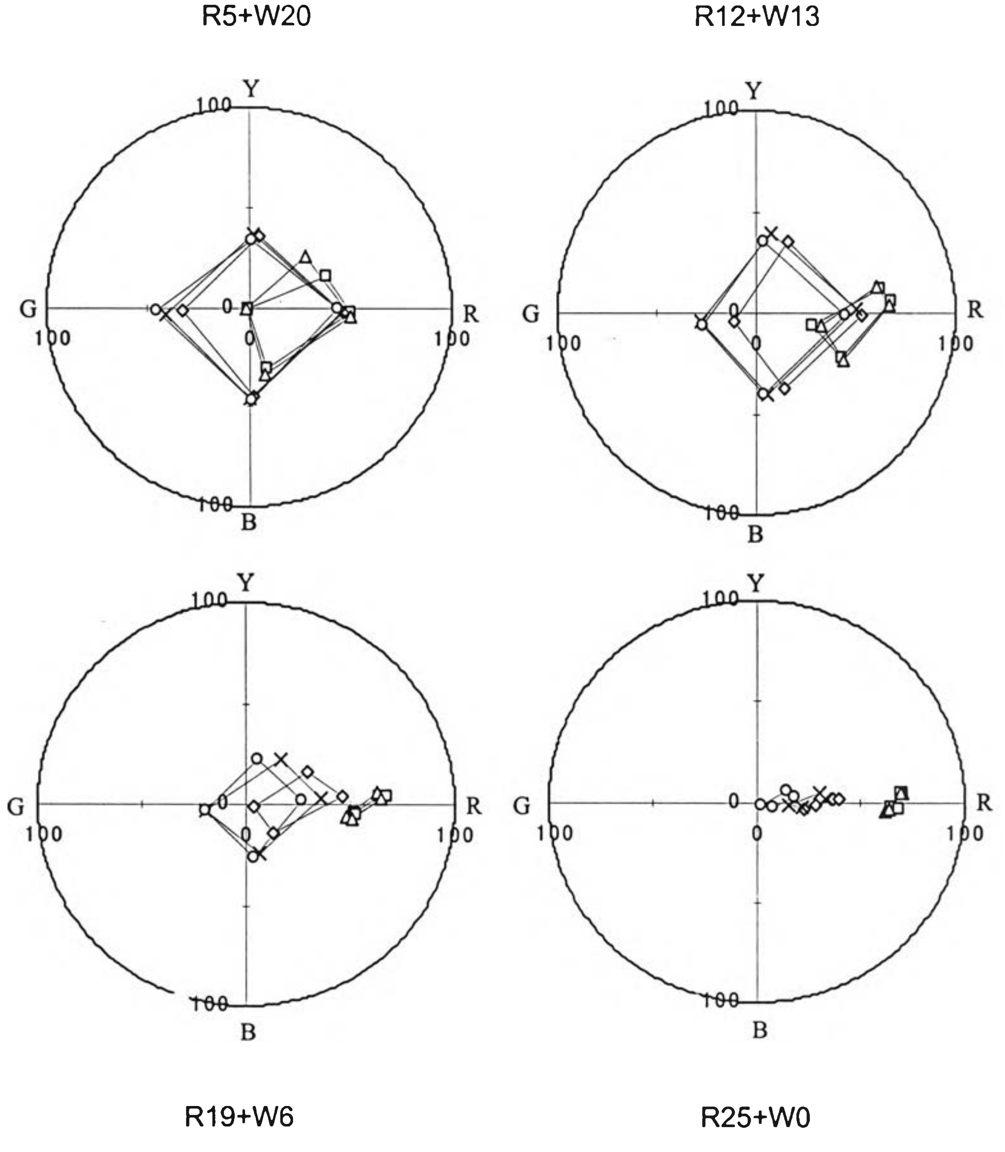

Fig. 5-2 Mean results for the red illumination and four test patches as seen through window of various sizes. Each section corresponds to the illumination condition. □, W1; △, W2; ◇ , W3; X , W4; ○ , W5.

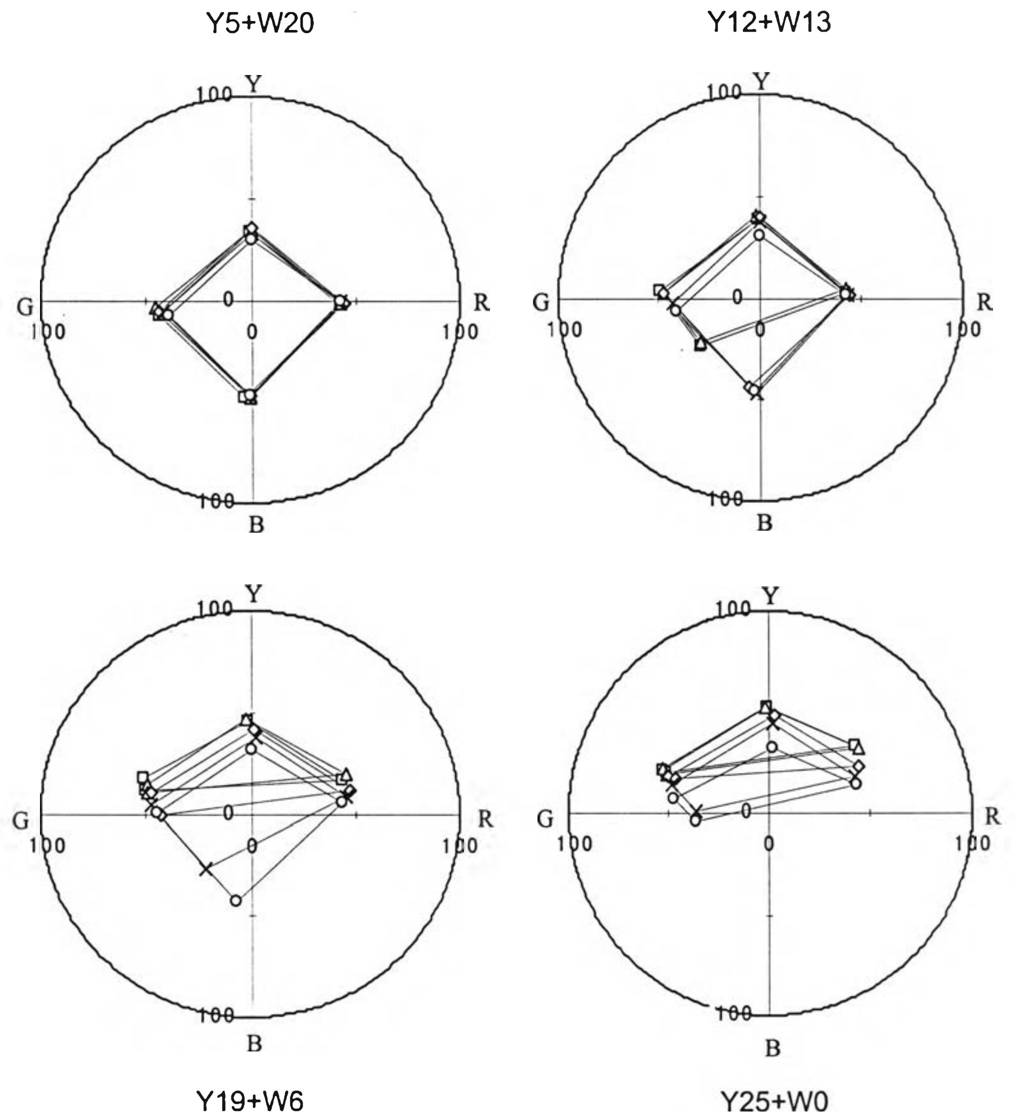

Fig. 5-3 Mean results for the yellow illumination and four test patches as seen through window of various sizes. Each section indicates the illumination condition. □, W1; △, W2; ◇ , W3; X , W4; ○, W5.