Oral paper OA12

EFFECT OF INITIAL VISUAL INFORMATION ON CONSTRUCTION OF A SPACE PERCEPTION AN ON THE COLOR CONSTANCY

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Keywords: Color constancy, Space recognition, Initial visual information, Illumination

ABSTRACT

We always perceive the color of an object correctly even if the color of illumination changes, which is called the color constancy. According to the Recognized Visual Space of Illumination (RVSI) developed by Ikeda and his colleagues the color constancy takes place only when the observer recognizes a space where the object is placed. This paper investigated how the space recognition was constructed and the color constancy took place by introducing clues, which we call the initial visual information IVI, one by one in a test room without illumination. The uniform white board at the back of the test room was observed through a large window from a subject room. The amount of whiteness of the wall was measured by the elementary color naming. The wall appeared a mere black paper filling the window if no object was placed in front of the board. But it gradually became whiter when the number of objects was increased and the white board began to appear white to indicate a gradual construction of a space perception or RVSI with increase of the IVI.

INTRODUCTION

The concept of the recognized visual space of illumination RVSI can explain clearly how the color constancy works [1-3]. When we enter a room illuminated by a red light we quickly adapt to the illumination and perceive a white object as white in spite of red light coming to our eyes from the white object. This phenomenon is called the color constancy. Pungrassamee et. al. [2] showed that it is important and vital to recognize the space where the object is placed to perceive the color of an object itself correctly. They employed two rooms technique where a subject observed a test patch placed in a test room from a subject room through a small window opened on the separating wall of the two rooms. When the subject could see only the test patch in the window without seeing any other objects in the test room the test patch appeared as an object pasted on the window and its color was determined by the subject's brain which adapted to the red illumination of the subject room. It appeared a vivid greenish blue patch. But as soon as the subject could see any objects in the test room surrounding the patch the color appearance of the test patch returned to the original achromatic patch. They explained the result as that the subject could recognize a space of the test room and could construct a RVSI for the test room by which the color of the test patch was judged. The objects in the test room were called the initial visual information IVI. The effect of IVI was investigated by Ikeda and Kaneko [4], Mizokami et al. [5, 6]. In their cases the lightness and color of objects in the test room were altered to change IVI and their effect on the illumination perception was investigated. Here in this paper we changed number of objects to change IVI and observed the change of degree of the color constancy.

APPARATUS AND EXPERIMENT

The experimental room of the size, 120 cm wide, 300 cm long, and 200 cm high was built. It was divided into two rooms, a subject room and a test room as shown in Fig. 1. On the separating wall a large window W of the size, 30 cm high and 40 cm, was opened. The subject room was illuminated by fluorescent lamps of the daylight type Ls and the test room by the same fluorescent lamps Lt. The subject room was decorated as the living room with picture frame, books, clock, pillow and artificial tree. The test room had a shelf at the height 85 cm from the floor so that the initial visual information IVI can be put. At the back wall of the test room a white board WB of the size 91 cm

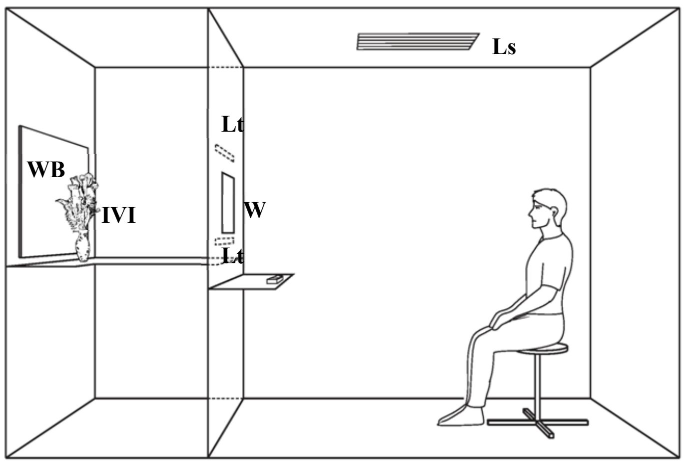

Fig. 1 Scheme of experimental room.

wide and 61 cm high was placed. It was large enough to cover the window and if there was no IVI in the test room the subject could not see any objects within the window. There were prepared six IVI as shown in Fig. 2. They were artificial flowers inserted into respective vases and the number of flowers was varied to make different IVI, I_1, I_2, I_3….I_6. The flowers were white carnations, red roses, small white flowers, and green leaves. If there was no IVI we used I_0 as the code. Beside these seven variations of IVI we prepared another IVI adding a pillow and flowers another vase to I_6, which appears as I_9 in the results. Initial visual information I_1 could not be put in a vase and it was hung by a thin string from the ceiling. Each IVI was placed near WB so that the flower(s) was touching WB. Subject could not see the bottom portion of the vase as indicated in Fig. 2.

Fig. 2 Six different initial visual information.

The subject room was illuminated at 757 lx all the time when measured on a front shelf. The test room was illuminated at 10, 20, 40 and 80 lx when measured on the shelf at the closest position to

WB. In fact the illuminance 10 lx was given without Lt but only with Ls of which light illuminated the test room through the window W.

A subject was asked to enter the subject room and to sit down on a chair at the distance 180 cm from the window W. The subject task was to judge binocularly the amounts of whiteness and blackness at the immediate surroundings of flowers by the elementary color naming method. The subject was asked not to fixate his/her eyes at a specific point of WB. The experimenter changed IVI in a random order and five repetitions of judgment were carried out for every condition.

RESULTS

When there was no IVI, which is the case of I_0, the entire window appeared very black with 10 lx of the test room illuminance. The subject could not recognize the white board at all but a black surface on the window. It was indeed a large black surface at the window. The black surface instantly turned to a gray board placed at the position of WB when I_1 was placed. The whiteness amount increased for the increase of IVI.

Figure 3 shows the results from the subject MI. The abscissa gives the IVI, I_0 through I_9 and the ordinate the percentage of whiteness. Different symbols correspond to the illuminance in the test room, squares for 10 lx, triangles for 20 lx, circles for 40 lx, and diamonds for 80 lx. If there was no initial visual information at all the subject could see only 1 % of whiteness and 99 % of blackness in spite he was seeing the surface of the white board in the test room. With I_1, that is only a carnation flower without leaves, the subject could see the board behind the carnation and could see whiteness of 29 %. The small initial visual information already let him to recognize the test room and the color constancy took place to some extent. The whiteness amount rapidly increased with increase of IVI and the increase became gradual for further increase of IVI. With I_9 the whiteness became 84 % and the subject perceived the white board as white with this large amount of IVI.

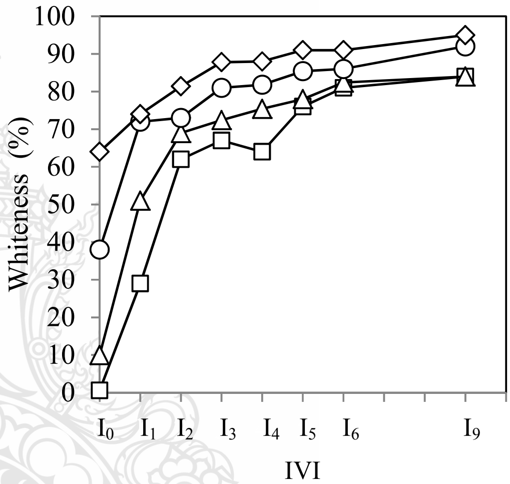

Fig. 3 Result from MI.

When the illuminance was increased the whiteness increased even with I_0 but the subject could not perceive board at the back of the test room but the gray surface on the window without IVI. There was no space perception and no object perception.

Figure 4 shows the average of five subjects. Tendency of curves is similar to that obtained from the subject MI but a clear increase of whiteness was observed when IVI was changed from I_0 to I_1. The increase is not so rapid for further increase of IVI. In other words the initial visual information of I_1 was very significant to construct a space perception for the test room. It was only a carnation flower but it gave information to subjects enough to construct a RVSI for the test room, though it was not a complete RVSI yet. We can understand now that the color constancy became perfect when the

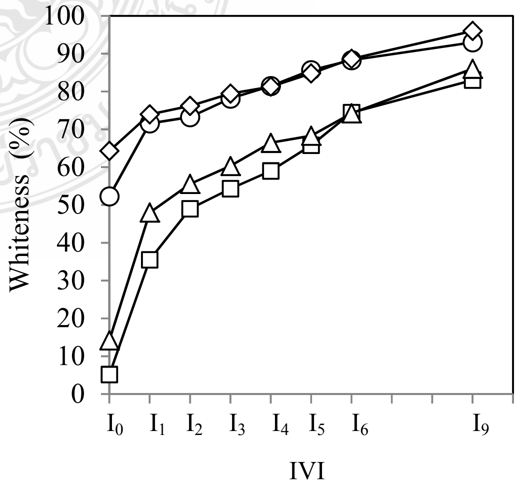

Fig. 4 Averaged result of five subjects.

window size was increased slightly so that it included only few objects in the test room surrounding a test patch in Pontawee et al.'s experiment [2]. Objects seen through the window in their case were larger in number than I_1 of the present case.

It is considered that the whiteness amount at I_0 simply reflects the luminance of the white board under the illuminance set for the test room, 10, 20, 40, and 80 lx. We took power of 1/3 for these illuminance values E to obtain the amount equivalent to L^* and plotted the whiteness amount at I_0 to see if the whiteness amount was determined only by the luminance. The results are shown in Fig. 5 with filled circles for the subject MI and open squares for the average. The whiteness is fairly proportional to E^(1/3) to confirm the supposition that the whiteness amount was determined only the luminance of the white board.

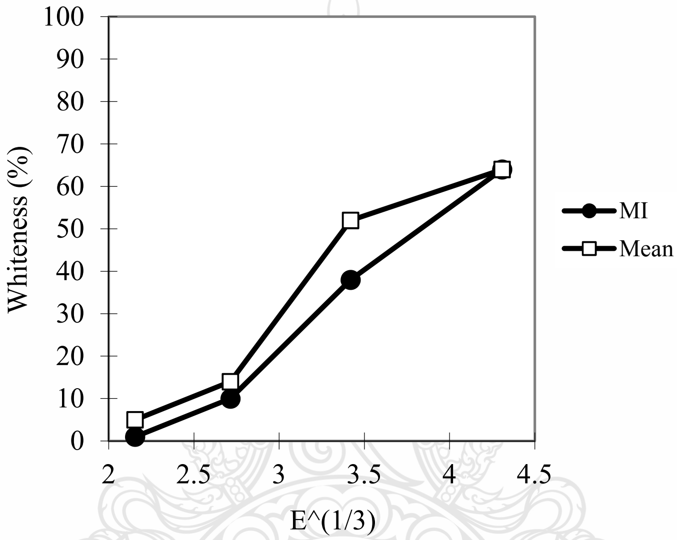

Fig. 5 Amount of whiteness at I_0 for *E*^(1/3) in lx.

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