What determines color appearance mode change between natural and unnatural object color?

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When the luminance of an object placed in a room is gradually increased by a local illuminance, it appears slightly brighter with a higher lightness than the original situation. However, its appearance remains natural as an object in the room. With further increase of the luminance, the object begins to appear unnatural as an object in the room. If the luminance further increases, the object finally appears in the light source color mode. The color appearance modes change from the natural object color to an unnatural object color, and to the light source color, crossing two borders. We investigated factors that determined the border between the natural object color and the unnatural object color (nBu). An understanding of this border has application in lighting design. According to a new concept of the recognized visual space of illumination (RVSI), the border nBu of the object color mode is reached when the luminance of the object becomes equal to the size of the brightness perception for the space where the object is placed. Four experiments were performed to investigate the factors determining nBu based on this concept. In the first experiment, the border luminance of 39 color charts was determined within two levels of the room illumination, 5 and 50 lx. The results showed that nBu was high for yellow and greenish yellow color charts and low for red color charts. The brightness matching task was employed for all color charts against an achromatic reference chart of N7. nBu was mainly determined by the brightness of the test stimulus. In the second experiment, according to the RVSI concept, we proposed an hypothesis that nBu is determined by the illuminance of the room, and not by the luminance of the immediate surroundings. nBu was determined, in one case, for various room illuminances while the luminance of the immediate surrounding of a test stimulus was kept constant by employing different lightnesses. In another case, the room illuminance was kept constant while the luminance of the immediate surroundings was varied by employing different lightnesses. The nBu of the test stimulus was almost proportional to the room illuminance with varied room illuminance, and increased only slightly for higher lightnesses of the immediate surroundings with varied luminance of surroundings. We concluded that nBu is mainly determined by the room illuminance, but there is some reduction of nBu derived from the low lightness of the immediate surrounding. From this effect, we assumed that the brain constructs a new RVSI for the immediate surroundings by transferring some part of the lightness from the immediate surroundings to the illumination of the space. The RVSI for the immediate surroundings was more completely constructed for larger spatial size of the immediate surrounding. The third experiment investigated the size effect of the immediate surroundings. The immediate surroundings field was varied in size from small to large and was varied with lightness, while keeping the room illuminance constant. The border luminance decreased for larger fields when the lightness of the immediate surroundings was very low at N4. In the fourth experiment, we assumed that the brightness size of RVSI was constructed by initial visual information (IVI) of the subject. The nBu was determined by changing the size of the IVI field for the subject from the smallest size (only the immediate surrounding) to the largest size (the entire room). The IVI field size was varied by changing the aperture sizes of a goggle box. Room illuminance was kept constant. The results showed that when the subject perceived the visual information field size limited within the immediate surroundings, nBu is determined by the luminance of the immediate surroundings. However, when the subject began to perceive wallpaper or an object in the room, nBu is mainly determined by the room illuminance. From the four experiments, we concluded that the primary factor that determines nBu is the brightness and appearance of the

color. Other factors, $_{n}B_{u}$ is dependent on the initial visual information obtained by an observer to construct the brightness size of RVSI. In ordinary rooms, $_{n}B_{u}$ was mainly determined by the room illuminance but it is also influenced by the lightness of the immediate surroundings to some extent. In some case, however, $_{n}B_{u}$ is determined by the luminance of the immediate surroundings if the initial visual information for obtained by the observer is limited only on back ground field.