

A PASSIVE PERCEPTUAL LEARNING TASK FOR PRIMAL COLOR MODIFIES DIFFERENCE THRESHOLD OF MIDDLE TONE COLORS

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Abstract

*Observers performed a memory task in which they learned the location of a target color in a 4 * 4 colored matrix. Each of the 16 squares within a matrix was assigned one of four unique hues (red, yellow, green and blue), and observers were asked to report the location of a target hue. The initial frame rate was 2 matrices per second and it was increased as observers' performance improved to as high as 25 matrices per second. Observers performed the color hue discrimination task before and after the memory task. Attending to a particular target color influenced discrimination of middle tone colors which contained the primal color. For example, reddish target color sensitized the hue discrimination of orange-yellow, orange, red, reddish-purple and bluish-purple.*

Many psychophysical studies have been attempted to find factors affecting the difference threshold. Perceptual learning improves performance on many tasks from discrimination to identification (Fahle, 2002; 2005; Fahle and Poggio, 2002). In a recent study it has been suggested that the visual search task for a particular color affect long-lasting sensitization (Tseng et al., 2004). To investigate the consequences of attending to a particular color, Tseng et al. (2004) designed the search task that requires observers to attend to a particular color and to ignore all other colors. We used the similar visual search and memory task which is to report the location of target color squares and to ignore all other colors squares. Observers performed the color hue discrimination task before and after the visual search and memory task. Here we explored that attending to a particular target color influenced discrimination of middle tone colors which contained the primal color. For example, reddish target color sensitized the hue discrimination of orange-yellow, orange, red, reddish-purple and bluish-purple.

Method

The present experiments were carried out using a computer with a 24-bit frame memory (Cambridge Research Systems VSG 2/5). Stimuli were presented on a 21-inch color cathode ray tube (CRT) display (Sony CPD-G520). Look-up tables in the computer compensated for the nonlinearities of each phosphor. The refresh rate was 100 refreshes per second, and the spatial resolution was 1,024×768 pixels. The display was viewed in a darkened booth at a viewing distance of 40 cm, at which the CRT subtended 47×34 deg. of the visual angle. Four observers participated in the present study. They had normal visual acuity and color vision as tested by Landolt ring, the Ishihara pseudoisochromatic plates, the Farnsworth-

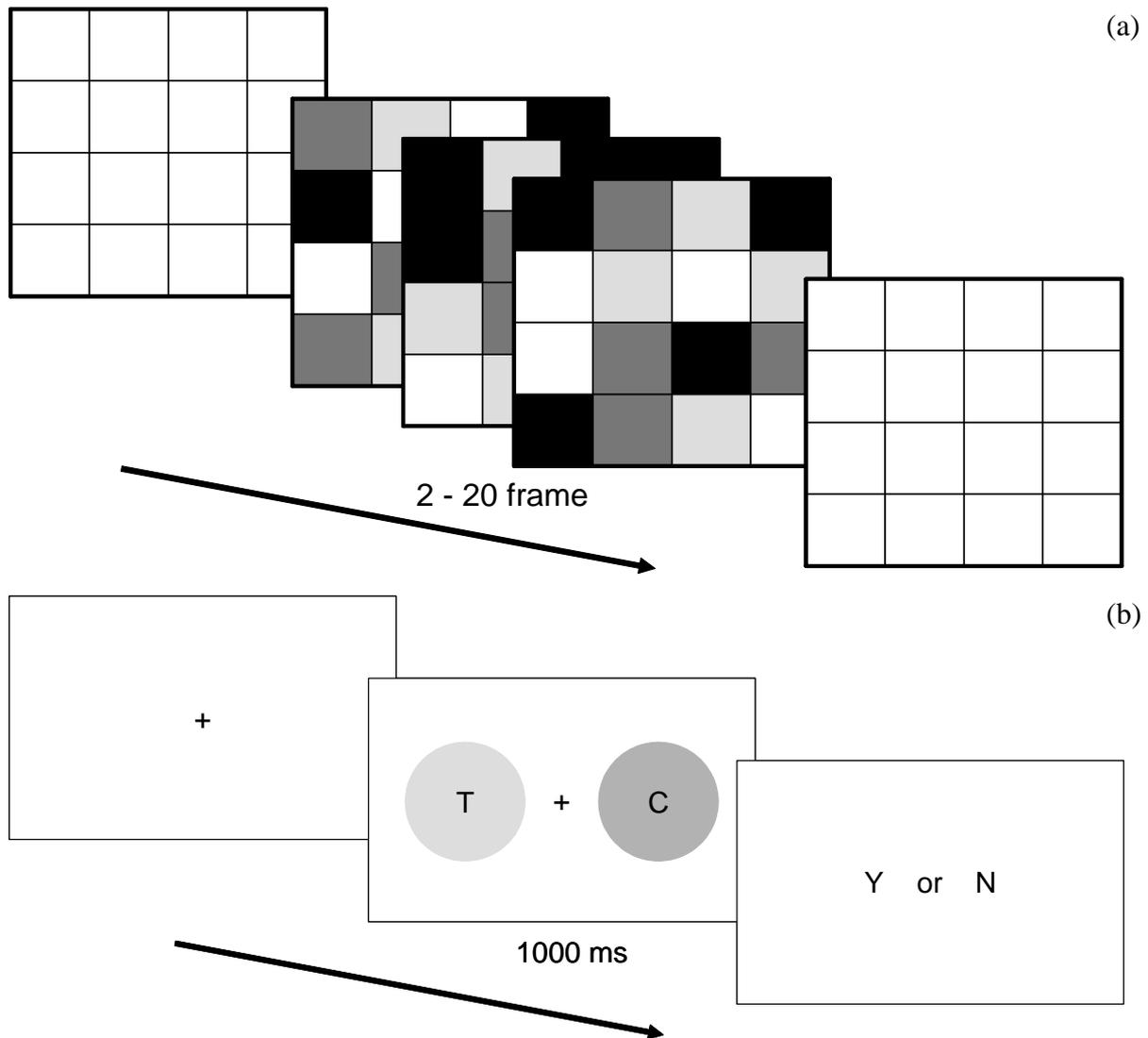


Fig. 1. The Visual memory task and hue discrimination task. (a) memory task. A target color (red, yellow, green or blue) is assigned to each subjects. This task contains 2-20 memory frames in which the 4 colored squares is visible. (b) hue discrimination task, using the chromaticity of Farnsworth-Munsell 100-hue test

Munsell 100-hue test and the Nagel-type anomaloscope (Hioki version, Handaya, Japan). The observers were not aware of the aims of this study. Figure 1(a) shows a schematic view of visual memory task. The task is to memorize the location of four target squares for a particular color among other three distracter colors. Each trial consists of 2-20 consecutive 4×4 matrices whose sides measure 10 degree v.a. Each of the 16 squares of a matrix is randomized four primal colors (red, yellow, green and blue). The initial frame duration was 1000ms and it was decreased as subjects' performance improved to 40 ms. Each color display was presented sequentially and the task display inserted abruptly (Fig. 1a). The task display consisted of $4 * 4$ blank matrices and a marker (0) superimposed on one of 16 blank. At the beginning of experiment, target color (red, yellow, green or blue) was assigned to each observer. They memorized four spatial location of each target color in the consecutive matrices. When the task display was presented, the observer reported whether or not the color of the marker's location in the preceding display was target color. As observers

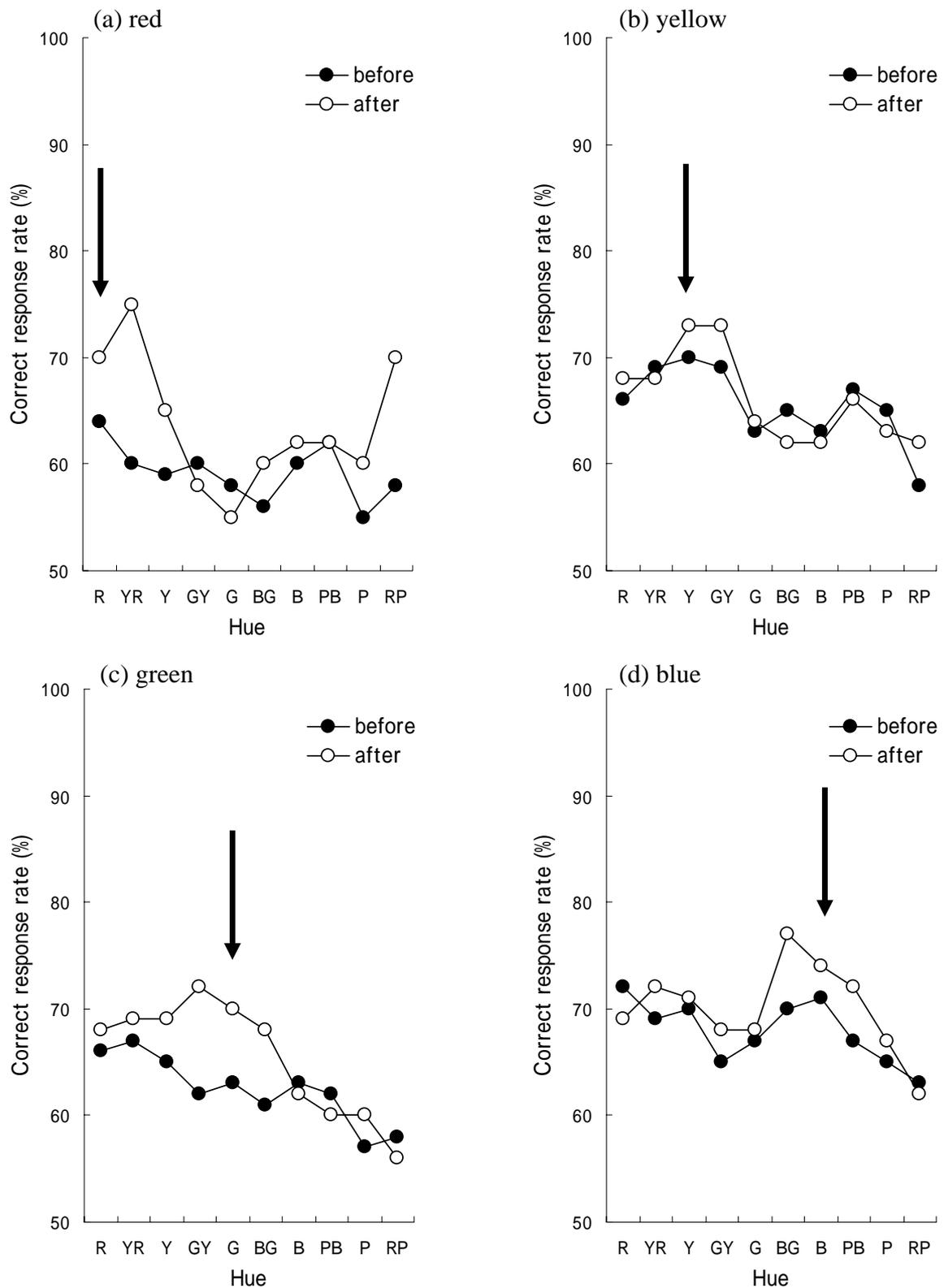


Fig. 2. Results obtained with difference threshold paradigm before (filled circles) and after (open circles) the color location memory task to target color. The correct response rate (%) is plotted as a function of chromatic hue for four observers, respectively. (a) target color was red, (b) yellow, (c) green and (d) blue. Vertical arrow in each panel showed the target color.

practiced, whenever performance reached 95 % correct, the frame duration was decreased. At the final rate, the duration of color matrix display was 40-100ms. Throughout the entire experiment, all observer was not exposed to the color display for more than 50 minutes.

Difference threshold was measured by a hue discrimination task (Fig. 1b), using the chromaticity of Farnsworth-Munsell 100-hue test (Farnsworth, 1943; Boynton, 1996). A circular test stimulus (T) and comparison stimulus (C) were presented to the observer at the right or left of fixation points for 1000ms. The diameter of T and C was 1.5deg. The chromaticity of T and C was systematically varied from red to reddish purple in two hundred steps. If the observer could discriminate T from C, they pushed a button.

Results and Discussion

Figure 2 showed typical data from difference threshold paradigm before (filled circles) and after (open circles) the color location memory task to target color. The correct response rate (%) is plotted as a function of chromatic hue for four observers, respectively. For each observers, four target color, red (a), yellow (b), green (c) or blue (d), were assigned. Vertical arrow in each panel showed the target color. In the after condition (open circles), the peak correct response rate was obtained around the target color for each observer. The implication of the present data seems unequivocal: i.e., the increase of sensitivity between before and after condition is prominent around the target color.

Attending to a particular target color influenced discrimination of middle tone colors which contained the primal target color, too. For example, Figure 2a showed that red target color sensitized the hue discrimination of yellow, orange, red, reddish-purple, bluish-purple and purple. Yellow target color showed the weak effects; i.e. yellowish target color sensitized only the hue discrimination of yellow and greenish-yellow. However, greenish target sensitized the hue discrimination of yellow, greenish-yellow, green and bluish-green (Fig. 2c), and blue target color sensitized those of bluish-green, blue, bluish-purple, reddish-purple and purple. The increase in correct response rate (%) around the target color could not be explained by the practice factors of before and after conditions, because the increase of rate was not constant. It is suggested that attending to a particular primal color (red, yellow, green and blue) influenced discrimination for broad expanse of middle tone colors.

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