THE EFFECTS OF DIAGNOSTIC COLOR IN NATURAL SCENE RECOGNITION

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Abstract

The present research tested semantic factors of colors affect natural scene memory. Particularly, we noticed diagnostic colors that mean highly predictive. Diagnostic color scenes were classified as the number of possible colorations that can be for each scene. It was defined as diagnostic color scenes had only a few colorations, while non-diagnostic color scenes had many options. We used natural scene pictures that highly occupied natural or man-made objects. Many of natural objects scenes were estimated as diagnostic color, while man-made objects scenes were non-diagnostic color scenes. Using these pictures, we execute a pair-comparison task that used blurred study images as study images in order to detect chromatic contrasts effectively. Diagnostic color scenes took more advantages of color information.

Previous studies suggest that color plays an important role in recognition memory for natural scenes (e.g., Suzuki & Takahashi, 1997; Wichmann et al., 2002). They are known that recognition memories are better for colored pictures than for white-and-black versions. In order to assess color advantages, some studies address physical factors of natural scene colors. In psychophysics studies, chromatic contrast sensitivity function shows low-pass frequency filtering characteristics. At low spatial frequencies below 0.5 c/deg., the contrast sensitivity was grater for the chromatic gratings than for either of the two monochromatic luminance component gratings used. At higher spatial frequencies, however, the contrast sensitivity was grater for monochromatic luminance gratings (e.g., Mullen, 1985). Another behavioral study shows, in image recognition representation, chromatic contrast represents low spatial frequency information such as global structures and layouts, while luminance contrast represents high spatial frequency information such as local structures and details (Kawabata et al, prep). However, there had been few studies about semantic factors of natural scene colors.

Therefore, we examine how colors contribute to scene recognition in terms of semantic factors. In this paper, we noticed diagnostic colors as one of the semantic factors of natural scene colors. Diagnostic colors mean high predictive and typical colors that represent objects (e.g., yellow banana). In object recognition, colors had effective information on diagnostic color objects(Tanaka & Presnell, 1999). Whether color cues are effective for diagnostic color scenes, or not? In this experiment, we execute a pair-comparison task that used blurred study images in order to detect chromatic contrasts effectively.

Method

Stimuli

The 80 natural scenes selected as stimuli materials were used in this experiment. The stimuli had been photographed by digital camera and chosen from material books. The spatial resolution of the stimuli was 640 ×480 pixel.40 scenes are used as study scenes, and the other 40 scenes were used as distracter scenes. Images were selected by a procedure similar to that described by Oliva and Shyns (2000). Their study defines natural objects occupied scenes as diagnostic color scenes and man-made objects occupied scenes as non-diagnostic color scenes. We applied their definition, diagnostic color scenes were classified as natural or non-diagnostic color scenes as man-made objects in this experiment. Images were classified into 10 categories. (a) fruits / vegetables (b) flower (c) seaside/riverside (d) green landscapes and (e) animals are natural scenes and diagnostic color scenes. The others are man-made object scenes and non-diagnostic color scenes. Those are (f) foreign country city (g) Japanese city (h) park (i) residential area and (j) room. Diagnostic color scenes were 20 scenes and non-diagnostic color scenes were 20 scenes.

All pictures were blurred by the cut-off spatial frequency of 0.3 c/deg and made in white-and-black images. Examples of the stimuli used in the experiment are shown in Figure 1. Color and white-and-black images had a similar luminance. All study images were blurred and presented color or black-and-white mode in this experiment. Test images were blurred or clear images and presented color or black-and white mode. There were 16 kinds of combinations of the study and test, therefore there were 640 pairs in all. The image set was composed of 40 pairs and there were 16 sets in all. Gaze cue "+" and "!" are also presented before and after the study images, the background of the cues were gray field at the mean luminance. Viewing distance was 3m, at which the stimulus subtended 45 ° ×33 ° .

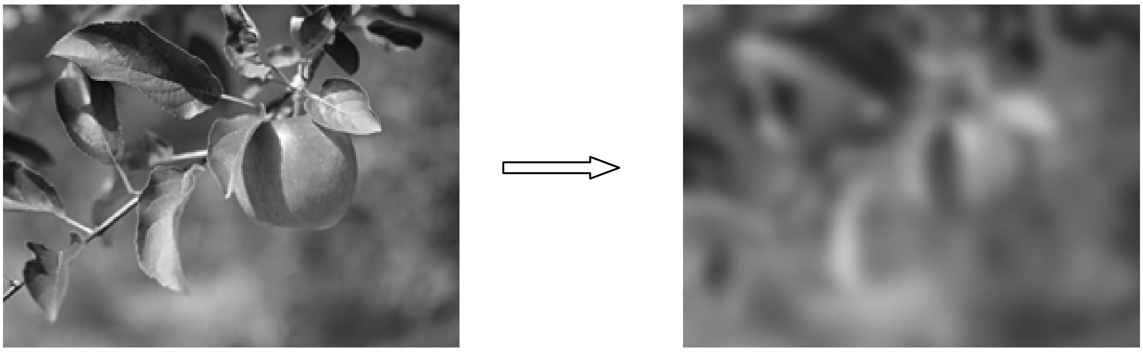

Figure.1. Example picture manipulated by the cut-off spatial frequency

Participants

Six men graduate students (mean age 24 years old) of Hokkaido University were participated in this experiment. All had normal color vision and corrected-normal vision acuity.

Procedure

The outline of this experiment shows Figure 2. Stimuli were projected to the screen by the projector. Participants were seated in front of the screen. This experiment was conducted in the darkroom. At first, gaze cue "+" appeared for 1000ms on the gray screen and the study image was presented for 2000ms. Participants were asked to memorize the scene. After gaze cue "!" appeared for 2000ms, test images were presented. The participants were asked to response "yes" as fast as possible when test image was identical to the study image, ignoring color mode or a degree of blurring. Each test image was presented until the participant gave response (yes-no answer). They were participated in 8 sets of all 16 sets. The participants were asked to judge 8 sets that is 320 pairs.

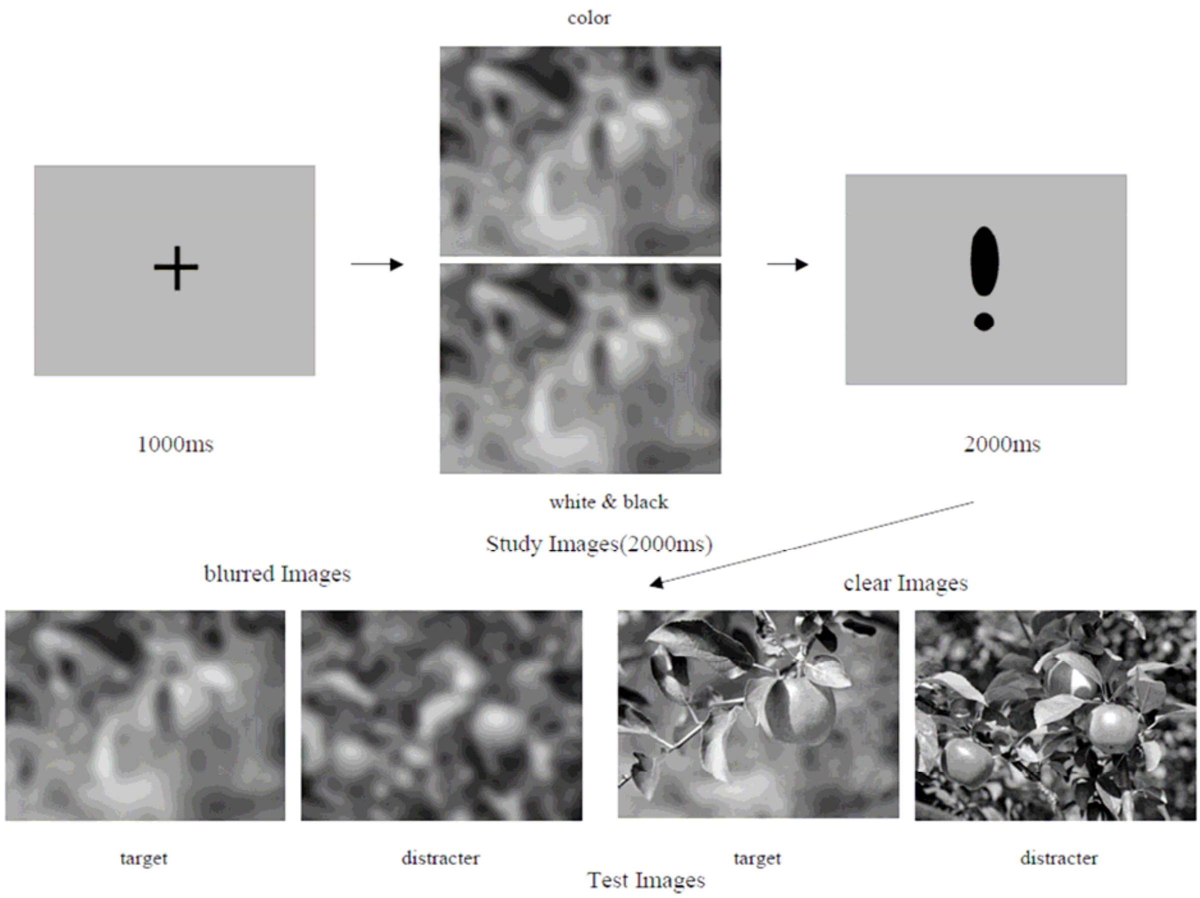

Figure2. The outline of this experiment

Results and Discussion

Figure3 and 4 show the results of this experiment. Figure3 shows correct response rate at when test images were presented (a)blurred or (b)clear images. Figure4 shows response time at when test images were presented (a)blurred or (b)clear images. Horizontal axis of each figure shows color mode when study and test images were presented: color images at both study and test (C/C), color images at study and white-and-black (C/W), white-and-black images at study and color images at test (W/C), and white-and-black images at both study and test (W/W). At clear images, in diagnostic color scenes the recognition rate increases when the images were presented in color mode. It implies diagnostic color scenes are easy to recognize when the appropriate colors are presented. Response time also suggests different tendency in diagnostic and non-diagnostic color scenes. In this experiment diagnostic color scenes defined natural objects occupied scenes. However, there might be another classification. For example, their scenes are reclassified as the number of possible colorations that can be imaged for each scene. We try to clarify the features of the diagnostic color scenes.

Acknowledgements

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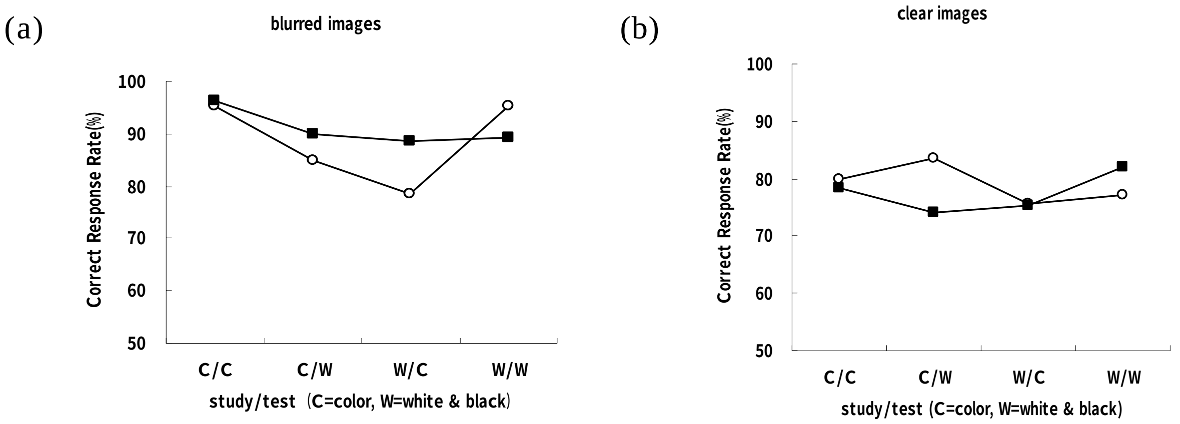

Figure3. Correct response rate as a function of color mode. ○ means diagnostic color, ■ means non-diagnostic color scenes.

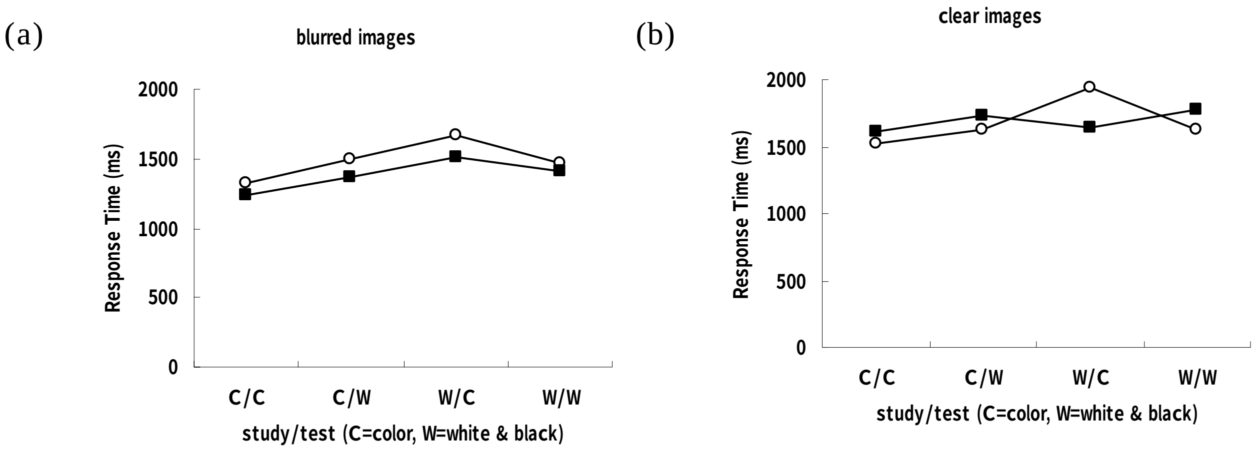

Figure4. Response time as a function of color mode. ○ means diagnostic color, ■ means non-diagnostic color scenes.

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