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# Cooperation between the achromatic and the chromatic systems in form perception

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## 1. Introduction

The initial information concerning the visual scene may be analyzed as several separate images, each involving a particular perceptual attributes such as luminance, color, motion, binocular disparity, or texture. The purpose of this paper is to examine some questions concerning the transformation of the retinal images into separate attributes and cooperation across the separate attributes in form perception. Here I concentrate on luminance and color attributes.

## 2. The fixed weights assumption of the cone signals into the opponent systems is not true

The existing color model asserts that the cone signals are fed into the opponent system with fixed relative weights. My question is whether the weighting factors of the transformation of the cone signals into the opponent system depend on viewing condition or not. We tested this fixed weights assumption by measuring the sensitivities of the L and M cone system and the spectral locus of unique yellow (null point of the red-green system) [1]. We showed that under the red adapting condition, the red-green equilibrium point shifts toward the shorter wavelength further than the Weber's law predicts (the fixed weights assumption predicts). This implies that the secondsite adaptation due to the red light seems to compensate selectively for the sensitivity reduction caused by the L cone receptor adaptation. This finding is against the fixed weights assumption in transformation of the cone signals into the opponent system. The rejection of the assumption is also reported by Eisner and Macleod[2] and Ahn and Macleod[3]. It should be noted that the post receptoral adaptation effect is opposite in nature between the achromatic (luminance) system and the red-green system. Under the red adapting condition, the contribution of the L cone to the luminance system is more reduced than that of the M cone, while the contribution of the M cone to the red-green system is relatively more reduced than that of the L cone. The existing color vision models based on the fixed weights assumption should be revised to explain the effect of the second site adaptation.

## 3. Colored after-image elicited by the figure-ground configuration

The color afterimages depend upon the spatial arrangement of colors. Some spatial arrangements produce negative afterimages, while others do positive ones. After adapting to a green patch on a gray surround, a pinkish afterimage is seen against any white or gray test field (negative afterimage). On the other hand, after viewing the same green patch on a more saturated green surround, the subsequent afterimage consists of a green spot (positive after image). Thus, by changing the saturation of the surround from desaturated to

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saturated, one can change the apparent color of the afterimage of the central green patch from pink to green. This implies that with equal adaptational state at the receptor site, the perception of the afterimage may depend on the surrounding area. My colleagues and I have shown that the dependence of the positive afterimage upon a spatial parameter is closely related to the spatial properties of the opponent-color processes and the interactions between them and that the neural site may be probably at the double-opponent process (Takahashi et al[4]).

These adaptation phenomena lead to the concept of a hierarchy of mechanisms which may be engaged at different background levels, different color appearance of illumination, and different configurations of colored objects. To approach a comprehensive color vision model, the hierarchy of the adaptation mechanisms which play a key role in achieving visual constancy under ordinarily visual circumstances should be clarified.

## 4. Cooperation between the achromatic and the chromatic systems in neon color effect

The spatial resolution of the achromatic (luminance) system is higher than that of the red-green and the yellow-blue systems. When a fine color image which is too fine for the chromatic system to resolve is presented, at least three separate images may be formed presumably at the opponent process. One is rather sharp image produced by the luminance system. The others are somewhat blurred images produced by the red-green and the yellow-blue systems. Here my question is how a unified sharp and colorful image is produced by the multiple images at the higher order process. To examine how the luminance and the chromatic systems cooperate to form a unified image, we investigated the neon color effect. The neon color effect is considered to occur only when the luminance system and the chromatic systems may not manage to make up a unified image. The neon color effect is generated by

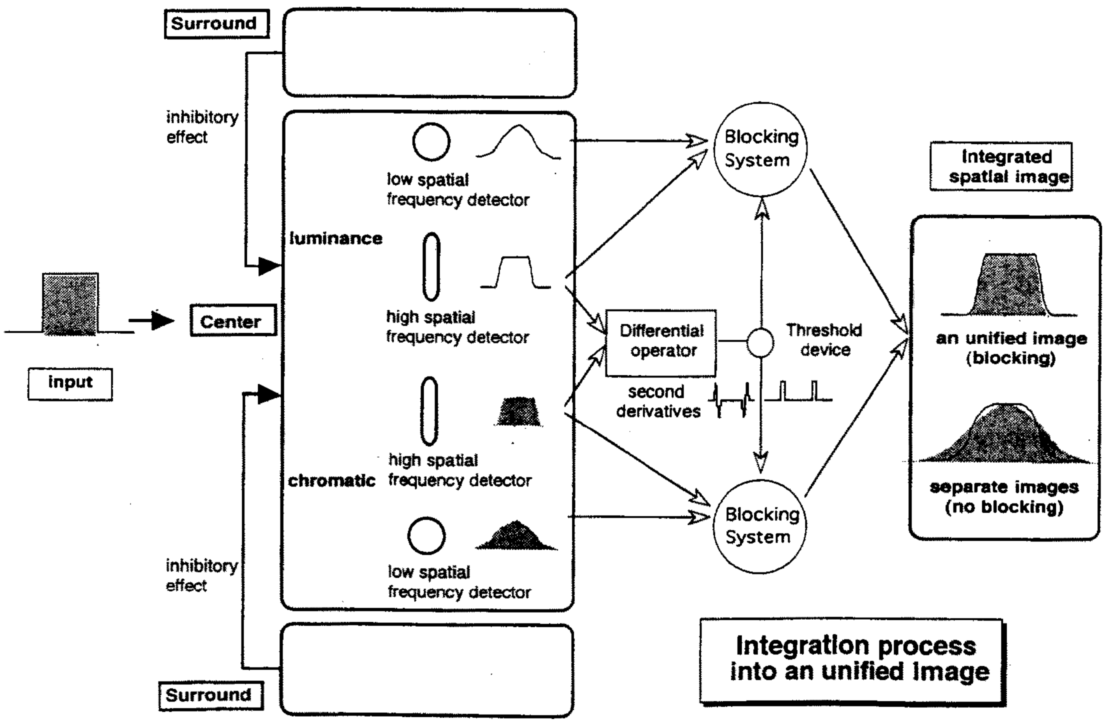


Fig. 1 Integration process into an unified image

a colored connecting line embedded in the gap situated between the proximal end points of radial lines. A circular veil of color in the illusory area is called neon color and has the same hue as the inducing cross. We determined the limits and relative effects of stimulus parameters such as color and luminance on the occurrence of the neon color effect, and proposed a model of the integration process to explain the cooperation of the luminance and the chromatic systems generating the neon color effect as shown in Fig. 1[5]. We assumed the blocking mechanism which articulates blurred images predominantly mediated by the chromatic system and makes separate images into a unified image. The blocking mechanism is assumed to be enabled to work as an articulator by the enabled signals of a differential operator with a threshold device. The operator receives high spatial frequency input signals mainly from the luminance system and partly from the chromatic systems, and outputs the second derivatives into the blocking mechanism. When the second derivatives are above the threshold, the blocking mechanism is enabled to articulate the blurred signals so as to make into a unified image. On the contrary, below the threshold the blurred signals pass through the blocking mechanism without being articulated.

This model is developed to explain how a unified image may be made from the separate images of different attributes.

## References


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