EFFECTS OF VISUAL STIMULATION OF THE COLOR & SHAPES ON THE AUTONOMIC AND THE CENTRAL NERVOUS SYSTEM

Kikuhiro Ota, Hiroyuki Ishikawa, Shigeki Watanuki
Department of Ergonomics,
Kyushu Institute of Design, Fukuoka 815-8540 Japan

INTRODUCTION

On viewing the superficial texture of objects, color and shape exhibit a close correlation. Perception of a certain shape is based on color discrimination. In short, we recognize the existence of an object by discriminating colors, and this is often taken as the shape for granted. Color, which does not exist as a single entity, is incorporated in shape to portray multifaceted expressions.

Focusing on color and shape, psychological studies in the 1960's have implicated that red is related to warmth and anxious feeling, blue represents cold feeling, while circular and triangular shapes indicate respectively dynamic and sharp characteristics commonly shared by humans. Although the probability of combining color and shape is unlimited, a physiological commonality may exist among the numerous combinations. Therefore, our present study attempted to examine the effects of various color/shape combinations on the autonomic and the central nervous system (CNS) in our physiological living systems.

METHODS

Eight healthy male university students without dyschromatopsia consented to participate in our study. Five different colors (blue, green, yellow, red and white) based on theirs wavelengths were employed as color stimuli, and they were respectively discriminated by filtration of multicolored illumination projected from a white light source. Concomitant combinations with 4 different shapes (circular, squared, triangular and reversed triangular) afforded 20 color/shape facets for testing (Fig. 1). Exposure of each color/shape stimulus lasted for 15 min, and the order of projecting combined stimuli was conducted at random. The initial and terminal 3-min intervals of each 15-min color/shape stimulus was respectively taken as the section 1 analysis time (S1AT) and section 2 analysis time (S2AT) with regulated respiration (0.33 Hz). Heart rate variability (HRV), blood pressure (BP) and electroencephalography (EEG), which served as the physiological evaluation indices, were measured accordingly (13 sites indicated

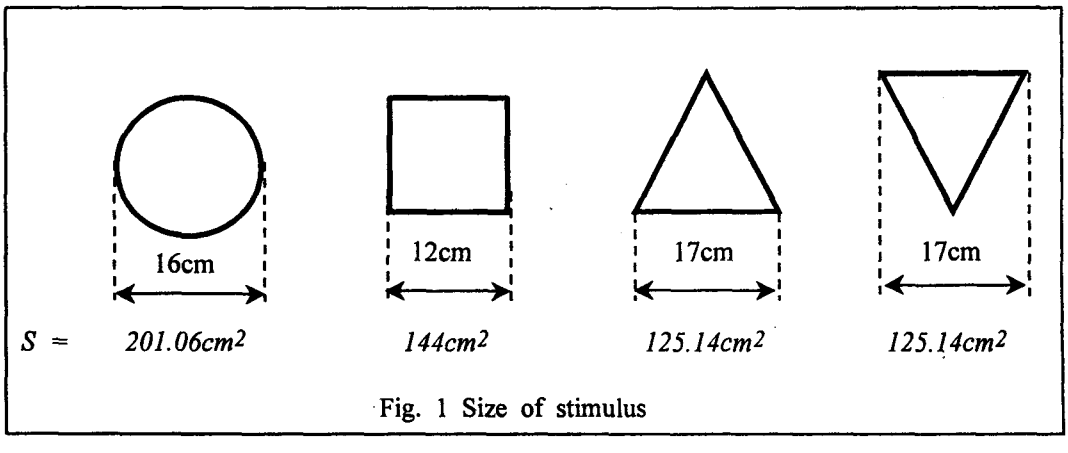

Fig. 1 Size of stimulus

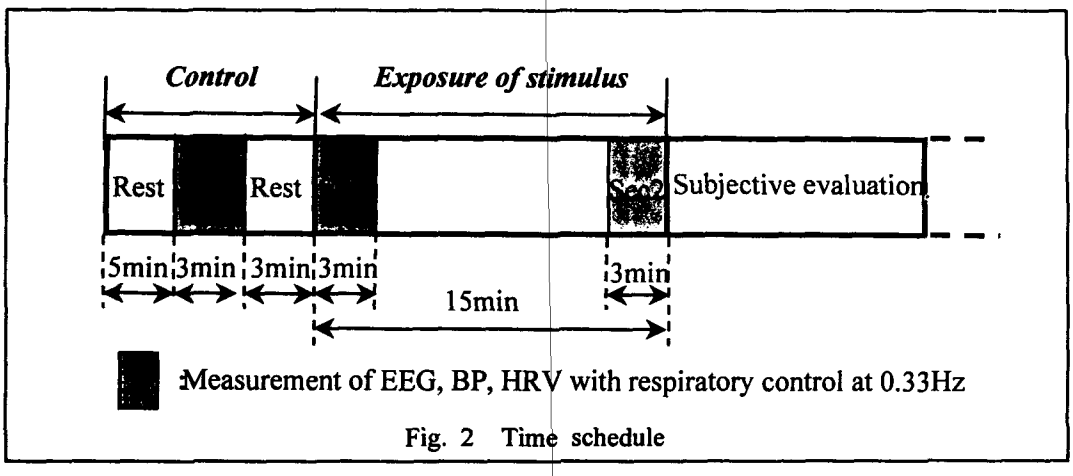

Fig. 2 Time schedule

in Fig. 3). As the white light was used as the color reference, analysis of white light stimulation was omitted (Fig. 2).

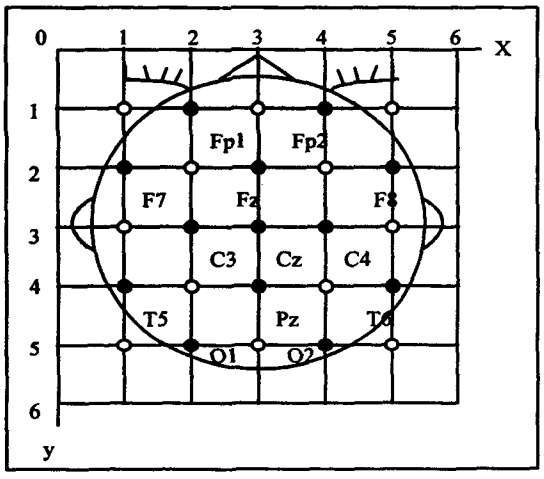

Fig. 3 Mesurement sites

RESULTS

The results of dispersion analysis of 4-way coordinates factoring the subject, color, shape and section using the low-frequency (LF), high-frequency (HF) and LF/HF components of HRV as indices representing cardiac autonomic activity, respective significant ($p<0.01$) interactions of the major effects of either subject or color, between subject and color, subject and shape, color and shape as well as subject and color/shape. Results verified with the paired Student's t-test revealed significant S1AT decreases of red color in the LF component (Fig. 4). However, systolic BP indexing vascular autonomic activities was not affected.

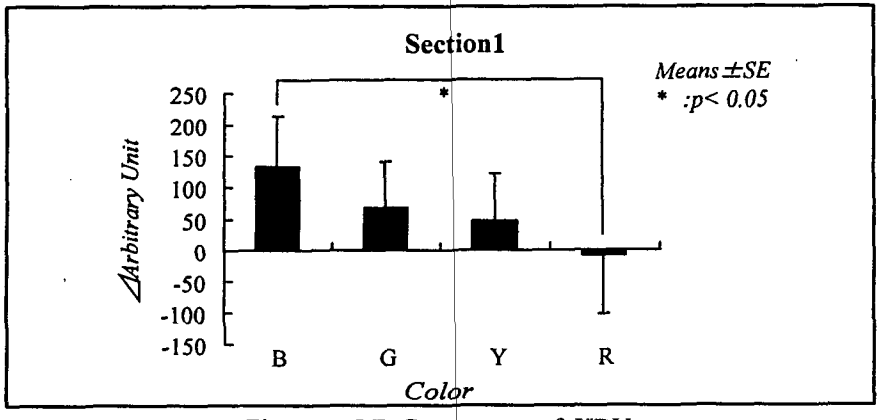

Fig. 4 LF Component of HRV

Based on dispersion analyses of 4-way coordinates factoring the subject, color, shape and section at sites F7, T5, Fz, Cz, Pz, C3, C4 and O2, respective significant ($p<0.01$) interactions encompassing appearance of the β wave component, color, subject and color, color and shape, subject and shape, color and shape, subject and color/shape were reflected as the major effects.

Verification with the Student's t-test demonstrated significant SIAT decreases at site O2 where yellow < blue and green(Fig. 5). As for S2AT at sites F7, T5, Fz, Cz, Pz, C3 and C4, more significant increases were recorded for red than blue, green and yellow, and marked decreases for yellow compared with blue and green colors (Fig. 6).

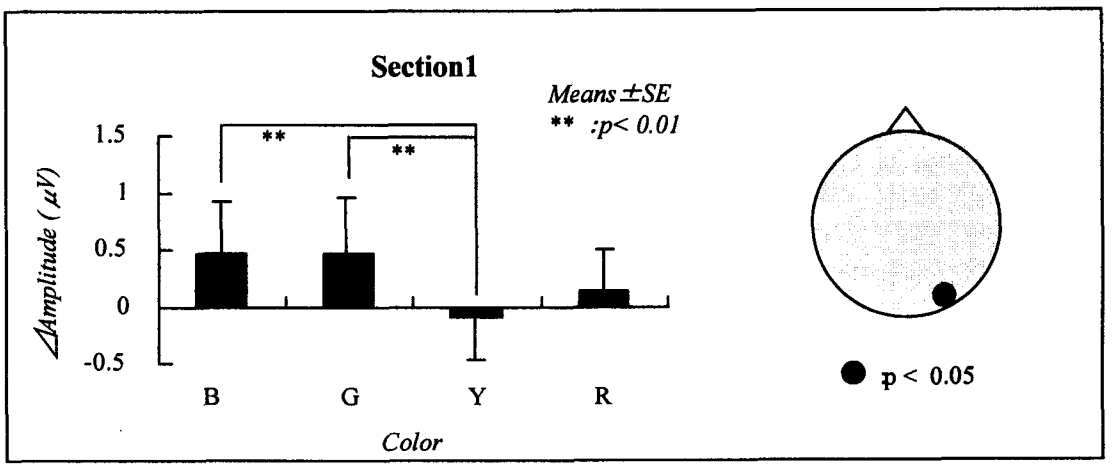

Fig. 5 · wave component of site O2

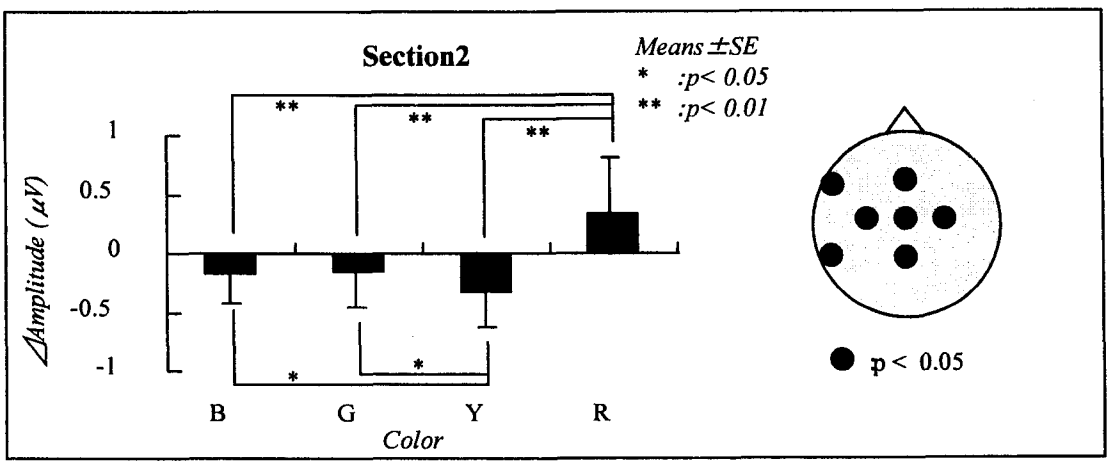

Fig. 6 · wave component of average
(sites F7,T5,Fz,Cz,Pz,C3,C4)

DISCUSSION

The present findings demonstrated that a combination of color with color/shape influenced cardiac autonomic activity and CNS accordingly. Red light suppressed cardiac autonomic activities more potently than blue with reference to S1AT, whereas color effects exerted on autonomic activities were erased in the case of S2AT. With S1AT, EEG at site O2 indicated that more potent suppression on the central arousal level was elicited by yellow light compared with those colored blue and green. This arousal suppressive tendency of yellow light was further aggravated with S2AT at sites F7, T5, Fz, Cz, Pz, C3 and C4 (left cerebral hemisphere). Compared with blue, green and yellow, red color definitely registered the highest score, implicating a highly possible function of red light in enhancing the arousal level. In other words, the effect on autonomic activity exerted by red light decayed while the CNS effect enhanced with time.

According to a study employing color stimulation on autonomic activity (Kawahara, 1993), red color elicited the most potent effect compared with blue, green and yellow, a finding that disagrees with our present results. In addition, using a total of 8 colors (red, yellow, green, blue, purple, white, gray and black), Mishima et al. (1992) have demonstrated that the β component of red color exerted a significantly lower activity within a designated 10-sec period than that subjected to green. Furthermore, the effect was not time-related. These findings do not converge with our results in this study. These discrepancies were probably due to a difference in stimulatory conditions; while they employed the color parameter alone in their investigations, the parameter of shape was incorporated with color in our present study. In short, the mutual effect of color and shape was elicited in the present study, and the shape parameter definitely, at least in part, influenced the outcome. Furthermore, as size may have participated as a factor in exerting the effects observed in this study, follow-up studies with the incorporation of size as an integrated stimulus (with probable casual relationship with other indices) in the present experimental protocol are warranted.

SUMMARY

The present study strongly suggests that a combined color/shape stimulus may exert marked influences on cardiac autonomic and CNS activities. The effects of red color on the autonomic activity decayed while the influence on CNS intensified with time, suggesting the probable central role of this color on the left cerebral hemisphere in humans.