Physiological and psychological responses to color lights under cold environmental condition

Yang Guo
Graduate School of Human Sciences
Waseda University

Miho Saito
Faculty of Human Sciences
Waseda University

Mayumi Nakamura
Faculty of Human Sciences
Waseda University

Kei Nagashima
Faculty of Human Sciences
Waseda University

Keywords: color light, physiological response, psychological response, cold environmental condition

1. Introduction
So far, physiological and psychological effects of color have been researched in many various aspects, which warm and cold sense of color as emotional effect is well known. Kaku, Saito, Oza, Tokizawa & Nagashima (2009) reported that in cold water stimulation experiments, color light can affect self-regulatory body temperature adjustment reaction, and affect the thermesthesia and mood.

To further explore the effects of color light, this study measured and analysed human physiological and psychological responses to color lights under cold environmental condition.

2. Methods
This study was conducted among 16 healthy Japanese female aged between 20 to 30 years old. The subjects entered the environmental chamber 1 hour before the experiment. During the experiment, subjects wore gray color (N6.5) short sleeves T-shirt and short pants, maintaining a sitting position. Respectively project white (x:0.403,y:0.448) and yellow (x:0.470,y:0.458) color light produced from a projector and a computer on a rear projection screen placed 70cm in front of the subject. The subject was fully covered by the color light.

The exposure time was 20 minutes for normal condition (28.5°C, 30%RH) from the beginning of the experiment. Then, the temperature was reduced to 23.5°C for a cold exposure process (23.5°C, 30%RH) of 60 minutes. After that, the temperature was raised to 33.5°C till the end of the experiment. Fig.1 shows the experimental procedure. White and yellow color light is divided into two days of the experiment for each subject.

Fig.1 Experimental procedure

Through the experiment, skin temperature, skin blood flow, rectal temperature, blood pressure, pulse rate were continuously measured as physiological indicators. Subject's impression towards the 2 color lights were measured before the start of the experiment (SD method, 9 adjective pairs, 5-point scale). In addition, mood (POMS, 15 words, 4-point scale), thermesthesia (7-point scale) and cold discomfort (7-point scale) of hands, feet, and body were evaluated 12 times as psychological indicators. (Fig.1: ①-②)

3. Results

Physiological responses
1) During cold exposure process, compare to white color light, under yellow color light, subjects' fingers and toes' skin temperature, skin blood flow and core temperature (rectal temperature) all maintained at higher level. 2) There are no significant differences on blood pressure and pulse under different color lights.

Psychological responses
1) Referring to subjects' impression of color light, white color light is thought to have neither cold nor warm feeling, while yellow light gives impression of warmth. 2) Evaluate the subjects' mood during the experiment under the 2 color lights, using factor analysis (major factor method, varimax rotation), select 4 factors: RELAX, ACTIVE, GLOOMY, TIRED. Among them using RELAX and GLOOMY as axes, produced a scatter plot of factor scores (Fig.2). Fig.2
shows under white color light, GLOOMY scores are significant higher than under yellow color light for 12 mood evaluations. However, during cold exposure process (5th-8th mood evaluations), yellow color light scores are higher than white color light in term of RELAX. These results indicate that under yellow color light sense of unpleasant and tense caused by cold can be eased. 3) Evaluation of thermesthesia and cold discomfort during cold exposure process, subjects feel relatively cold and discomfort under white color light.

4. Discussion & Conclusion

Kaku, Momose & Saito (2007) show yellow color light has high level of activity can make a person happy and a higher rate of α wave in brain wave. Kaku et al. (2009) report under specified condition as cold water simulation, red color light referred as warm color can ease unpleasant sense caused by cold. Blue color light evaluated as cold color more enhance the unpleasant feeling causing psychological tension and arousal, suppression of skin sympathetic excitement, to promoting the recovery of skin temperature, and inhibition of the contraction of the skin blood vessels.

This study shows under cold environmental condition, yellow color light similar to red color light as warm color ease unpleasant sense and discomfort significantly. Analysis of the physiological indicators shows that skin temperature, skin blood flow and core temperature relatively maintains higher level comparing to white color light. These results can be understood as yellow color light may reduce the excitement of the skin sympathetic nerve activity, and reduce discomfort caused by cold physiologically and psychologically.

The results of this study show that color light can affect the body’s temperature regulation, and can significantly affect persons’ mood. In the future further studies and applications of color effects may promote adjuvant treatment of disease and improve quality of life.

References


Fig.2 Scatter plot of factor scores (RELAX×GLOOMY)