



Original Article

The effects of treatment room lighting color on time perception and emotion

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Abstract. [Purpose] The purpose of this study was to investigate the perceived treatment times and emotional reactions under different light colors in the treatment room. [Subjects and Methods] Subjects in this study were 20 healthy young students in their 20s. Under each lighting condition (blue, red, white, and yellow) differentiated by color, each subject laid on a therapeutic bed and underwent ultrasound therapy. Subjects were instructed to press a stopwatch every 1 minute, for a total of 5 times, after therapy started according to their perception of time while the stopwatch's time indicator was blocked. After the experiments, self-administered questionnaires were given to subjects to measure their emotional reactions. [Results] In terms of K-POMS scores, the mood states of depression-dejection, anger-hostility, and confusion-bewilderment were higher scores for blue and red lights compared to yellow light. The mood state of vigor-activity were higher scores for yellow and white lights compared to blue and red lights. [Conclusion] Therefore, it is important to take necessary measures to prevent the negative effects that blue and red light-based therapy can have on patient mood.

Key words: Color, Lighting, Time

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INTRODUCTION

The interior design of health care facilities is crucial to improving patient satisfaction; therefore, the psychological needs of patients and their caregivers and the functional elements of the facilities need to be considered¹⁻³).

Patients and their caregivers commonly perceive time passing in hospitals. They want to receive treatment for as long as necessary, but they also want to keep their waiting time as short as possible; therefore, patient satisfaction is affected accordingly⁴⁻⁶). The perception of time is affected by the color of interior spaces⁷). In addition, various psychological responses to interior colors have impacts on treatment outcomes and patient satisfaction⁸).

Furthermore, color is involved in phototherapy, which primarily uses infrared light and ultraviolet radiation and exposes patients to red and blue lights. Light and color not only affect the visual environment but also affect physiological and psychological satisfaction. Gerard described that exposure to blue light led to an overall reduction in physiological aspects and an increase in relaxation and psychological comfort⁹). Woo-seok reported that warm colors used for lighting were associated with perceived fast response times but decreased accuracy¹⁰). Jin-hee reported that yellow light triggers positive emotions and activities⁸).

There have been some studies of clinical settings¹¹⁻¹³). However, studies investigating time perception and emotional reactions based on the light color of the treatment area are scarce. The purpose of this study was to investigate the perceived treatment times and emotional reactions under different light colors in the treatment room.

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Table 1. Comparison of time perception according to changing light color (n=20)

Mean ± SD (s)			
Blue	Red	White	Yellow
70.5 ± 27.5	78.7 ± 22.2	73.7 ± 16.6	76.2 ± 24.4

Table 2. Comparison of K-POMS according to change light color (n=20)

	Mean ± SD (score)				Post-hoc ^a
	Blue	Red	White	Yellow	
Tension-Anxiety	4.6 ± 3.3	4.3 ± 2.7	3.3 ± 2.7	3.3 ± 1.8	-
Fatigue-Inertia	6.7 ± 6.0	4.0 ± 5.5	3.2 ± 2.8	4.4 ± 4.0	-
Depression-Dejection**	6.9 ± 9.1	2.6 ± 3.0	1.1 ± 2.2	0.1 ± 0.4	B, L >L, W > Y
Anger-Hostility*	1.1 ± 1.9	0.4 ± 0.8	0.3 ± 0.9	0.0 ± 0.0	B, L, W >L, W, Y
Confusion-Bewilderment*	2.4 ± 2.4	2.3 ± 1.9	1.0 ± 1.5	0.9 ± 1.8	B, L >W, Y
Vigor-Activity**	3.1 ± 5.4	2.9 ± 4.4	5.3 ± 5.4	7.0 ± 6.6	Y, W >W, B > B, L

^aWilcoxon Sing test

*p<0.05, **p<0.01

SUBJECTS AND METHODS

Subjects in this study were 20 healthy young students in their 20s. The mean age, height, and weight of the subjects were 22.7 ± 1.8 years, 169.2 ± 5.3 cm, and 71.9 ± 10.8 kg, respectively. Ethical approval for the study was granted by the Institutional Review Board of U1 University (Bioethics 2017-3). All subjects were fully informed of the objectives and methods of the study beforehand and provided informed consent to participate in the experiments.

The room where the experiments were performed had white walls, white ceiling, and white floor and used blackout curtains and thick paper to keep out any of external light. The lighting devices were smart LED lightings (hue; Philips, Netherlands). Illuminance was fixed at 150 lux for all lighting conditions. An illuminometer (LX-1010B; Vetus, China) and a color difference meter (TES-135A, TES, Taiwan) were used to ensure consistency of color produced for each experiment.

To minimize learning effects on study results associated with repeated experiments, light colors were used in random order and only one light color was used per day for measurements.

Subjects were instructed to stay in a dark room for 3 minutes before being exposed to the prepared lighting conditions (blue, red, white, and yellow). Under each lighting condition differentiated by color, each subject laid on a therapeutic bed and underwent ultrasound therapy, with the intensity set at 0. During ultrasound therapy, subjects were instructed to press a stopwatch every 1 minute, for a total of 5 times, after therapy started according to their perception of time while the stopwatch's time indicator was blocked. After the experiments, self-administered questionnaires were given to subjects to measure their emotional reactions.

Statistical analysis was performed using SPSS 18.0; a statistical significance level of 0.05 was used. Friedman test was used to determine differences in the ability to perceive time and K-POMS (Korean Edition of Profile of Mood States) scores. Post hoc analysis was performed using a Wilcoxon Sing test.

RESULTS

The mean values of time perception with different light colors were not statistically significant ($p > 0.05$) (Table 1).

In terms of K-POMS scores, tension-anxiety and fatigue-inertia showed no significant differences with respect to different light colors ($p > 0.05$). However, the mood states of depression-dejection, anger-hostility, and confusion-bewilderment were significantly different according to light colors, with higher scores for blue and red lights compared to yellow light ($p < 0.05$). The mood state of vigor-activity varied with light colors, with higher scores for yellow and white lights compared to blue and red lights ($p < 0.05$) (Table 2).

DISCUSSION

Based on the results of the experiments, there were no significant differences in tension-anxiety and fatigue-inertia factors. This can be explained by the familiarity the subjects felt because the experiment laboratory was prepared identically to the treatment room that they had frequently visited, thereby allowing them to relax. Furthermore, the mood states of tension and fatigue were more likely induced by labor intensity or work proficiency than light color¹⁴.

Previous studies reported that blue tended to trigger negative emotional states such as depression, whereas yellow trig-

gered positive emotional states of being cheerful and delightful¹⁵). In this study, the scores of the depression-dejection, anger-hostility, and confusion-bewilderment factors were significantly higher for blue light than for yellow light, whereas the score for the vigor-activity factor was significantly lower for blue light than for yellow light. These findings signify that patients may be more susceptible to depression, anger, inertia, and confusion under blue light in clinical settings. In contrast, it was found that yellow and white lights can help patients to be positive, stable, active, and focused. Therefore, the use of yellow lights can be suitable for settings where active therapy is required, including pediatric physical therapy and exercise therapy rooms.

Patients may be prone to depression in addition to physical injury^{16, 17}). For example, patients with skin disease such as psoriasis and vitiligo may report severe depression as a result of being separated from others socially and emotionally¹⁸). These patients undergo light therapy using ultraviolet rays, particularly natural blue lights. The results of this study suggest the possibility that such blue light-based therapy may cause patients to feel more depressed. Therefore, it is important to take necessary measures to prevent the negative effects that blue light-based therapy can have on patient mood. For instance, wearing colored glasses that do not recognize blue color or installing a screen to block blue light can be recommended to protect patient mood.

This study examined only healthy subjects in their 20s in a certain geographic area. Therefore, future studies should target a wider variety of subjects in terms of region, age, and disease. In addition, they should involve a wider variety of postures and various muscles.

The purpose of this study was to investigate the perceived treatment times and emotional reactions under different light colors in the treatment room. It is important to take necessary measures to prevent the negative effects that blue light-based therapy can have on patient mood. For instance, wearing colored glasses that do not recognize blue color or installing a screen to block blue light can be recommended to protect patient mood.

This study was concerned only with healthy subjects in their twenties in a certain geographic area, and the number of subjects was small. Therefore, in the future, an experiment with a larger number of subjects with more-diverse diseases should be conducted.

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