

# PREFERRED COMBINATIONS BETWEEN ILLUMINANCE AND COLOR TEMPERATURE IN SEVERAL SETTINGS FOR DAILY LIVING ACTIVITIES

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## ABSTRACT

Illuminance and color temperature are widely recognized as important factors in interior lighting. Luminance and preferred color temperature are known to be related each other, since Kruithof showed the comfortable illuminance zone related to the color temperature of light sources. However, recent research papers showed the Kruithof's curve is not always useful.

It seems to be because Kruithof does not consider the influence of activities to the preference of lighting condition. This paper shows the result of subjective evaluation of scale models on preferred combinations between luminance and color temperature in six settings of living activities at home.

For the experiment, 1:10 scale models illuminated with the light source consists of red, green, and blue compact fluorescent tubes with controllers were used. Lighting conditions used are the combination of illuminance (50, 100, 200, 400, 800lux) and color temperature (3000, 4200, 5000, 6500K). Interior color is white, with a small color patch on the wall. Six settings of Living activities are the space for "relaxing", "family gathering", "dining", "cooking", "studying", and "retiring (bedroom before sleep)". Three variables: "preference", "brightness", and "naturalness of color appearance" are evaluated.

In the space for relaxing, low color temperature and relatively low illuminance are preferred. In the space for family gathering, preferred conditions are similar to the Kruithof's comfortable zone except high illuminance over 200lux. These results are generally similar to Nakamura's result.

In the space for dining, preferred conditions are similar to the Kruithof's comfortable zone. Especially, relatively high illuminances are preferred. In the space for "cooking" and "studying", preferred combinations are the combination of high illuminances and high color temperatures but slightly different from Kruithof's zone. In the bedroom before sleep, the preferred conditions are low illuminances.

The preferred combinations of illuminance and color temperature are showed which are vary depend on the living activities, though Kruithof's comfort zone seems to be useful for dining space in Japan.

*Keywords: Illuminance, Color temperature, Preference, Scale model, Daily activity*

## 1. INTRODUCTION

Illuminance and color temperature are widely recognized as important factors in interior lighting. Luminance and preferred color temperature are known to be related each other, since Kruithof showed the comfortable illuminance zone related to the color temperature of light sources. However, recent research papers, such as Nakamura et al. showed the Kruithof's curve is not always useful.

It seems to be because Kruithof does not consider the influence of activities to the preference of lighting condition. This paper shows the result of subjective evaluation of scale models on preferred combinations between luminance and color temperature in six settings of living activities at home.

## 2. METHODS

For the experiment, 1:10 scale models (420mm x 420mm x 240mm) were used. The light source consists of red, green, and blue compact fluorescent tubes with controllers. Lighting conditions

## Oi, Preferred Luminance and Color Temperature Combination

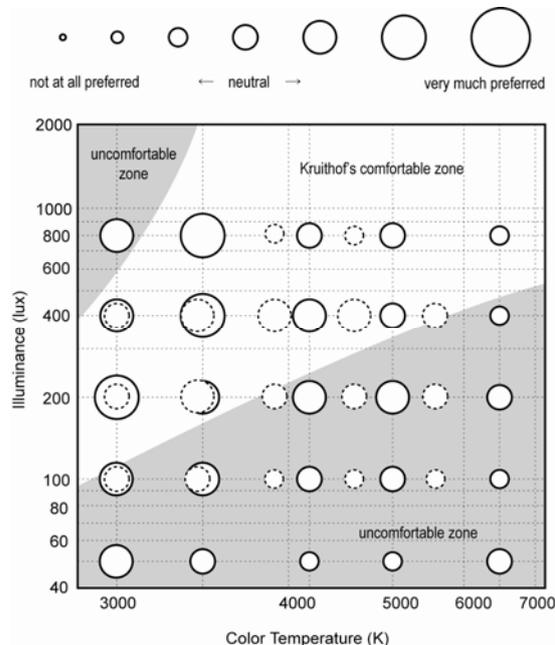
used are the combination of illuminance (50, 100, 200, 400, 800lux) and color temperature (3000, 4200, 5000, 6500K). Interior color is white, with a small color patch (blue, green, yellow, red and purple) on the wall. Six settings of Living activities are the space for "relaxing", "family gathering", "dining", "cooking", "studying", and "retiring (bedroom before sleep)". Three variables: "preference", "brightness", and "naturalness of color appearance" are evaluated. Subjects are 8 Japanese students (5 female and 3 male).

**Table 1** Settings and Lighting conditions

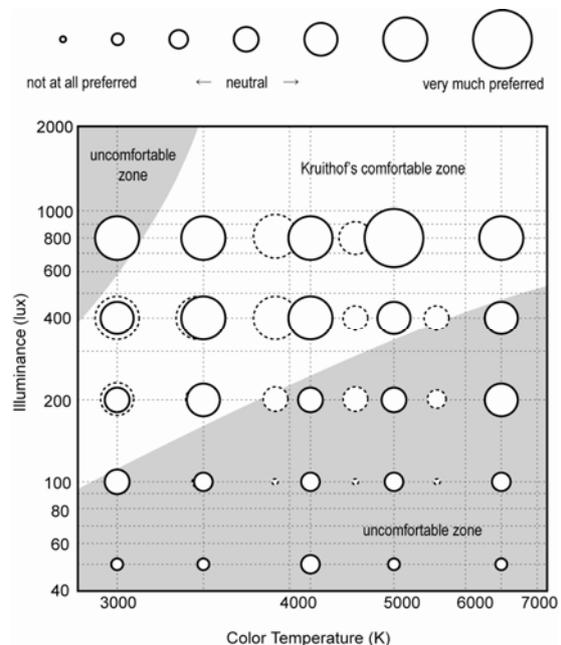
Settings			
Standard	Livingroom	Dining, Kitchen	Bedroom
Activities			
—	relaxing, family gathering	dining, cooking	studying, retiring
Color Temperature			
4200K	3000K(warm), 3500K(warm white), 4200K(white), 5000K(cool white), 6500K(cool)		
Illuminance			
200lx	50lx, 100lx, 200lx, 400lx, 800lx		

### 3. RESULTS

In the space for relaxing, low color temperature and relatively low illuminance are preferred. In the space for family gathering, preferred conditions are similar to the Kruithof's comfortable zone except high illuminance over 200lux. These results are generally similar to Nakamura's result.



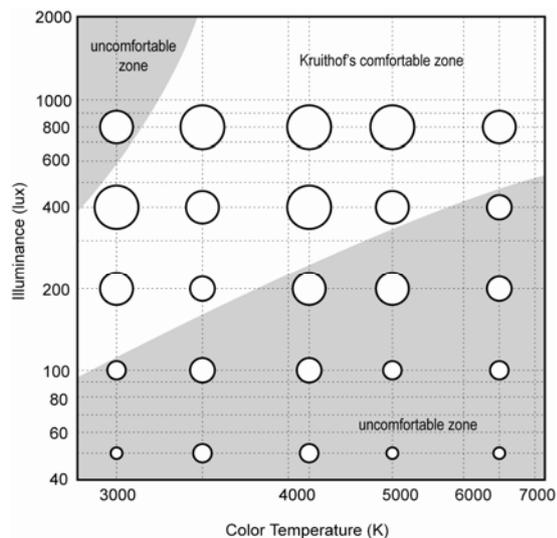
**Figure 1** Preference in relaxing space



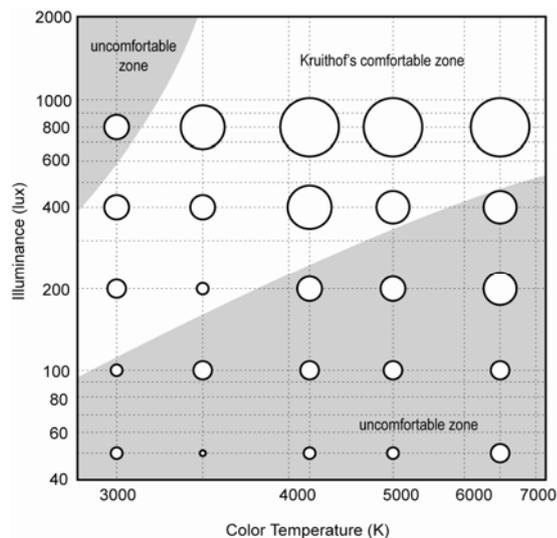
**Figure 2** Preference in gathering space

In the space for dining, preferred conditions are similar to the Kruithof's comfortable zone. Especially, relatively high illuminances are preferred. In the space for "cooking" and "studying", preferred combinations are the combination of high illuminances and high color temperatures but slightly different from Kruithof's zone. In the bedroom before sleep, the preferred conditions are low illuminances.

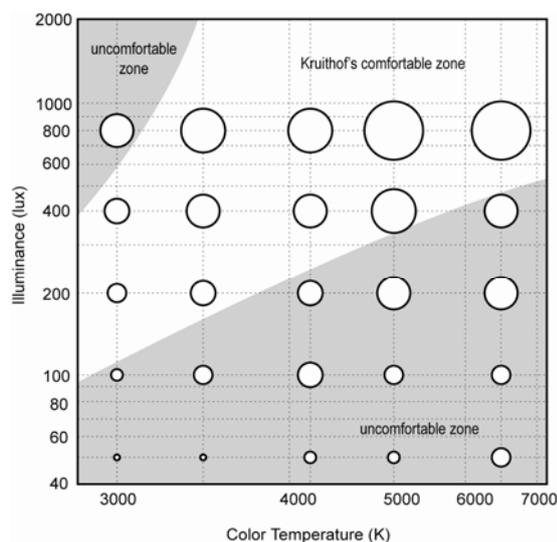
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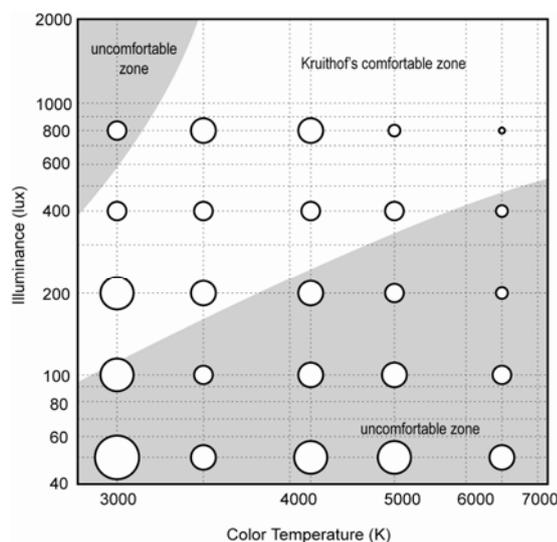
**Figure 3** Preference in dining space



**Figure 4** Preference in cooking space



**Figure 5** Preference in studying space



**Figure 6** Preference in retiring space

## 4. CONCLUSIONS

The preferred combinations of illuminance and color temperature are shown which vary depend on the living activities, though Kruithof's comfort zone seems to be useful for dining space or gathering space in Japan.

In short, in the bedroom before sleep, low temperature is preferred, while low temperature is not preferred in cooking space and studying space where high illuminance is needed. In relaxing space, relatively low color temperature is preferred and under higher color temperature limited illuminance range is acceptable. Kruithof's comfort zone is not appropriate for lighting under relaxed situation.

## REFERENCES

- (1) KRUIHOF, AA. Tubular Luminescence Lamps for General Illumination, *Philips Technical Review*, 6, 1941, 65-96.
- (2) NAKAMURA, H. Is Kruithof's Curve correct?, *J. Illum. Eng. Institute of Japan*, 2001, **85-9**, 793-795. (in Japanese)

(3) NAKAMURA, H. et al. Relation between Preferred Atmosphere and Luminance Color Temperature Combination. *J. Illum. Eng. Institute of Japan*, 1997, **81-8A**, 687-694. (in Japanese)

(4) OI, N. et al. The Preference of the Indoor Illuminance and Color Temperature: Scale Model Experiment Assuming Daily Activity. *J. of Environmental Eng. Transactions of Architectural Institute of Japan*, 2007, **4**, 87-92. (in Japanese)

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