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# Psychological Evaluation of Artistic Lighting Using A Large Number of Subjects

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## Abstract

Whether the results of psychological experiments targeting a small number of people can be expanded when targeting a large number of people is an important issue. We are researching Kansei (sensitivity) lighting, which combines glass art and lighting, as joint research between a university and a company. About 1,800 visitors evaluated the developed Kansei lighting at an exhibition for the public. We used the same evaluation items used in the evaluation experiments already conducted by us using a small number of people so that the results of both experiments can be compared. In this paper, we report the results of evaluation experiments using a large number of people.

**Keywords:** Kansei lighting, Psychological experiment, Large number of subjects.

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## 1 Introduction

Kansei evaluation is often performed using psychological experiments. Psychological experiments conducted in university laboratories usually focus on a strict condition setting, and the number of subjects is often limited to several dozens. Because it is aimed at students, it is also biased regarding age. Therefore, when we present the results of such psychological experiments at conferences, we often receive questions about their generality when extending them to the public. "We will consider it as a future issue" is a typical answer, but it is rarely considered in practice. This is an important issue related to the credibility of psychological experiments.

In this study, we intend to compare the results of small-scale psychological experiments conducted in the laboratory with those conducted on many ordinary people on the same problem. As we have already carried out a specific experiment using a small number of subjects, we carried out the same experiment using a large number of subjects.

Mitsubishi Electric and Kyoto University Art Innovation Industry-Academia Joint Research Division are conducting joint research toward developing Kansei lighting. The Kansei lighting is a new product that appeals to people's sensitivity by

applying the art created by Naoko Tosa, one of the authors, to lighting. As a result, we developed a prototype of the Kansei lighting called the "Light Table." First, it was evaluated in a small-scale psychological experiment targeting dozens of students at Kyoto University [1]. In addition, we had the opportunity to exhibit the Light Table at Mitsubishi Electric's showroom METoA Ginza. We asked about 1,800 visitors at METoA Ginza to conduct a psychological evaluation through a questionnaire.

This paper describes the results of many people's evaluation experiments of the Kansei lighting. As an extension of this report, we will compare the results with another psychological experiment with a small number of people. By this, we will try to answer whether the results of psychological experiments with a small number of people can be expanded to those for a large number of people.

## 2 Light Table

Naoko Tosa, one of the authors, used a high-speed camera at 2,000 frames/sec to capture jumping up liquid such as paints to which a sound vibration is given, resulting in a beautiful shape that is invisible to the human eye [2] [3] [4]. Based on this, she has created a video artwork called "Sound of Ikebana [4]."

Since the Sound of Ikebana obtained as a video image has an organic and beautiful shape, many people request it to be obtained as a three-dimensional shape. To make the Sound of Ikebana three-dimensional, we are trying to photograph the generation process of the Sound of Ikebana using multiple high-speed cameras and restore the three-dimensional shape of the Sound of Ikebana from the images taken by multiple cameras [5].

At the same time, in an attempt to make the Sound of Ikebana three-dimensional using another material, we have researched to create a similar shape using glass. This is because the actual ikebana combines multiple types of flowers and plants to create a single Ikebana. One idea is that the 3D Sound of Ikebana is composed of multiple parts, and made each part out of glass. By combining these, we try to create a three-dimensional model that resembles the Sound of Ikebana.

As an art production method using glass, we used a method called hot work, in which glass is melted by heat and then molded. Instead of breathing like blown glass to create a hollow shape, we twisted or hung soft glass to create various shapes. In the process, we tried to color the glass art created by adding various pigments. Figure 1 shows an example of the glass art created.



Fig. 1. Example of glass art produced

Using these glass arts as parts, we found that a beautiful table that appeals to the sensibilities can be created by creating a shape that combines multiple parts, placing it on the table, and illuminating it from the side. The table was named "Light Table" [1] [6].

We also found that a more beautiful light shape can be created using the "caustics light" developed by Mitsubishi Electric as the light source. A caustic light is a light that has the function of producing parallel rays, whereas a normal light produces dispersed light.

At the same time, when parallel rays are applied to glass or water, a collection of reflected or refracted light is generated, creating a unique and beautiful shape. This is called "caustics." Sunlight, which is far enough away from the light source, is a parallel ray, so when the sun hits the surface of the

water, a beautiful glow is formed through the waves on the surface of the water, which is an example of caustics.

Glass art made of transparent glass is suitable for creating caustics, and by using Mitsubishi Electric's caustics light as a light source, beautiful caustics, as shown in Fig. 2, are created. The slow rotation of this table changes the caustics produced over time, creating a more sophisticated shape of light.

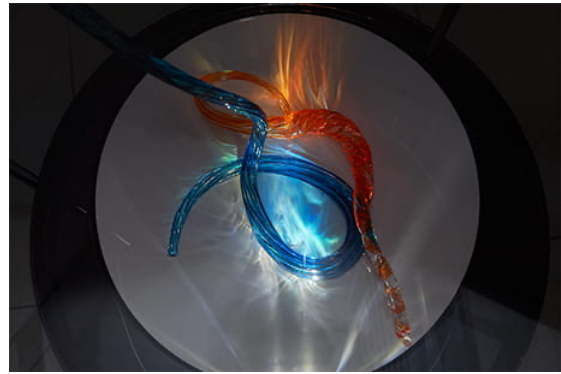


Fig. 2. "Light table" using caustics light as a light source

The light table fits well with the concept of the Kansei lighting that appeals to people's sensibilities, which was the initial goal of joint research between Kyoto University and Mitsubishi Electric. In order to examine the possibility of commercialization, which is the next stage, it is necessary to evaluate it through psychological experiments. Therefore, the experiments described in the following chapters were conducted.

### 3. Psychological evaluation experiment of Light Table

#### 3.1 Basic concept

Emotional evaluations based on psychological experiments can be divided into emotional evaluations as research at universities and emotional evaluations aimed at commercialization in companies. The former experiments attempt to analyze the characteristics of human sensibilities by setting strict conditions and analyzing the differences under different conditions in detail. The subjects are mainly university students, and the number of subjects is often limited to dozens. Therefore, there is a problem of whether the sensitivity evaluation conducted for a small number of students at a university has generality when it is extended to a large number of ordinary people.

On the other hand, sensitivity evaluation by companies is aimed at commercialization, so generality is more critical than rigor. The subjects are often significant because of the emphasis on generality. In addition, the results often belong to trade secrets and are not disclosed. As a sensibility evaluation

belonging to the latter, it is often done in a questionnaire format at product exhibitions, etc. The aim is to have them purchased as products; therefore, the evaluation items differ from the university's sensibility evaluation. Therefore, few studies have compared these two different assessments.

We aim to compare the evaluation using a small number of people at our university with that using lots of the general public as an answer to such a problem. We have already conducted experiments with a small number of subjects [1]. This time, we conducted an evaluation experiment with many people to obtain primary data for comparison between evaluation experiments with a small number of people and a large number of people.

### 3.2 Light table used for evaluation

Two types of light tables were used for the evaluation: a light table using white glass art and a light table using colored glass art in which various colors were applied to the glass. Figure 3 shows the "Light Table: White" using white glass, and Fig. 4 shows the "Light Table: Color" using colored glass.

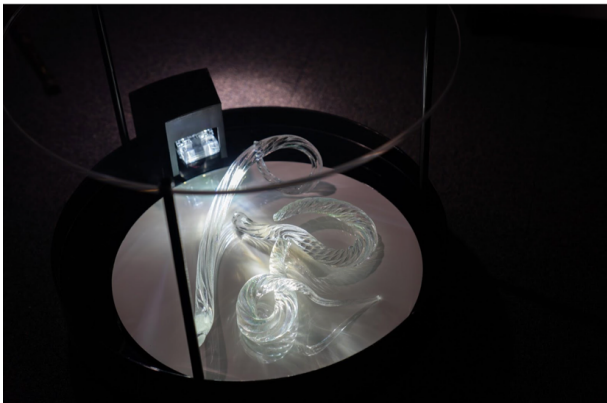


Fig. 3. Light Table: White used in the evaluation experiment.

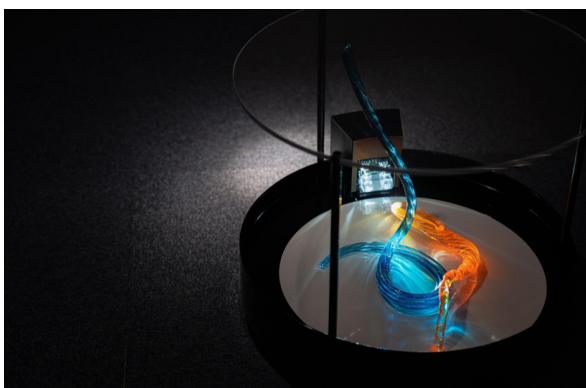


Fig. 4. Light Table: Color used in the evaluation experiment.

### 3.3 Evaluation by a small number of subjects

Apart from this experiment, we already carried out an experiment using a total of 24 students and staff from Kyoto

University (13 males, 11 females, ages the 20s - 40s) as subjects for evaluation [5] [6]. The results of this previous experiment will be compared with those of this study.

### 3.4 Evaluation by a large number of subjects

In this study, we evaluated the Light Table for many of the general public. As an exhibition place for the Light Table, we got the following opportunity to exhibit it at METoA Ginza, an exhibition space owned by Mitsubishi Electric in Ginza, Tokyo.

Title: Hope for Universe

Location: METoA Ginza

Period: January 27, 2021, to June 29, 2021

URL: <https://metoa.jp/event/hope-for-universe/index.html>

The theme is "space," developed through joint research by Kyoto University and Mitsubishi Electric. The Light Table was exhibited along with the spacecraft "Konotori" developed by Mitsubishi Electric to carry supplies to the ISS and the "misola" lighting that artificially reproduces the blue sky. Many people visited the venue during the event, and about 1,800 evaluated the "Light Table." The White and Color versions of the Light Table were exhibited in different places and were evaluated separately.

### 3.5 Evaluation item

In order to evaluate how people felt about the Light Table, we used a questionnaire and asked the subjects to fill in the questionnaire on a five-point Likert scale. The question consists of 19 items belonging to three groups: "How did you feel the lighting?" "What kind of effect does the lighting have?" "What kind of scene is the lighting suitable for?" Table 1 shows the contents of the questionnaire. These questions were determined with reference to other similar studies [7] [8] [9].

Table 1 Contents of the questionnaire

1. How did you feel about the lighting?	2. What kind of effect does the lighting have?	3. What kind of scene is the lighting suitable for?
Comfortable	I can relax – I cannot relax	Appropriate for sleeping –
Uncomfortable	I can be creative – I cannot be creative.	
Friendly – Unfriendly	I feel energetic – I do not feel energetic	
Beautiful – Not beautiful	I can face difficulty – I cannot face difficulty	
Calm – Restless	I feel refreshed – I do not feel refreshed	
Interesting – Boring		
Warm – Cold		
Changeable – Not changeable		
Luxury - Sober		
Unique - Mediocre		

	Inappropriate for sleeping
	Appropriate for eating
	Inappropriate for eating
	Appropriate for relaxing
	Inappropriate for relaxing
	Appropriate for working
	Inappropriate for working
	Appropriate for chatting
	Inappropriate for chatting

## 4. Analysis of evaluation results

### 4.1 Number of visitors

One thousand eight hundred seventy-five of the visitors evaluated the light table.

### 4.2 Gender

Figure 5 shows a graph of the genders of the people who answered the questionnaire. About 70% are female, and about 30% are male.

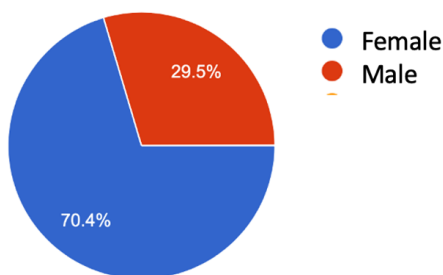


Fig. 5. Evaluator Gender

### 4.3 Average value for each evaluation item

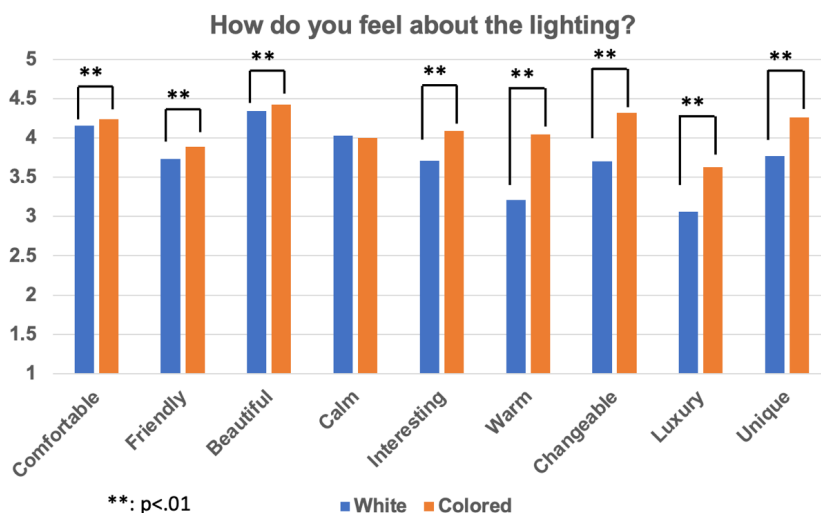


Fig. 6. Average value of evaluation results for "How did you feel about the lighting?"

As is shown in Table 1, the questions are classified into three

groups; "How do you feel about the lighting?", "What kind of effect does the lighting has?" and "What kind of scene is the lighting suitable for." Figures 6, 7, and 8 show each group's graphs. Each graph also shows the result of the t-test (\*\*:  $p < .01$ ).

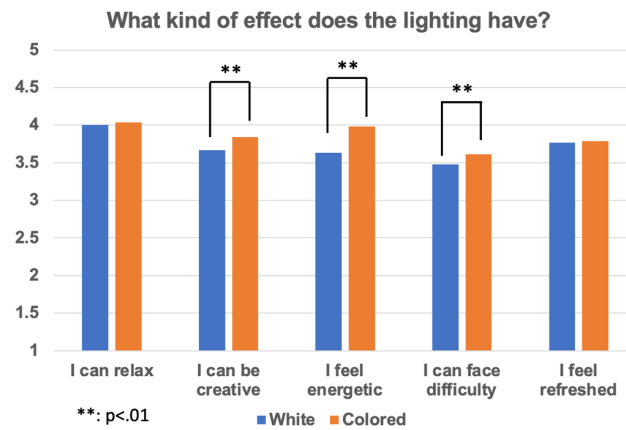


Fig. 7. Average value of evaluation results for "What kind of effect does the lighting have?"

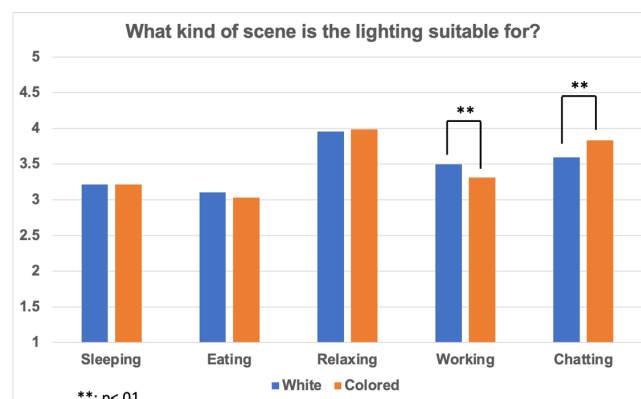


Fig. 8. Average value of evaluation results for "What kind of scene is the lighting suitable for?"

### 4.4 Consideration about "How do you feel about the lighting?"

For all evaluation items and both White and Color, the average value of the evaluation values (from now on referred to as "evaluation value") is higher than three or the median value, which means a good evaluation is obtained.

For the White, "Beautiful" had the best evaluation value, followed by "Comfortable" and "Calm," and these three items out of nine

items got an evaluation value of 4 or more. On the other hand, for Color, "Beautiful" had the best evaluation value, and "Changeable," "Unique," "Comfortable," "Interesting," and "Warm" followed. A total of 6 items have an evaluation value

of 4 or more. This is because the change that appears in the caustics created by using the colored glass contributed to the evaluation value.

When we performed a t-test on the difference between White and Color, we found that for the items "Comfortable," "Friendly," "Beautiful," "Interesting," "Warm," "Changeable," "Luxury," and "Unique" Color have a significantly higher rating than White (Comfortable:  $t(3598.3) = 2.93$   $p < .01$ , Friendly:  $t(3613.7) = 4.63$   $p < .01$ , Beautiful:  $t(3614.8) = 3.26$   $p < .01$ , Interesting:  $t(3528.7) = 11.4$   $p < .01$ , Warm:  $t(3341.8) = 23.7$   $p < .01$ , Changeable:  $t(3342.5) = 18.7$   $p < .01$ , Luxury:  $t(3642.6) = 16.4$   $p < .01$ , Unique:  $t(3432.2) = 15.3$   $p < .01$ ). Regarding "Calm," there was no significant difference between White and Color. The results showed that Color was significantly superior to White in almost all items.

#### 4.5 Consideration on "What kind of effect does the lighting have?"

Here, too, all the evaluation values are three or more, which means a good evaluation is obtained. The best evaluation value was "I can relax" in White and Color, with an evaluation value of four or higher. However, there are no other evaluation items of four or more, and all have evaluation values between three and four.

For White, "I can relax," "I feel energetic," and "I can be creative" are in descending order of evaluation value. For Color, "I can relax," "I feel energetic," and "I can be creative" are in descending order of evaluation value. Interestingly, the item "I can be creative" comes in third place both for White and Color. This means that even in the work scene, the Light Table is effective in coming up with ideas.

For the comparison between White and Color, for the items "I can be creative," "I feel energetic," and "I can face difficulties," Color is significantly higher than White (I can be creative:  $t(3623.9) = 5.03$   $p < .01$ , I feel energetic:  $t(3594.3) = 10.4$   $p < .01$ , I can face difficulties:  $t(3644.0) = 3.95$   $p < .01$ ). On the other hand, there was no significant difference in "I can relax" and "I feel refreshed." These results show that there is no difference between White and Color when one wants to take a rest, but Color is superior to White when one needs a positive mind, such as working.

#### 4.6 Consideration on "What kind of scene is lighting suitable for?"

Here, the evaluation values are all three or more, which means a good evaluation is obtained.

However, both for White and Color, the evaluation results for evaluation items such as "Sleeping" and "Eating" are 3 to 3.5,

which is not very high. This is because "Eating" and "Sleeping" are both physiological desires. Kansei lighting, such as the Light Table, does not directly satisfy physiological but mental desires such as emotions. At the same time, it is interesting that the item "Working" is more highly evaluated than "Eating" and "Sleeping." Combined with the relatively high evaluation of the item "I can be creative" mentioned earlier, the Light Table may also be effective in work situations. Applying the Kansei lighting to work situations will be an issue for future study.

A comparison between White and Color shows that White is significantly superior to Color in "Working" ( $t(3651.2) = 4.67$   $p < .01$ ). On the other hand, regarding "Chatting," Color is significantly superior to White ( $t(3646.5) = 6.31$   $p < .01$ ).

### 5. Conclusion

It is an exciting question in psychological experiments whether the results of psychological experiments conducted in a university laboratory for a small number of students can be extended to a large number of ordinary people. In this study, as part of the study on this problem, we reported the results of a psychological evaluation experiment on many subjects, targeting the Kansei lighting that combines glass art and lighting.

When the Kansei lighting was exhibited to the general public, we asked visitors to become subjects and conducted a questionnaire survey. The number of visitors who answered the questionnaire was about 1,800, two orders higher than the psychological experiments conducted at universities using only dozens of students.

Two types of glass lighting, one using white glass and the other using colored glass, were used for comparison. We also added some discussions to the results.

We have already conducted experiments on a small number of people under almost the same conditions. So, as a next step, we will conduct a detailed comparison between the results of this psychological experiment and that of a small number of people.

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