



Difference in Relaxation Effect of Planetarium Depending on Women's Menstrual Cycle after Working

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Abstract. In recent years, the symptoms associated with menstrual cycle, including premenstrual syndrome (PMS) which lead to poor body condition and their effects on daily life and work have been recognized as a health problem distinctive to women. There are various coping methods to improve PMS symptoms, and stress management is also important for this improvement. It is said that to manage stress, you must be aware of it, and must adopt a relaxation method suitable for you to relax your mind and body. This study examined the difference in the relaxation effects of planetarium watching after work with regard to working women during their menstrual cycle. Twenty women in their 20s and up to their 40s were the participants, and they were classified into three groups: pre-menstrual, menstrual, and another period; verification was done using two planetarium programs. Results suggested that premenstrual women showed a rapid increase in body surface temperature while watching the program, and this was not limited to the program structure. In addition, analysis results of POMS2 revealed there were significant decreases in Confusion-Bewilderment, Tension-Anxiety, and TMD scores after planetarium watching. Accordingly, the planetarium could have relaxation effects for women during premenstrual period.

Keywords. premenstrual, menstrual cycle, planetarium, relaxation, heart rate variability, body surface temperature, POMS2

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1 Introduction

In recent years, the symptoms associated with the menstrual cycle leading to poor body condition and their effects on daily life and work have been recognized as a health problem distinctive to women. In corporations, the “health management” initiative promoted by the Ministry of Economy, Trade, and Industry is spreading, and efforts related to women’s health issues, including menstrual symptoms such as premenstrual syndrome (PMS), are becoming widespread [1].

The impact of working women’s PMS on their work performance is, according to the Ministry of Economy, Trade, and Industry’s survey on “Actual Conditions of Working



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Women's Health Promotion," perceived as follows: about 40% of working women recognize that their efficiency is decreased, but not to the extent that they need to take leave [2]. PMS refers to various mental and physiological disorders that take place three to ten days before the start of menstruation. Depending on the intensity of the symptoms, there are various coping methods such as self-care and treatments from medical institutions. It has also become clear that stress management is important to alleviate PMS symptoms [3].

Generally, in stress management, it is better to be aware of your own stress and to adopt methods of relaxation that suit your own mind and body. Typical relaxation methods used in stress management include autonomic training, muscle relaxation, abdominal breathing, mindfulness; other methods include aromatherapy, yoga, massage, listening to your favorite music, and touching nature [4]. The relaxation method is aimed at adjusting the function of the autonomic nerve and adjusting the appropriate balance. Recently, stress relaxation effect using sensory stimuli such as music, natural images, aromatherapy have been revealed [5-7]. On the other hand, foot baths with aromatherapy are said to help reduce the pain and unpleasant moods that are often associated with PMS symptoms [8].

However, it has not yet been revealed whether the use of various sensory stimuli that can have a relaxation effect is actually effective during the premenstrual period. In addition to trying these relaxation methods as self-care at home and at work, it is expected that they will be used in facilities such as planetariums, aquariums, and movie theaters. Nevertheless, the relaxation effects of the facilities have not been clarified or disclosed.

Previously, planetarium facilities were often used for astronomical watching and learning purposes. In contrast, recent planetarium programs have been developed based on a variety of concepts such as healing, science, fantasy, and powerful image, based on the needs of visitor surveys. However, their relaxation effect is yet to be verified [9].

Our first study focused on planetarium watching as one of the methods women could use to relieve stress after work; we examined its relaxation effects in the menstrual cycle for 20 working women between their 20s and 40s. Heart rate variability and body surface temperature were adopted as physiological responses to verify the effect. The effect was then analyzed from the measurement results while watching the planetarium program [10].

In this study, to clarify the difference in relaxation effects depending on the menstrual cycle of working women during watching of the planetarium after work, we analyzed using these physiological responses and psychological responses obtained by POMS2® (Profile of Mood States 2nd Edition for adults: Japanese short-version) results acquired before and after watching the program.

2 Experimental Methods

2.1 Outline of the experiments

To verify the difference in relaxation effects associated with women's menstrual cycles, we conducted an experiment with 20 working women between their 20s and 40s. In this study, we used two different planetarium programs to verify this effect in three groups classified according to menstrual cycle. Table 1 shows an outline of the experiments.



Table 1. Outline of the experiment

Experiment Place	Konica Minolta Planetarium “TENKU” in TOKYO SKY TREE TOWN®
Planetarium Program	Used two planetarium programs based on Healing [Program I and Program II]
Participants	20 working women [age, between 20s and 40s]
Classification of participants	Classified into 3 Groups according to their menstrual cycle - Group A: Premenstrual Period (1 to 10 days before the start of menstruation) - Group B: Menstrual Period (1st to 7th days of menstruation) - Group C: Another period (From the 8th days of menstruation to 11 days before the next menstruation)
Number of Experiments	2 times to each participant *In this experiment, considering the menstrual cycle of the participants, the first experiment and the second experiment were about two weeks apart.
Experiment timing	About 90 minutes. - Preparation for experiment: 30 min. - Experiment in a planetarium facility: about 55 min. - After the experiment: 5 min. *Experiment conducted in the general screening timing of 1 hour.
Physiological Responses	- Body surface temperature, - Heart Rate and Heart Rate variability (LF/HF) *These responses detected by Wearable Heart Rate Sensor WHS-1 (Union Tool Co., Ltd.) and Body surface temperature was analyzed based on data obtained from this sensor. (Detected with 12-bit resolution : in units of 0.0625 degree) *LF/ HF was analyzed using analysis software. (WIN Frontier Co., Ltd.)
Psychological Responses	POMS2 (Profile of Mood States 2nd Edition for adults: Japanese short-version) results; Acquired before and after watching planetarium program.
Menstruation related Information	- Last menstruation start date - Menstrual cycle
Experimental Procedure	The experiment was conducted each time according to the following procedure. [Before planetarium watching] Step 1: Check menstruation-related information Step 2: Attached WHS-1 (directly to the skin to the left chest) Step 3: Answer the POMS2 [before the planetarium] [Experiment in a planetarium facility] Step 4: Move to the planetarium “TENKU” Step 5: Sitting reclining seat and keep calm (about 10 min.) Step 6: Watching the Planetarium program (about 40 min. / Program I or II) Step 7: Answer the POMS2[after the Planetarium] [Before planetarium watching] Step 8: Move out the “TENKU” Step 9: Removing WHS-1



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2.2 Experimental place and Selected planetarium program

The experiment was conducted at Konica Minolta Planetarium “TENKU” in TOKYO SKY TREE TOWN® [11] after participants finished work on a weeknight. We conducted experiments by selecting two programs with higher Healing scores from all the planetarium programs that were generally shown in “TENKU.” Figures 1-2 show the feature of the selected planetarium program (Program I and Program II).

“TENKU” shows various planetarium programs every one hour. We conducted the experiments at weeknight using the general screening timing. In addition, “TENKU” has 189 general seats, we used the last two rows for this experiment.

2.3 Classification of participants

To verify the difference in relaxation effects associated with women's menstrual cycles in this study, the women were classified into three groups based on their menstrual cycle: from one to ten days before the start of menstruation (premenstrual period: Group A); from the first to the seventh day of menstruation (menstrual period: Group B); those that do not fall under A or B, from eight to eleven days before the start of the next menstruation (premenstrual, another period other than menstruation: Group C). The experimental participants were classified into three groups based on the obtained menstrual cycle information, and the relaxation effect of the planetarium for each group was verified.

Figure 3 shows the classification of participants according to their menstrual cycle.

The image shows a promotional graphic for a planetarium program. At the top, Japanese text reads: 'きみに乗せた この列車の向かう先には 美しい星空が待っている ~Ticket to Starry Night~'. Below the text is a photograph of a steam train crossing a stone bridge over a river at night, with a starry sky in the background. At the bottom left, there is a 'Feature of program' table. At the bottom right, there is a 'Details' box containing a description of the program and its screening time.

Feature of program	
Science	★★★★★
Healing	★★★★★
Starry sky, constellation	★★★★★
Powerful image	★★★★★
Fantasy	★★★★★

【Details】
Screening time: about 42min.
A program that enhances healing effects by using two types of aromas in addition to the combination of an optical starry sky and digital videos. It features content that allows guests to escape their daily lives and experience the feeling of immersion in a beautiful world of starry skies that spreads through the night sky, and nostalgic railway scenery, while being rattled by the motion of a train.

Fig. 1 Characteristics of the selected planetarium program I



Feature of program	
Starry sky, constellation	★★★★★
Science	★★★★★
Healing	★★★★★
Powerful image	★★★★★
Fantasy	★★★★★

【Details】
 Screening time: about 36min.
 A program that combines an optical starry sky and digital videos. It features content that allows guests to feel as if they have traveled to France using live-action videos such as a night view of Paris over the Seine, Mont Saint Michel floating in the night sky, and a beautiful view of the sky full of stars as seen from the Pic du Midi de Bigorre, and so forth.

Fig. 2 Characteristics of the selected planetarium program II

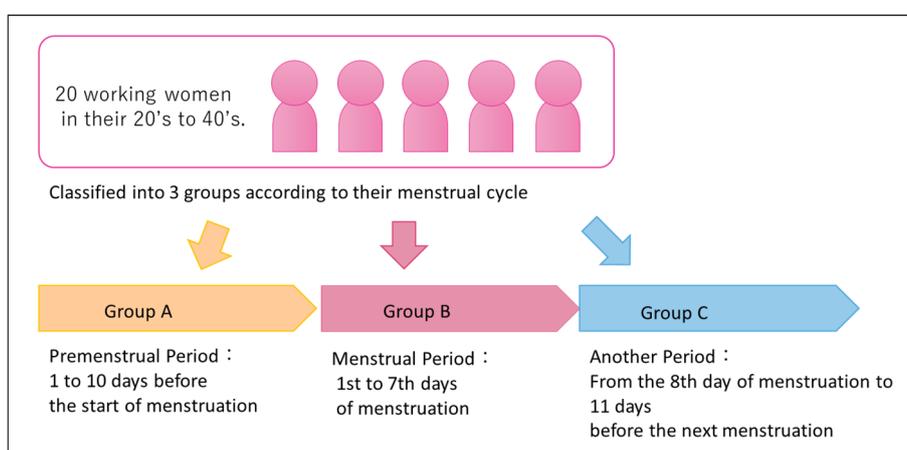


Fig. 3 Classification of participants into three groups according to their menstrual cycle

Table 2. Number distribution of the 3 groups according to their menstrual cycle

Planetarium Program	Group A	Group B	Group C	Total
Program I	6	9	5	20
Program II	8	5	7	20

Participants in the experiment were selected from 20 women in their 20s to 40s who experience regular menstruation; two experiments were conducted per person after obtaining their consent with the details of the experiment and handling of personal information. In this experiment, considering the menstrual cycle of the participants, the first experiment and the second experiment were about two weeks apart.

Table 2 shows the results of the two experiments using two Planetarium programs, classified into three groups according to the menstrual cycle based on the information obtained from each of the participants at the start of each experiment.

2.4 Physiological responses

To verify the relaxation effect, body surface temperature, heart rate, and heart rate variability analysis results were selected as quantitative evaluation indices of physiological



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responses. These physiological responses were detected by Wearable Heart Rate Sensor WHS-1 (Union Tool Co., Ltd.) [12].

Before the experiment in the planetarium "TENKU," WHS-1 was attached to each participant's skin on their left lower chest directly using a gel pad, and then covered with their own underwear and shirt or blouse throughout the experiment. Body surface temperature in this study refers to the temperature measured at the part where WHS-1 was attached to the participant during the experiment. WHS-1 can detect the temperature with a resolution of 0.0625 °C (12 bits), therefore we used the obtained data for analysis. On the other hand, heart rate variability was analyzed by means of a dedicated software (WINFrontier Co., Ltd.) using heart rate data acquired by this sensor.

The heart rate variability analysis results mentioned above are based on the heart rate information obtained by the sensor, and the frequency analysis method [13] was used to calculate the low-frequency component (LF: 0.04Hz ~ 0.15Hz) and high-frequency component (HF: 0.15Hz~0.4Hz). The ratio of LF according to HF of the heart rate variability (LF/HF) has been used as an index reflecting sympathetic nervous system activity balance. LF/HF was used as an index to indicate tension, concentration, excitement, and morale.

In general, it has been clarified that when a person feels stress or is in a state of tension, sympathetic nerves become the predominant state, thereby reducing blood flow in the skin temperature. On the other hand, when a person is in a relaxed state, parasympathetic nerves become the predominant state, thereby increasing blood flow in the skin temperature. The relationship between the increase in skin temperature and the relaxation effect has been used for the verification of care in the nursing field. Furthermore, the relationship between the increase in skin temperature or body surface temperature and the relaxation effect has been clarified in reports on the effect of increasing the skin temperature when the part different from the measurement site is warmed [14] and the effect of increasing the skin temperature after massage [15]. In addition, the possibility of a relaxation effect due to an increase in body surface temperature using music has been suggested [5].

In this study, the trend of decrease in LF/HF and the trend of increase in body surface temperature were checked to verify the relaxation effect.

2.5 Psychological responses

To detect psychological responses, we used POMS2 (Profile of Mood States 2nd Edition for adults: Japanese short version).

POMS2 consists of the seven subscales of [Anger-Hostility (AH)], [Confusion-Bewilderment (CB)], [Depression-Dejection (DD)], [Fatigue-Inertia (FI)], [Tension-Anxiety (TA)], [Vigor-Activity (VA)], and [Friendliness (F)]. The abridged version consists of five items for each subscale, and a five-level rating scale for each of the 35 items. Since it is a mood profile test method that can also calculate a [TMD score] that comprehensively represents negative mood states [16].

Generally, POMS2 is used to determine relaxation effects in experimental studies. Therefore, in this study, we used it to confirm the participant's mood changing as psychological responses of before and after planetarium watching.

2.6 Acquisition timing of data used for analysis

In this study, as described above, experiments were conducted using two different planetarium programs with different screening times (one was about 36 min and the other was about 42 min). In order to verify the effects of planetarium watching, four scenes



(SCENE1, SCENE2, SCENE3, SCENE4) were extracted and analyzed. Figure 4 shows the screening times of two planetarium programs and SCENE extraction.

The experiment was performed twice, 90 minutes each. Participants gathered in the waiting room near the “TENKU” facility, and checked the menstrual cycle, attached the WHS-1 sensor, answered the POMS2 before watching the planetarium, and moved to “TENKU.” The experimental procedure acquired data and acquisition timing of data in this study are shown in Figure 5.

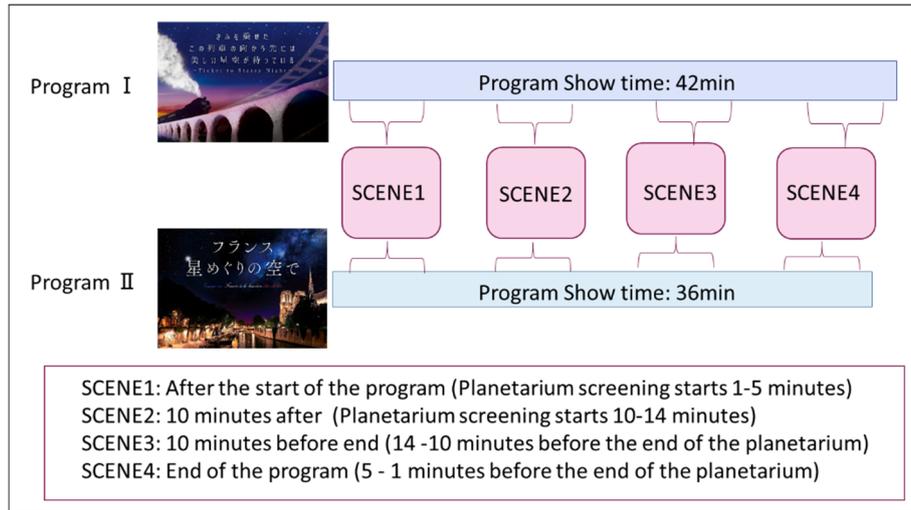


Fig. 4 Screening times of two planetarium program and SCENE extraction

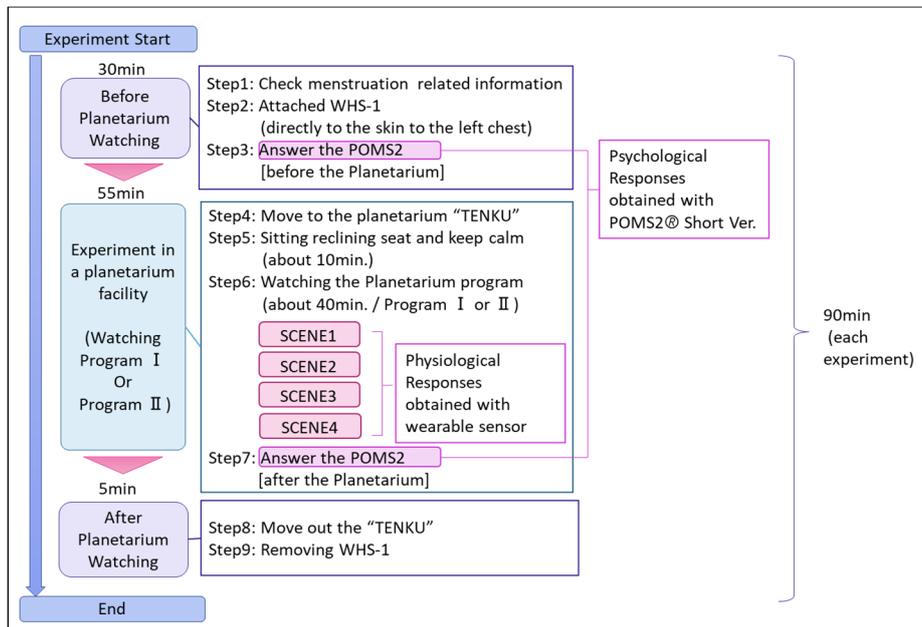


Fig. 5 Experimental procedure and acquisition timing of data used for analysis



3 Results

The differences in relaxation effects on the menstrual cycles of the 20 participants during the two experiments using planetarium programs I and II were analyzed based on the quantitative evaluation indices of body surface temperature, heart rate, sympathetic nerve activity (LF/HF) and subjective evaluation results using the abridged version of POMS2 (Profile of Mood States 2nd Edition) for Adults.

3.1 Analysis result of Physiological responses

The trend of changes in body surface temperature, heart rate, and LF/HF from the start to the end of planetarium watching were analyzed based on the average number of people corresponding to the three groups as shown in Table 2. IBM SPSS Statistics Subscription was used in the analysis with a significance level of 5%. The results of the body surface temperature and LF/HF show the following trends. Note that there was no significant change in heart rate during program watching.

3.1.1 Body Surface Temperature Trends

From the analysis results, in both programs I and II, all the groups had tendencies for body surface temperature to increase between the start and the end of planetarium watching. Groups A and B, in particular, showed a significant increase in temperature.

For Group A, who were within one to ten days before menstruation, the body surface temperature showed a significant increasing trend between SCENE1 and SCENE2 from the difference in mean values. Based on this, an increase in temperature could be observed early from the start of the planetarium watching in both programs, and the temperature increase is larger for Group A than Groups B and C.

On the other hand, for Group B, who were within one to seven days of menstruation, the timing in which the difference in temperature increase became significant differed depending on the program. In Program I, a significant temperature increase was observed early on, similar to Group A; meanwhile, in Program II, a significant temperature increase was observed in SCENE4 just before the end of the program.

Note that the WHS-1 sensor used to measure body surface temperature had been attached to each participant for at least 20 minutes before planetarium watching. The experiment had started after a sufficient time had elapsed since the sensor was attached. Therefore, the result of this body surface temperature increase was thought to be influenced by physiological responses caused by planetarium watching. Table 3 and Figures 6-7 show the results.

Table 3. Increase in body surface temperature from SCENE1 (Ave.)

Planetarium Program	Group	SCENE1	SCENE2	SCENE3	SCENE4
Program I	A	30.347	+0.818 °C *	+1.333 °C	+1.320 °C
	B	29.883	+0.539 °C *	+1.358 °C	+1.847 °C
	C	30.232	+0.743 °C	+1.205 °C	+1.353 °C
Program II	A	29.832	+0.963 °C *	+1.088 °C	+1.128 °C
	B	30.119	+0.033 °C	+0.221 °C	+0.772 °C *
	C	29.758	+0.112 °C	+0.421 °C	+0.708 °C

*p<0.05

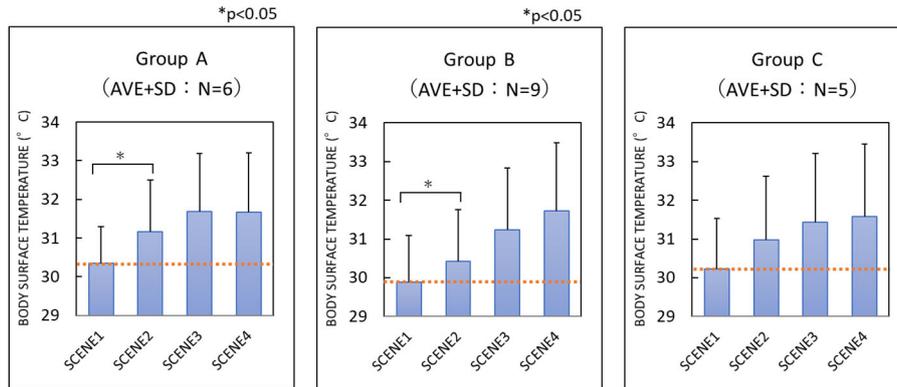


Fig. 6 Body surface temperature of participant by each SCENE of Program I (Ave + SD)

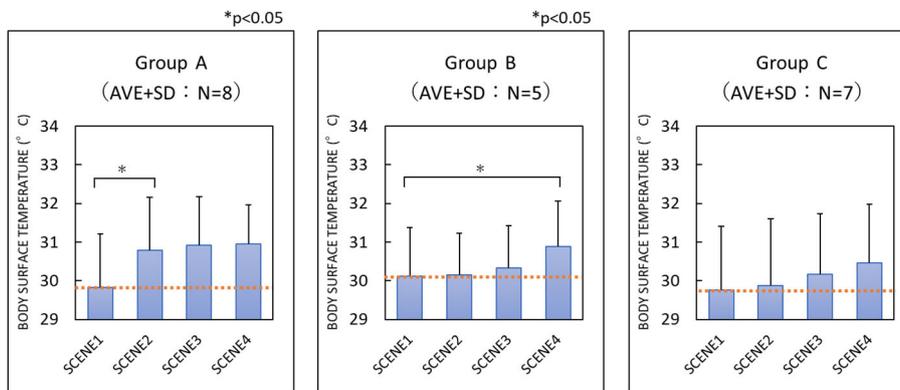


Fig. 7 Body surface temperature of participant by each SCENE of Program II (Ave + SD)

3.1.2 Sympathetic Nerve Activity (LF/HF) Trends

From the analysis results, in both programs I and II, Group A had a tendency to have a low average value of LF/HF with little variation in any of the SCENES compared to Groups B and C. On the other hand, LF/HF tended to be higher in Group C, who were within the period other than before and during menstruation. Furthermore, there was a tendency for the variation to be larger during program II in Group C.

In addition, these three groups had different LF/HF value trends at the time of SCENE1 in Both programs I and II. SCENE1 refers to one to five minutes after the start of planetarium watching. These results suggest that the feeling of the relaxation effect in each group may be different at an early timing after starting the planetarium watching.

Table 4 and Figures 8-9 show the results.



Table 4. LF/HF measurement results for each SCENE (Ave + SD)

Planetarium Program	Group		SCENE1	SCENE2	SCENE3	SCENE4
Program I	A	AVE	0.82	1.19	1.47	1.17
		SD	0.58	0.70	0.72	0.57
	B	AVE	1.75	1.89	1.81	2.08
		SD	1.20	1.59	1.51	1.88
	C	AVE	1.50	1.36	2.69	1.26
		SD	0.88	1.03	2.34	0.40
Program II	A	AVE	1.04	0.80	1.14	0.79
		SD	0.61	0.36	0.47	0.32
	B	AVE	1.87	1.32	1.40	1.24
		SD	1.46	0.83	0.81	0.65
	C	AVE	3.28	2.64	2.96	1.96
		SD	2.70	2.41	3.08	1.52

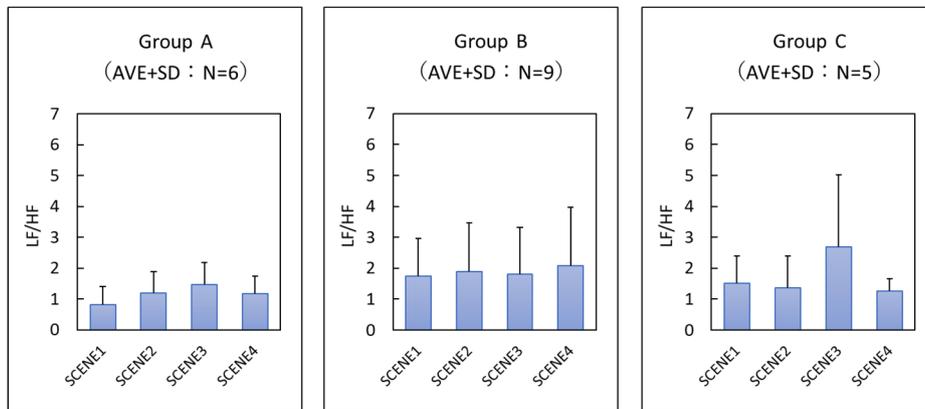


Fig. 8 LF/HF of participant by each SCENE of Program I (Ave + SD)

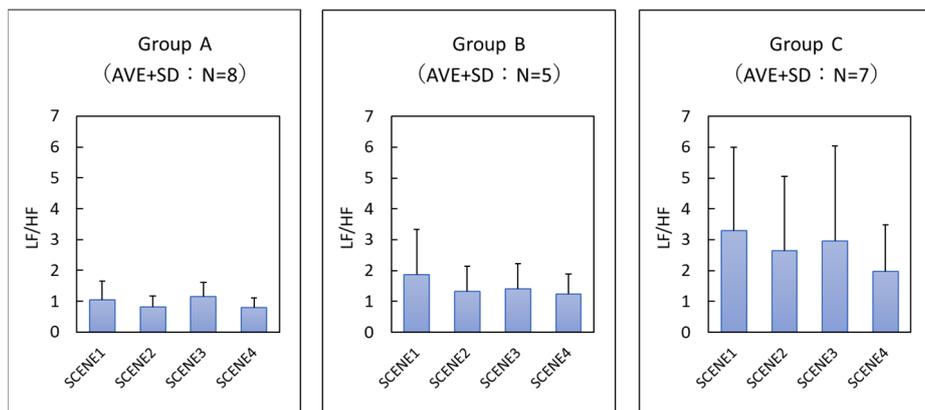


Fig. 9 LF/HF of participant by each SCENE of Program II (Ave + SD)

3.2 Analysis result of Psychological responses

For the results of the seven scales [Anger-Hostility (AH)], [Confusion-Bewilderment (CB)], [Depression-Dejection (DD)], [Fatigue-Inertia (FI)], [Tension-Anxiety (TA)], [Vigor-Activity (VA)], and [Friendliness (F)] from the mood profile test (POMS® 2:



Profile of Mood States 2nd Edition Japanese Version, Abridged version for Adults) obtained from the participants before and after watching program I and II, and the [TMD score results] that comprehensively represent negative mood states, the average values were comparatively analyzed using IBM SPSS Statistics Subscription for each of the three groups classified by menstrual cycle.

3.2.1 Trends in Group A (Group between one to ten days before the start of the menstrual period)

For Group A, [Confusion-Bewilderment (CB)], [Tension-Anxiety (TA)], and the [TMD score] decreased significantly after watching program I. In addition to the above scales, [Depression-Dejection (DD)], [Fatigue-Inertia (FI)], and [Vigor-Activity (VA)] de-creased significantly after watching program II.

Table 5 and Figures 10-11 show the results.

Table 5. Comparison of POMS2 Before and After (Group A: Program I, II)

Planetarium Program	Group	AH	CB	DD	FI	TA	VA	F	TMD	
Program I (Group A)	Before	AVE	1.8	5.0	2.5	5.7	3.8	9.5	10.8	9.3
		SD	2.2	5.2	2.6	3.2	4.4	3.7	3.8	12.6
	After	AVE	0.7	1.8	0.8	2.7	1.8	7.2	10.5	0.7
		SD	1.5	3.7	1.2	2.2	4.1	5.1	3.3	8.1
Program II (Group A)	Before	AVE	2.4	6.3	2.5	6.4	5.6	8.6	11.6	14.5
		SD	2.7	2.5	2.2	3.7	3.5	4.2	3.0	11.8
	After	AVE	0.5	2.4	1.1	3.0	1.8	7.5	10.5	1.3
		SD	1.0	1.7	1.5	2.5	2.0	5.5	4.0	6.6

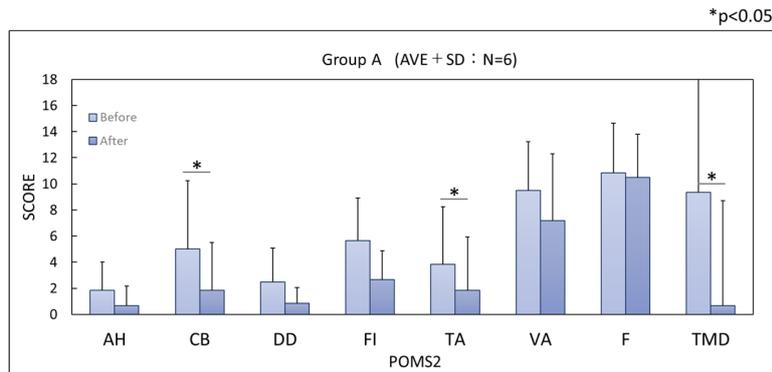


Fig. 10 Comparison of POMS2 before and after Program I (Group A)

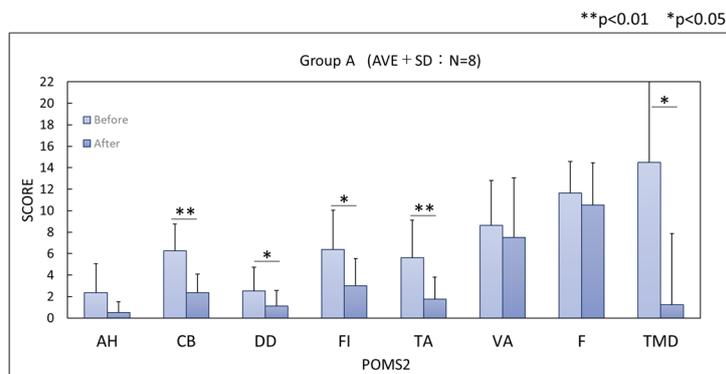


Fig. 11 Comparison of POMS2 before and after program II (Group A)



3.2.2 Trends in Group B (Group between the first and seventh day of the menstrual period)

For Group B, [Anger-Hostility (AH)], [Tension-Anxiety (TA)], and the [TMD score] decreased significantly after watching program I. In addition to these scales, [Vigor-Activity (VA)] tended to decrease significantly after watching program II.

Table 6 and Figures 12-13 show the results.

Table 6. Comparison of POMS2 Before and After (Group B: Program I, II)

Planetarium Program	Group		AH	CB	DD	FI	TA	VA	F	TMD
Program I (Group B)	Before	AVE	3.4	5.2	2.9	7.2	4.9	7.4	10.2	16.2
		SD	4.3	4.1	4.0	5.6	2.5	3.7	2.2	19.1
	After	AVE	1.9	2.2	2.2	3.4	1.8	7.6	9.6	4.0
		SD	3.9	3.2	3.2	4.1	2.1	4.6	4.2	16.1
Program II (Group B)	Before	AVE	9.2	5.6	5.8	9.2	6.8	9.4	9.4	27.2
		SD	4.6	3.3	3.7	4.7	3.5	3.7	3.6	17.6
	After	AVE	4.2	6.2	4.8	5.8	5.0	8.4	9.4	17.6
		SD	4.2	4.2	2.8	4.1	2.8	3.6	3.7	16.2

**p<0.01 *p<0.05

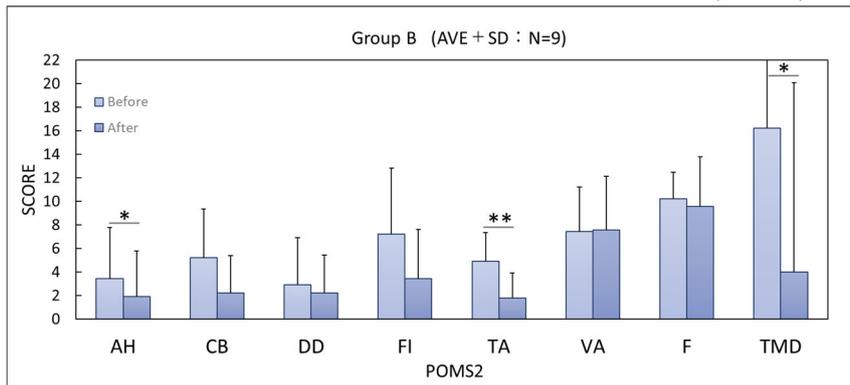


Fig. 12 Comparison of POMS2 before and after Program I (Group B)

**p<0.01 *p<0.05

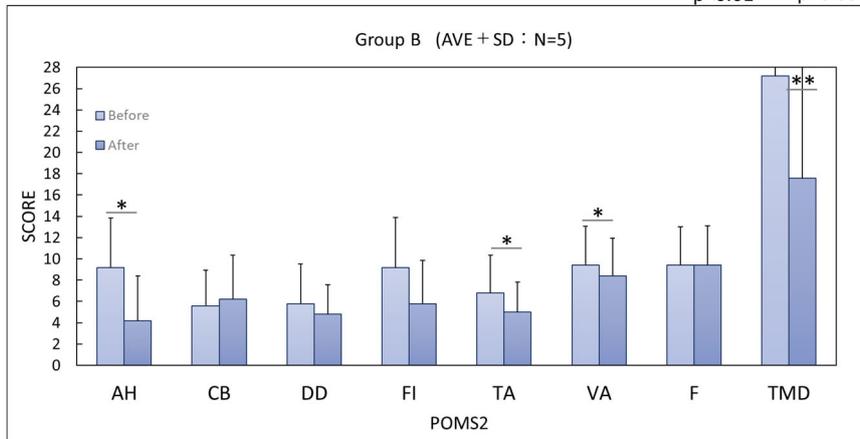


Fig. 13 Comparison of POMS2 before and after Program II (Group B)



3.2.3 Trends in Group C (Group between eight to eleven days after the start of the menstrual period)

In Group C, all evaluation scales tended to decrease after watching compared to before watching both programs I and II, but there was no significant difference in program I. On the other hand, in program II, a significant decrease was observed in [Confusion-Bewilderment (CB)] and [Fatigue-Inertia (FI)], while [Vigor-Activity (VA)] tended to decrease significantly. Table 7 and Figs. 14-15 show the results.

Table 7. Comparison of POMS2 Before and After (Group C: Program I, II)

Planetarium Program	Group	AH	CB	DD	FI	TA	VA	F	TMD	
Program I (Group C)	Before	AVE	4.2	6.6	3.6	8.0	8.0	8.4	10.8	22.0
		SD	3.5	3.9	2.0	3.3	4.6	5.0	4.0	11.9
	After	AVE	0.8	3.4	2.2	4.6	4.0	7.2	10.2	7.8
		SD	1.6	2.7	1.3	2.9	3.5	5.5	3.7	5.1
Program II (Group C)	Before	AVE	2.6	2.3	1.9	4.0	2.1	8.6	10.1	4.3
		SD	3.5	1.5	1.6	1.9	2.0	2.9	3.3	10.1
	After	AVE	0.0	0.1	0.6	1.0	0.3	4.3	8.0	-2.3
		SD	0.0	0.3	0.5	1.4	0.5	1.8	3.4	2.4

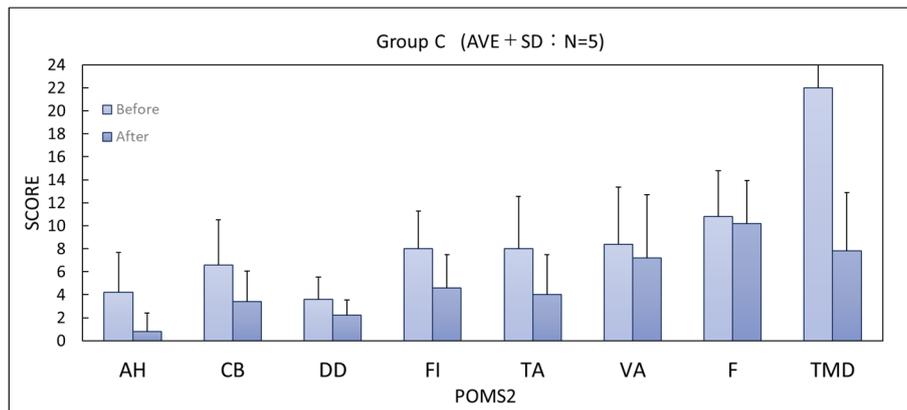


Fig. 14 Comparison of POMS2 before and after Program I (Group C)

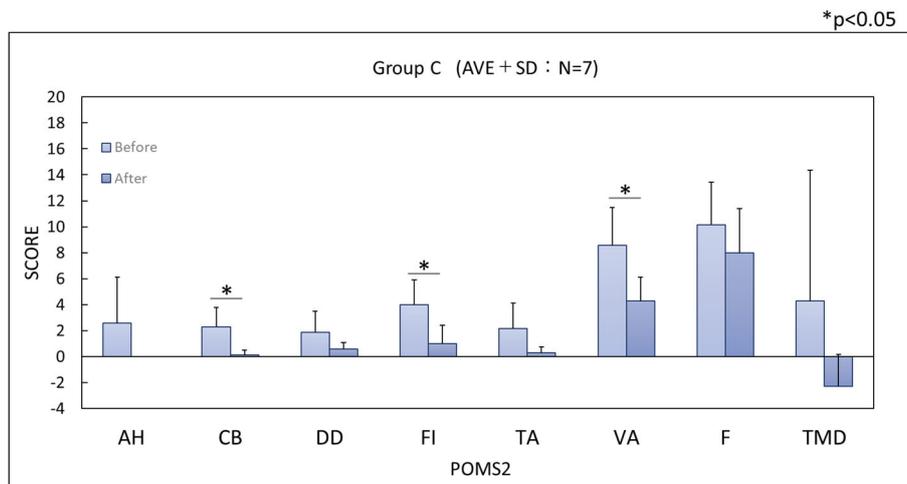


Fig. 15 Comparison of POMS2 before and after Program II (Group C)



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4 Discussion

The differences in the relaxation effect of planetarium watching for the three groups classified according to menstrual cycle were considered based on the analysis results of a quantitative evaluation index (body surface temperature, LF/HF) and a subjective evaluation index (POMS2).

4.1 Differences in the relaxation effect for 3 Groups

Both Physiological and Psychological responses showed different characteristics for each of the groups: Group A, Group B, and Group C.

First, in Physiological responses, regarding Body surface temperature, the temperature increases of Group A tended to be significantly higher between SCENE1 and SCENE2. On the other hand, Group C showed a moderate upward trend. Regarding LF/HF, Group A showed a lower LF / HF and lower standard deviation during planetarium watching as compared with other groups. In addition, in SCENE1, the three groups showed different characteristics.

Generally, the lower the LF / HF value brings a feeling of relaxation. Moreover, the LF/HF value tends to be low at rest and tends to be lower during sleep than when waking [17]. Therefore, the trend of Group A suggest that participants of this group might have the most relaxing effect and keep a relaxed condition during each program. We considered that one of the reasons Group A had maintained low HF / LF value was that they have watched the planetarium with their seats reclining. On the other hand, LF/HF becomes higher when concentrated, besides when in a stress state. From the trends of Group C, we considered that participants of this group had a large variation in the effects on planetarium watching and might have concentrated on the program content.

Then, the results of Psychological responses also suggest similar results to Physiological responses. From the results of POMS2, Group A had the largest number of subscales with significant differences, while the number of subscales with significant differences in the order of Group B and Group C decreased. In addition, the POMS2 results showed different characteristics of each group. In Group A, [Confusion-Bewilderment (CB)] was significantly decreased both programs I and II, whereas in Group B, [Anger-Hostility (AH)] was significantly decreased. These results suggested the mood changes brought about by planetarium watching might differ depending on the menstrual period.

Furthermore, the two planetarium programs used in this study both added the concept of healing, however, POMS2 results suggest that all groups feel relaxation effects in Program II than in Program I.

From the results above, in comparison to the three groups, it is evident that planetarium watching has more relaxation effects for premenstrual women, and has a certain degree of relaxation effects for women during menstruation, and limited relaxation effects for women during other periods. The relaxation effect of each group is described below.

4.2 Effectiveness Verification in Group A (Group between one to ten days before the start of the menstrual period)

The rapid increase in body surface temperature and the low tendency in LF/HF for Group A in both programs I and II suggest that there is an immediate relaxation effect for women in this period.

In addition, for this group, the subjective evaluation results using POM2 are: after planetarium watching of either program, significant decreases were observed in the



overall mood assessment [TMD score], except for negative emotions [Confusion-Bewilderment (CB)] and [Tension-Anxiety (TA)]. In Program II, significant decreases were also observed in [Depression-Depression (DD)], [Fatigue-Inertia (FI)], and [Vigor-Activity (VA)]. These results suggest that Group A feels more relaxed than other groups.

4.3 Effectiveness Verification in Group B (Group between the first and seventh day of the menstrual period)

Group B showed a significant increase in body surface temperature from the start to the end of the planetarium watching in both Programs I and II, but the increased timing varied depending on the program. In addition, from the subjective evaluation results using POMS2, while significant decreases in [Anger-Hostility (AH)], [Tension-Anxiety (TA)] and the [TMD score] between before and after watching either of the two planetarium programs were observed.

Furthermore, a decreasing trend in positive emotion [Vigor-Activity (VA)] was observed in Program II. It is possible that these results were brought by the experimental environment that participant could rest for a certain period of time while watching a planetarium program at night of the end of work.

In program II, LF/HF had a tendency to decreasing trend from the start of the program to the end. These results suggest that a constant relaxation effect can be achieved even during menstruation.

4.4 Effectiveness Verification in Group C (Group between eight to eleven days after the start of the menstrual period)

In Group C, the results of the subjective evaluation using POMS2 showed a tendency for body surface temperature to increase approximately between the start and end of the planetarium watching in both Programs I and II. Aside from the significant decreases in [Confusion-Bewilderment (CB)] and [Fatigue-Inertia (FI)] after program II, a significant decrease was also observed in [Vigor-Activity (VA)]. Meanwhile, LF/HF values varied widely in Group C, which suggests that LF/HF may vary greatly from person to person compared to other groups.

These results suggest that, although it is possible to obtain relaxation effects based on the results of the subjective evaluation for the women in this group, the effect may vary from person to person.

5 Conclusion

The purpose of this study is to clarify the difference in relaxation effects depending on the menstrual cycle of working women during watching the planetarium after work. We used two different planetarium programs to verify these effects in three groups classified by the menstrual cycle. The results were that premenstrual women showed a rapid increase in body surface temperature during program watching, regardless of program structure. In addition, from the POM2 analysis results, there were significant decreases in the Confusion-Bewilderment, Tension-Anxiety, and TMD score after planetarium watching, which revealed that women in this particular period can obtain relaxation effects from the planetarium program.

Meanwhile, menstruating women can be obtained some relaxation effect by planetarium watching. In contrast, the effects obtained by women who are in periods other than menstruation may vary from person to person.



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In the future, based on this result, we will continue to examine the effects of planetarium watching to provide relaxation methods to support women suffering from premenstrual syndrome. Moreover, to alleviate the symptoms that working women experience before menstruation, we also wish to contribute to improving women's QOL by aiming to provide information and develop services on relaxation methods that can be used in various situations such as when they are at home, working, resting, or on their way home.

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