Psychological Effects of Water Landscapes
- Comparison of the Experiment Results Carried out in Summer and Winter-

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Abstract

In recent years, the increase of temperature in urban area is becoming a serious problem. This problem is considered to be caused by artificial ground surface and the exhaust heat according to energy consumption increase. For that reason, the effects by such as green space, river and irrigation pond toward thermal environment are studied.

In addition, a study based on hue-heat for more adequate air-conditioning system to reduce energy consumption is carried out by many researchers.
There are several studies focusing on the effect of water toward thermal environment.

Fukagawa et al. (2005) researched the outside temperature around irrigation ponds and clarified its effect toward thermal environment.

Matsubara et al. (2004) had experiment on hue-heat and clarified that the effect of visual

stimulus causes 0.3 degree centigrade difference.

However, those researches have not targeted the effect of landscape with water as visual stimulus on hue-heat.

This research is based on a subject experiment in an artificial weather chamber. For this experiment, 4 patterns of temperature condition were taken, which are 20, 25, 30, and 35 degree centigrade. In addition, 24 photographs selected out of over 479 were projected on a screen hanged on the chamber wall by a video-projector. 3 people in each time. The subjects were asked to answer to image evaluation questionnaire and thermal sensation vote in each pattern of the temperature setting.

In former study, the authors grasped the effect of landscapes containing water factor. The declaration vote taken for this experiment was composed of image evaluation and thermal sensation vote. For the image evaluation, scores of +3 to -3 are given to each declaration. In addition, the scores of 0 to +6 are given to the thermal sensation vote for the analysis.

Furthermore, to avoid the effect of sudden temperature change, the anterior chamber was controlled to be the same temperature as the inside of the artificial weather chamber. In each experiment setting, the subjects stayed in the anterior for 30 minutes and then went in the weather chamber. In addition, this experiment spent more than 6 hours each time and for that reason, spent 1.5 hours after lunch to avoid the rise of body heat by the digestion.

For more detailed analysis, the same experiment was carried out in summer and winter to wipe out the effect of outside temperature in unconsciousness.

The purpose of this research is to clarify the effect of landscape with water as visual stimulus on hue-heat in the condition of several fixed environment patterns and to investigate its psychological effect to design more adequate air conditioning system.

Introduction

In recent years, global warming is becoming a serious problem. This problem is considered as human disaster mainly caused by the increase of artificial ground surface and the exhaust heat based relating to the energy consumption increase. As the attempts to prevent those problems, the effects of natural resources such as water and green spaces are focused and studied by many researchers.

In addition, a study based on hue-heat and thermal comfort for more adequate air-conditioning system to reduce energy consumption is carried out by many researchers.

There are several studies focusing on the effect of water toward thermal environment. Author et al. have had researches on the outside temperature around irrigation ponds by focusing on the effects in summer and clarified its effect toward thermal environment.

Matsubara et al. have had experiment on hue-heat and clarified that the effect of visual stimulus causes 0.3 centigrade differences.

The purpose of this research is to clarify the effect of visual stimulus toward hue-heat in the condition of fixed environment in summer and winter. Furthermore, to compare the psychological effect of summer and winter.

Experiment Over View

This research is based on a subject experiment in a weather chamber as shown in Figure 1. The subjects are asked to fill in the declaration votes about the landscapes being projected on the screen in the artificial weather chamber. Detailed information is as followings.

Experiment Parameter

This experiment was carried out in summer and winter. 3 people in each time and the total of 24 are targeted.

In addition, the experiment began with 35 centigrade. Then put down the setting 5 degree each time. The landscape visuals used on this experiment were taken by the irrigation

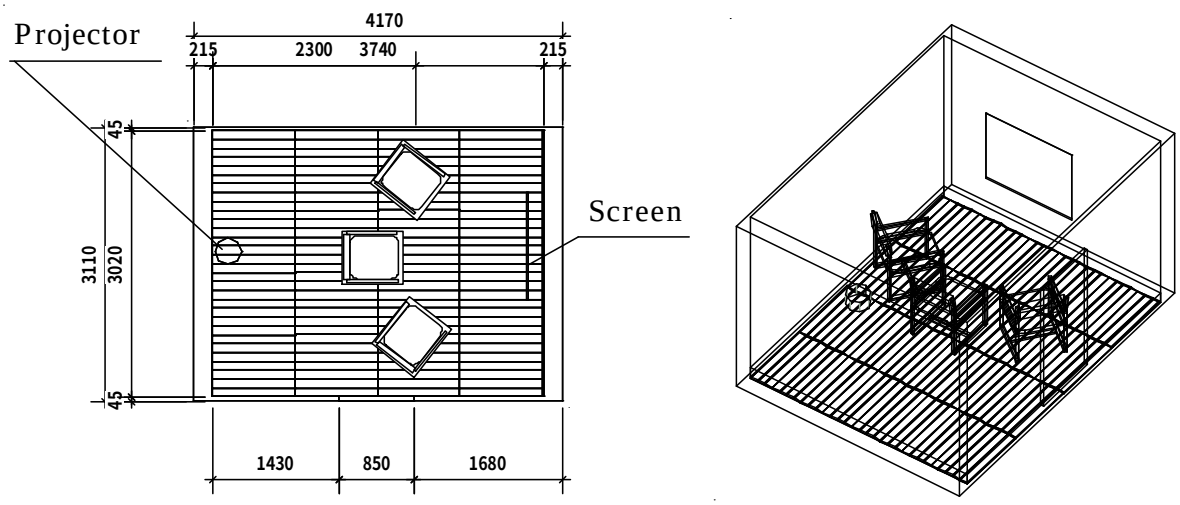

Figure 1 Details of the Artificial Weather Chamber

Table1 Composition of Water Landscape

Name	Sign	Reflection	Algae		Algae Coverage	Artifact Exsitence	Water Color	Total Water Area rank
			Spred	Gathered				
Mizutoriba	A1	○	Non	Non	0%	○	Blue	18
	A2	○	Non	Non	0%	○	Blue	2
	A3	×	Non	Non	0%	○	Blue	16
	A4	×	Non	Non	0%	○	Blue	17
	A5	×	Non	Non	0%	×	Blue	1
	A6	×	Non	Non	0%	×	Blue	19
Shouya	B1	○	○	×	Over 5%	○	Green	8
	B2	○	○	×	Over 5%	○	Green	23
	B3	○	×	○	Less 5%	○	Green	3
	B4	○	×	○	Less 5%	○	Green	13
	B5	○	×	○	Over 5%	○	Blue	14
	B6	○	×	○	Over 5%	○	Blue	7
	B7	×	×	○	Less 5%	○	Blue	6
	B8	×	×	○	Less 5%	○	Blue	24
	B9	×	×	○	Over 5%	○	Green	10
	B10	×	×	○	Over 5%	○	Green	9
Osawada	C1	○	Non	Non	0%	○	Blue	12
	C2	○	Non	Non	0%	○	Blue	11
	C3	○	Non	Non	0%	○	Green	22
	C4	○	Non	Non	0%	○	Green	15
	C5	×	Non	Non	0%	○	Blue	21
	C6	×	Non	Non	0%	○	Blue	5
	C7	×	Non	Non	0%	○	Green	20
	C8	×	Non	Non	0%	○	Green	4

Table2 Positive Adjectives

30 Positive Adjectives				
Enjoyable	Near	Big	Active	Noble
Crisp	Necessary	Familiar	New	Calm
Beautiful	Rich	Likable	Cold	Coexistensive
Open	Energetic	Attractive	Changeable	Fresh
Bright	Gentle	Fast	Natural	Quiet
Pure	Comfortable	Airy	Healthy	Masculine

ponds located in Higashihiroshima city. 444 photos were taken and 24 were finally selected. The targeted ponds are Mizutoriba, Osawada, and Shouya. The taken photos were classified by the factor in Table 1.

Details of Declaration Vote

The declaration vote taken for this experiment was composed of image evaluation and thermal sensation vote both in 7 levels. The positive adjectives used for the image evaluation are shown in Table 2. For the image evaluation, scores of +3 to -3 are given to each 7 level. In addition, the scores of 0 to +6 are given to the thermal sensation vote for the analysis. Furthermore, the examinees are asked to fill out one declaration vote to each picture. The total of 1440 votes is filled out through the experiment.

Experiment Steps

To avoid the influence of sudden temperature change, the anterior chamber was controlled to be the same temperature as the artificial weather chamber. Each experiment, the examinees stayed in the anterior for 30 minutes and then went in the weather chamber. In addition, this experiment spent more than 6 hours each time and for that reason, spent 1.5 hours after lunch to avoid the rise of body heat by the digestion.

Experiment Result

The average score of image evaluation in summer and winter are shown in Figure 2. By this figure, there is mainly little change in summer. The result in winter, on the other hand, shows the quite big change in each setting of the temperature. However, the tendencies of the evaluation, except in the case of 20 degree centigrade setting, in each adjective are similar

Comparing summer and winter, the image evaluation scores in the setting of 20 degree centigrade and 30 degree centigrade, there is obvious difference of the tendency. However, in the other settings of the temperature, the difference of the season does not affect

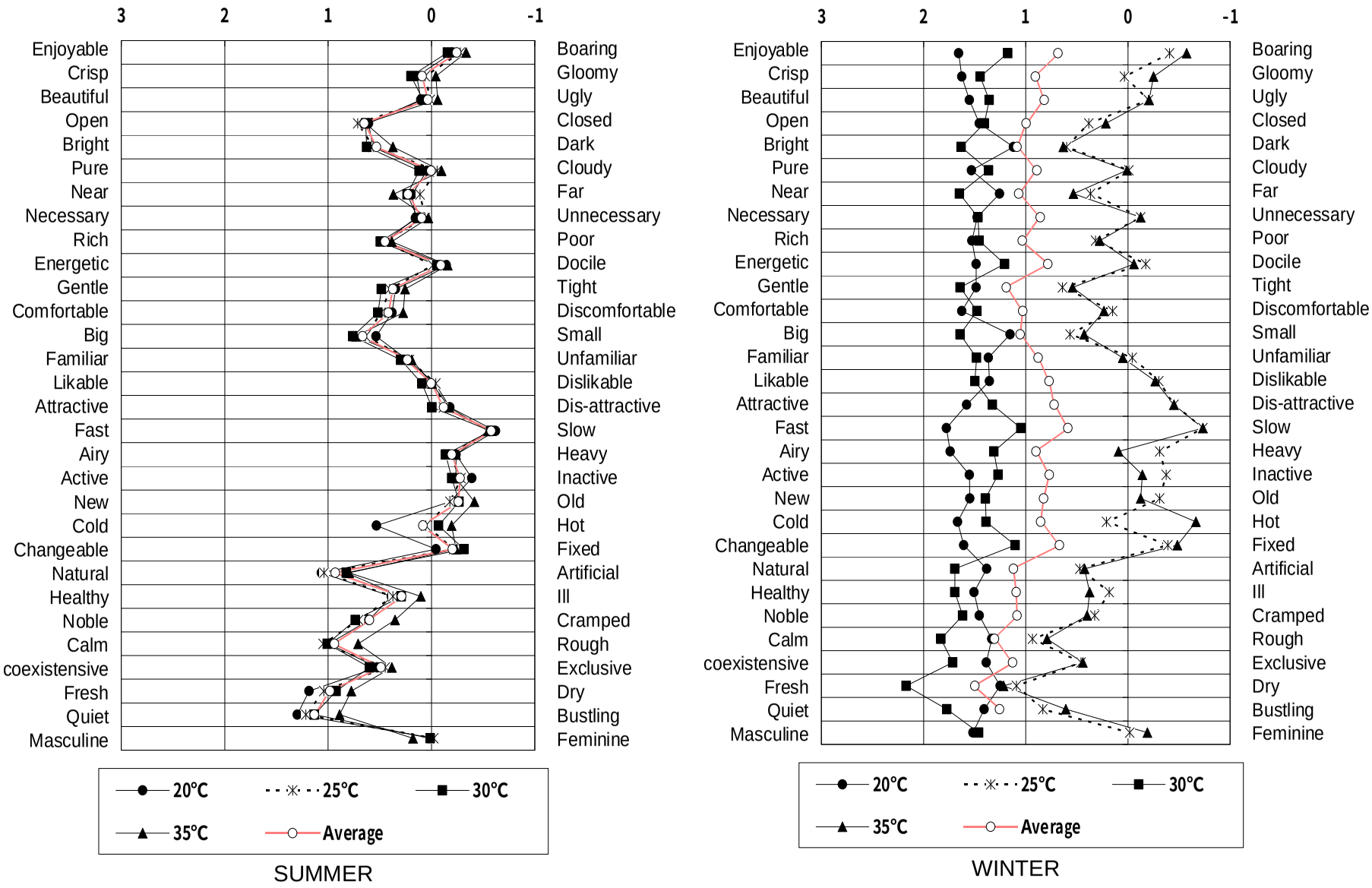

Figure 2 The Average Scores of Image Evaluation in Summer and Winter

this experiment obviously.

Analysis on Image Evaluation

In this chapter, the relationship between the image evaluation by the examinees and Thermal sensation vote is analyzed by factor analysis.

Construction Factor of Image Evaluation

To analyze the tendency of the image evaluation by the examinees, factor analysis was taken. For this analysis, the both result in summer and winter are combined and used for factor loading matrix analysis. The result, setting the factor number as 3, is shown in Table 3.

Table 3 The Factor Loading Matrix

Adjective Pair	Familiarity	Mobility	Spatiability
Familiar - Unfamiliar	0.761	0.278	0.310
Bright - Dark	0.750	0.261	0.215
Beautiful - Ugly	0.738	0.316	0.362
Likable - Dislikable	0.735	0.362	0.340
Pure - Cloudy	0.730	0.252	0.367
Rich - Poor	0.727	0.304	0.244
Comfortable - Discomfortable	0.719	0.160	0.472
Crisp - Gloomy	0.713	0.336	0.335
Attractive - Dis-attractive	0.707	0.386	0.331
Open - Closed	0.677	0.177	0.363
Necessary - Unnecessary	0.675	0.437	0.291
Healthy - Ill	0.639	0.292	0.420
Coexistensive - Exclusive	0.621	0.248	0.252
Enjoyable - Boaring	0.607	0.555	0.205
Airy - Heavy	0.594	0.547	0.193
Gentle - Tight	0.542	0.261	0.444
Fast - Slow	0.373	0.788	0.077
Masculine - Feminine	0.017	0.697	0.230
New - Old	0.504	0.646	0.090
Energetic - Docile	0.564	0.576	-0.026
Cold - Hot	0.207	0.475	0.442
Near - Far	0.310	0.416	0.128
Changeable - Fixed	0.049	0.138	0.029
Active - Inactive	0.067	0.099	0.095
Quiet - Bustling	0.097	0.129	0.777
Calm - Rough	0.320	0.056	0.684
Noble - Cramped	0.476	0.173	0.615
Natural - Artificial	0.241	0.154	0.615
Fresh - Dry	0.394	0.114	0.529
Big - Small	0.372	0.266	0.377

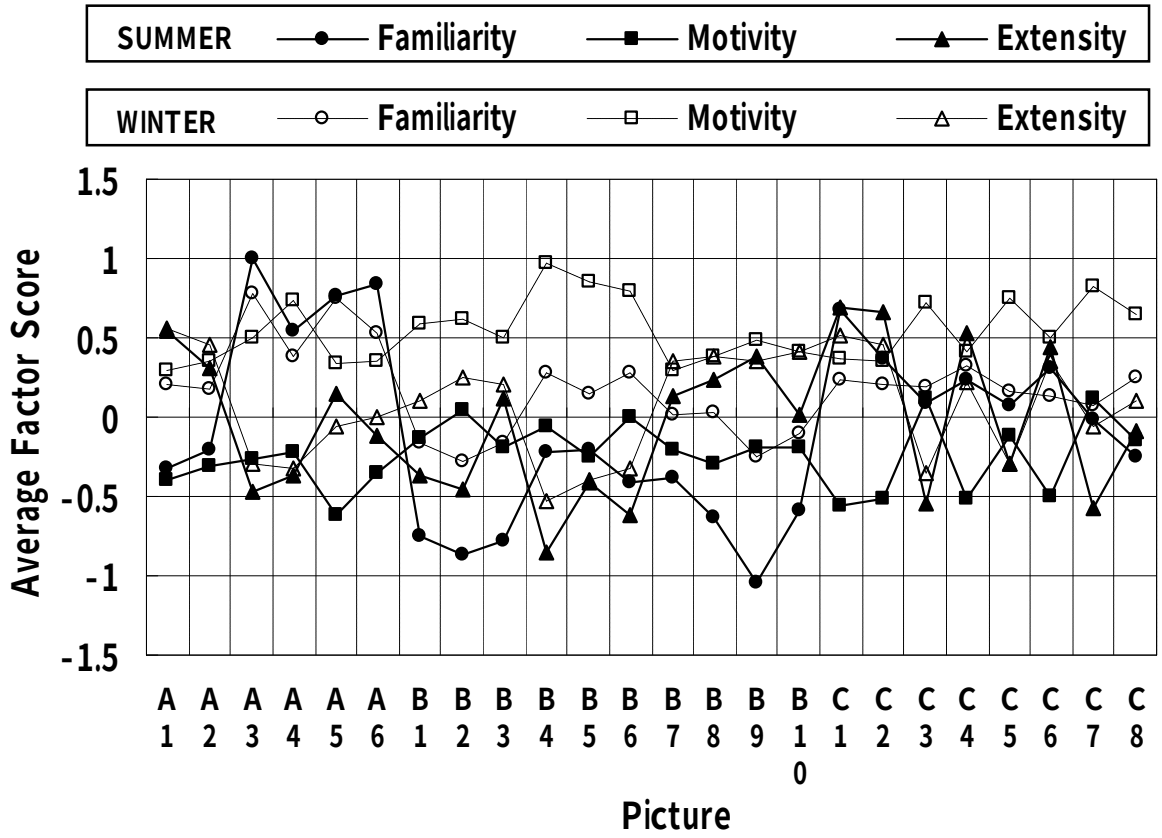

Figure 3 Average Factor Score of Each Landscape

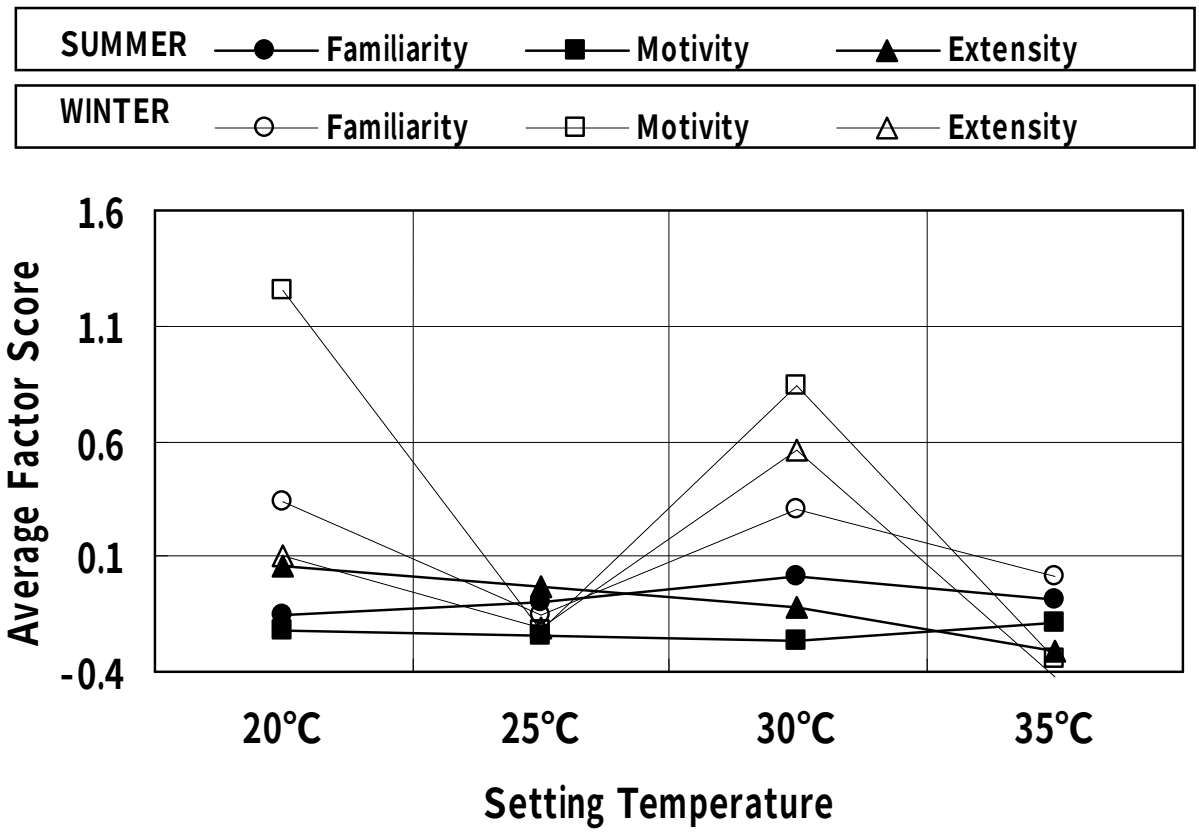

Figure 4 Average Factor Score of Each Setting Temperature

Focusing on the items marked high factor loadings, the first factor is named as “Familiarity” because the items such as “Familiar-Unfamiliar”, “Beautiful- Ugly” and “Likable-Dislikable” are relating to the familiarity of the landscapes. The second factor is named as “Motivity” because the selected items, such as “Airy - Heavy”, “Fast – Slow” and “Energetic - Docile” are relating. The third factor is named as “Extensity” because the items such as “Calm - Rough” “Natural – Artificial”, and “Fresh – Dry” are relating.

The Image Evaluation Construction on Each Landscape

To analyze the aspects of the derived 3 factors, the average factor score was calculated in each landscape. The result is shown in Figure 3. In I1 and I2, the average score of “Extensity” is high. Only “Extensity” showed the similar tendency in the comparison of the 2 seasons.

The Analysis of the Image Evaluation in Each Temperature

The average factor score in each temperature for 4 experiment setting is shown in Figure 4. Focusing on the factor “Extensity” which showed the similar tendency in summer and winter, there is a big gap at the setting of 30 degree centigrade. However, the change of the evaluation score in each setting is likely to decrease when the temperature rises. In the

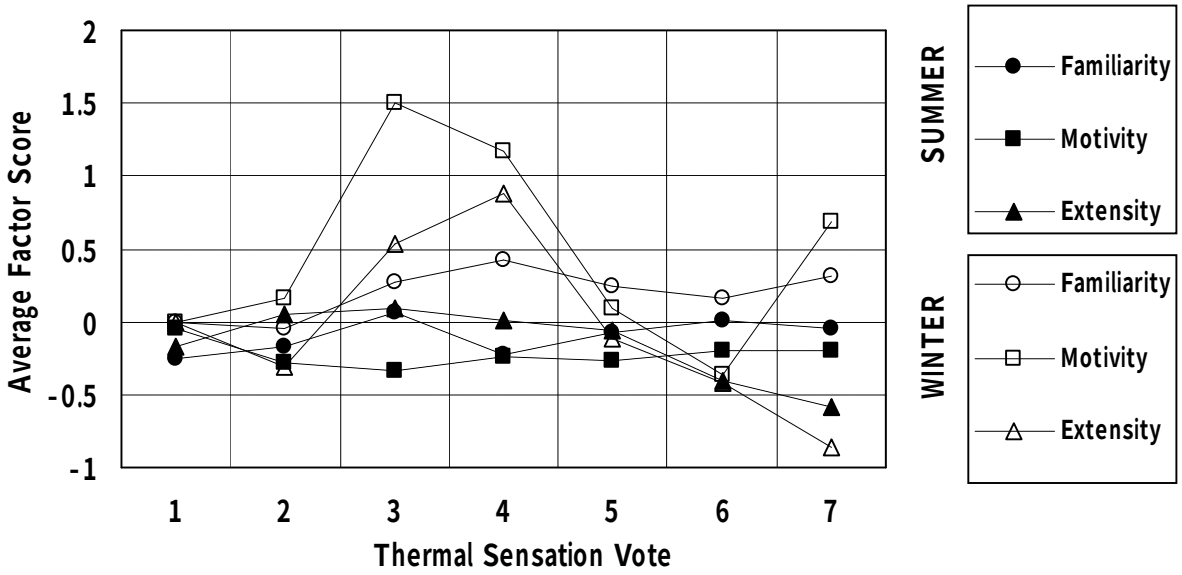

Figure 5 Average Factor Score of Each Thermal Sensation Vote

setting of 20 and 30 degree centigrade, the average scores of each factor are scattering.

The analysis on the image evaluation in each thermal sensation vote

The average factor score was calculated by each Thermal sensation vote result, shown in Figure 5.

By the result, the average score of “Motivity” shows no regularity relating to the thermal sensation vote in both summer and winter. In addition, “Familiarity” does not be affected by the result of thermal sensation vote and it does not change widely.

The score of “Extensity” goes down when the average score thermal sensation vote increases. Especially the change of the score is big between the thermal sensation score of between 5 and 7.

Analysis on the Correlation of the Factors and Thermal Sensation Vote

To analyze the relationship between the 3 factors and thermal sensation vote, Pearson's correlation analysis was taken in this chapter. The result is shown in Table 4.
Focusing on thermal sensation vote, “Extensity” and “Motivity” showed significance coefficient of correlation of 1%. In addition, “Extensity” showed the bigger value than “Motivity”.

According to the results on the previous chapters, it is possible to say that the essences which are evaluated as “Extensity” by the examinees affect the thermal sensation of the humans. Furthermore, the effect appears both in summer and winter.

Table 4 Result of Correlation Analysis

	Thermal Sensation	Motivity	Extensity
Familiarity	0.033	-0.110 **	-0.106 **
n=	1984	2027	2027
Motivity	-0.071 **		0.017
n=	1984		2027
Extensity	-0.131 **	0.017	
n=	1984	2027	

** shows the 1% significance coefficient of correlation

Conclusion

In this study, subject experiment was done with the water landscapes to clarify the effects on hue-heat by stabilizing the environment condition. The grasped results are below.

1） even, with a same landscape, the result of image evaluation changes in each environment condition. Furthermore, the image evaluation result was categorized to 3 factors, such as “Familiarity”, “Motivity”, and “Extensity”. The result was same as Fukagawa’s previous research result done in summer.

2） Focusing on the 3 factors, only “Extensity” showed the some relationship to the temperature setting and to the thermal sensation vote score.

3) The psychological effect by the water landscape likely to be the same in summer and winter in the factor “Extensity” obtained by this experiment.

To design more adequate air conditioning system by utilizing the water landscape, it is important to choose the landscape which can be highly evaluated on the factor of “Extensity”. That Extensity can make human’s thermal sensation fit the thermal condition at that time.

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