The Effect to Evaluation of Lighting Environment by Human "Acquired through Experience"

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Abstract: We notice relevancies between objective and subjective evaluation to adopt psychological and physiological indicators with a full understanding of human "acquired through experience". In a result, there are differences in subjective evaluations obviously. This shows that human "acquired through experience" would take effect to evaluate of lighting environment of an indoor space on which man lives daily.

Key words: Lighting environment, Brain activity, Evaluation

1. Introduction

A human being is surrounded by the space about all of life, and it is known that an illumination will affect it greatly to the impression of a space especially. Therefore, it can be said to be significant to a comfortable life to measure a valuation of an illumination space to a proper and to create the indices of a space planning.

Wakatsuki reports [1] that an accumulation of the sensory information that has received from exposed lighting environment from born to now, and accompanied behavior pattern is reflected in a valuation about the valuation method of an illumination space. Shukutani and others reports [2] a feeling of brightness, and the behavior according to it make evaluation of photic stimulation obtained from the surrounding lighting environment to compare from lighting environment that accumulated in the brain. As mentioned above, Valuation of an illumination space is result from human being's experience of infinite variety. It is suggested that "Acquired through Experience" exists and we have to take into consideration about the influence that the individual difference from experience has on an evaluation result in the case of a valuation. Furthermore, Kikuchi and others report [3] the subjective evaluation to lighting environment. It raised internuncials of a transmutation dispertion, interpretation to language, the time ambiguity, the will, and the intention as an error factorial of a reason. Although the dimension that is a consideration of examinees is possible for these avoids, we indicate that the analytical method using a physiology indices is effective in order to compensate the above weak points and to perform a multilateral and objective verify. In this test, hence we investigated whether do the experiences inequality after birth, "Acquired through Experience" exist in and affect to the valuation process of an illumination space. We performed examination from both sides of the subjective evaluation and object evaluation to make clear the inequality of experiences from examinees of different age.

2. Experiment

2.1 Method

2.1.1 Examinees

This experiment was treatment of a data that examinees are eight 20's women (=f), and eight 50's women (=5f), total sixteen women. 28 years old of the 20th generation women's average age and 53 years old of the 50th generation women's average age, and I checked all the members are right-

hander. They have a visual acuity normal still more wholly or corrected eyesight and do not have a color blindness. That fill the number required for an analysis from the existing investigational. We carried out the hearing of turning on an illumination at a household every day before a test, and checked that there was no inequality in the lighting environment which in everyday life. [Table1]

Table 1. Summary of examinees

Number	Age	Occasion to light	Number	Age	Occasion to light
f1	28	If it becomes dark	5f1	53	If it becomes dark
f2	23	If it becomes dark	5f2	58	If it becomes dark
f3	24	If it becomes dark	5f3	58	If it becomes dark
f4	25	If it becomes dark	5f4	59	If it becomes dark
f5	21	If it becomes dark	5f5	57	If it becomes dark
f6	23	If it becomes dark	5f6	53	If it becomes dark
f7	22	If it becomes dark	5f7	55	If it becomes dark
f8	21	If it becomes dark	5f8	54	If it becomes dark

2.1.2 Stimulation

Since this experiment is examination of the valuation method for the illumination space design in everyday life, its valuation to the light source familiar for the examinees is desirable. I made it conscious of making an illumination space evaluate rather than carrying out by changing a stimulation location about a luminous-flux-density turn to and evaluating the stimulation itself further. With Technical guide for residential lighting design hand of the Illuminating Engineering Institute of Japan[4], we use a daytime white (= w), and daylight color (= r), About Ra, it is supposed more than 80. Based on the above, the photic stimulation used the neo ball Z reality of Toshiba Lighting & Technology Corp., which satisfies requirements, and the electric bulb typed luminescent lamp. Daylight color lights are general color rendering index 83 Ra, luminous intensity 59 cd and luminous flux 810 lm, Daytime white lights are general color rendering index 83 Ra, luminous intensity 53 cd and luminous flux 73 lm. [Figure1-2]

Figure 1. Daytime white electric bulb

Figure 2. Daylight color electric bulb

From stimulation that furthermore looks at a light source directly, there is a possibility of feeling a discomfort from the glare of a photic. Therefore, we equipped with the milky cover to prevent feeling a discomfort given from an inequality with a going too far luminous flux density and installed five light sources per 50 cm of verticals. [Figure 3-4]

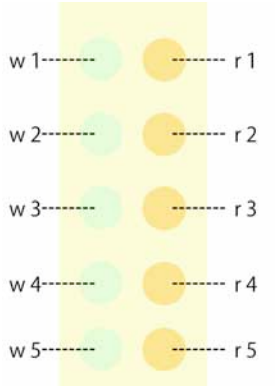

Figure 3. Placement relation and name of stimulations


Figure 4. Sample of stimulations

2.1.3 Environment

The experiment environment [Figure 5] made the surface of a wall white solid color in consideration of weakening a relationship with a space and clearing location changed for a specify gave the significance from the surrounding environment, In order to reduce a physiological workload of examinees, we changed into the near status silently, examinees sit down on a chair in a natural posture, and can see the light irradiated to the space. I use color luminometer Konica Minolta CL200A and the luminous flux density and correlated color temperature within each measured stimulations are shown in the following tables. [Table2]

Table 2. Luminous flux density and correlated color temperature to stimulation

Stimulations	Luminous flux density	Correlated color temperature
w1	37.2lx	4967k
w2	27.9lx	5002k
w3	26.1lx	4697k
w4	23.1lx	4569k
w5	21.8lx	4472k
r1	33.3lx	2434k
r2	31.2lx	2418k
r3	26.9lx	2341k
r4	25.0lx	2320k
r5	24.3lx	2354k

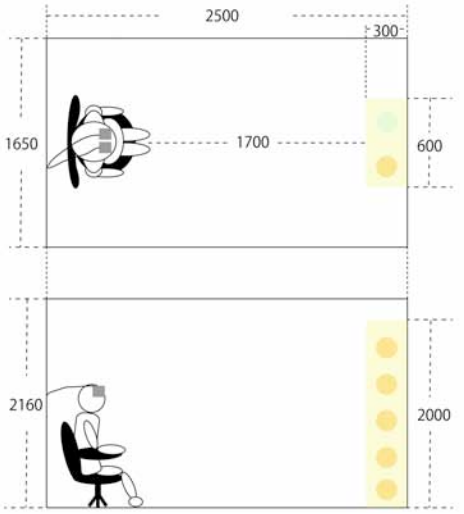

Figure 5. Experiment environment

2.1.4 Subjective Evaluation

We performed the subjective evaluation after observing stimulation changes in a lab measuring a brain blood flow. As consideration of a brain blood flow measurement, it is desirable that not to be engaged in a specific task but to make a subject merely observe. Therefore, we asked a question by oral in the place which came out of the lab after the end of a measure. Since, before a brain blood flow measurement, we have not told examinees to evaluate end of the examinees so that an illumination space may not be made to observe with a prejudice. It is difficult to reappear with putting fine set into a subjective evaluation. Then, we made two questions for subjective evaluation that can reply even if they passed through different life. "the most favorite illumination space" and "the worst favorite illumination space". In addition, it is not the purpose to measure the fine impression of an illumination space in this test. Although examinees declared the location and color temperature of stimulations to each inquiry, there were little examinees who can notify to an exact that there are five steps of illuminations and there were much examinees who answers by the top, the middle, or the bottom in a prior test. Therefore we set up the irradiation location for a subjective evaluation as shown in the following tables. [Figure6]

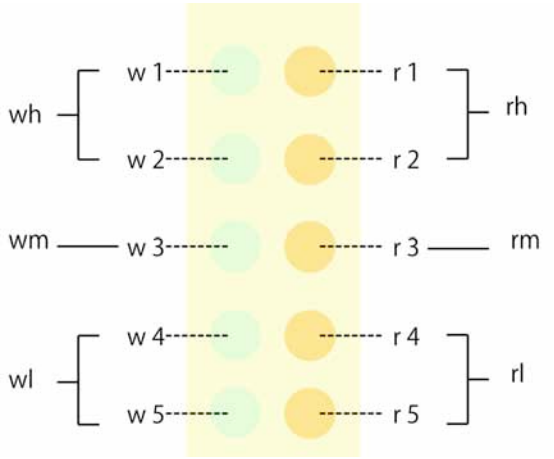

Figure 6. Name of stimulations

2.1.5 Sequence

The test experiment conducted in the following routines.

1. Examinees take a seat in a predetermined location.
2. Examinees receive an illustration of stimulations, and the illustration about a test from an experimenter.
3. We begin experiment, after do not leave a question and explaining it about experiment.
4. After equipping examinees with the probe of optical topography, we shut the door of a lab and put out the light.
5. Examinees are enlightened 60 seconds after a rest closed ophthalmic, and looks at an indoor space.
6. Examinees are suffered the stimulations representational x stimulations of several lines for 60 seconds.
7. We open the door of a lab, and remove a probe after turning on the light. And carry out the end of experiment.

In addition, we make stimulation to be different for every examinee so that it may not be affected by the influence of a representational sequence.

2.1.6 Brain Blood Flow Measurement and Analysis

In this experiment, it is required to obtain a quantitatively and numerically the data concerning the psychological and physiological influence on people. Furthermore, We notice that it is optimal to measure a brain activity since the purpose of this stimulation is to measure the physiological

response of a process that evaluates the illumination's stimulations. In the physiology indices of a typical brain activity measure, a brain-function imaging has the specificity character to be observed alive brain activity from outside. [5] It is already completed as a safe investigation and the many are very useful to a realization of people's emotional reaction. Then, in this experiment, we adopted the measure of the brain blood flow, and used Hitachi Medical ETG-4000. Based on international 10 / the 20 methods, the measure used the probe of 3x4 focusing on the Fz section, and recorded right and left 24 channels. It is 3 cm between measures of a probe. Since this experiment was measuring the change of examinee's emotion, the measure location of the brain blood flow made it the frontal association area that manage the high order activity. [Figure7]

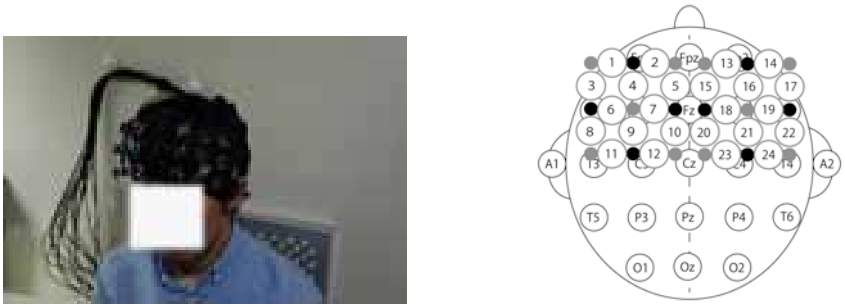

Figure 7. Probe posting

I analyzed the data measured with an NIRS device in the following routines.

- Although there are an oxyHb, a deoxyHb, and a totalHb that are those sum totals measurable by NIRS, we adopted an oxyHb as a data. Because it is suppose that make the largest feedback at a local brain blood flow. [6,7]
- We computed moving average over five seconds. [8]
- Physiological fluctuation produces the baseline of an oxyHb by the fatigue accompanying a successive. We defined that the Pre-stim period, 10 seconds just before stimulations presentation during 60 seconds, the Recover period, 20 seconds when a brain blood flow turn to recovers to a baseline just after stimulations presentation during 60 seconds, the Post-task period, 10 seconds just after the Recover period. Since it becomes an irradiation location how many stimulations of each color temperature I received without w3 and r4 and moved by this experiment and it serves as a subject for a measure, w3 and r3 is attached to the initial of several stimulation. Before the w3 and r3 stimulation was shown, we made 10 second into the mean value, and the software in ETG-4000 performed the baseline correction. [9][Figure8]
- Since oxyHb is a relative value in examinees, the comparison between examinee is impossible, it is necessary to convert an oxyHb changed into Z that can be compared between examinees. [10] Each data work out an average might come to be set to 0 and a SD might come to be set to 1 by each channel.
- We defined that the finite difference between the average of w3 and r3 that are the above-mentioned treatment and the average of stimulations concerned are the variation by several stimulation.
- Since there are many items as which have a trend of taking a change at 30 seconds the graph of the RAW data in each stimulations representational temporal, I analyzed by three patterns, start 0 second to an end 60 second, from 0 seconds to 30 seconds, and from 30 seconds to 60 seconds.

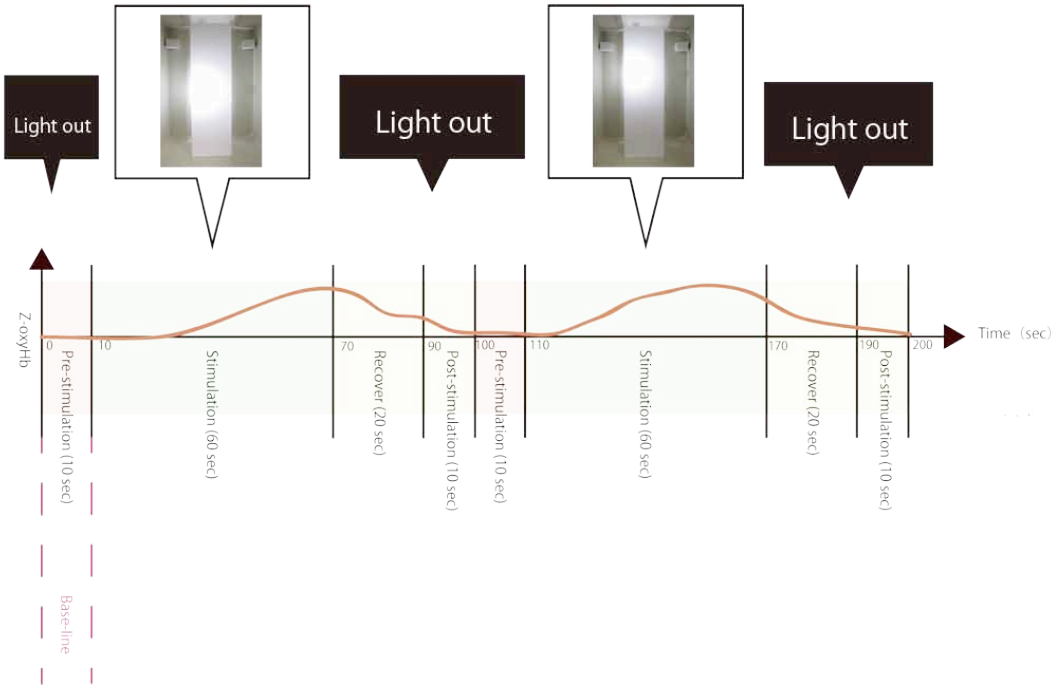

Figure 8. Stimulations composition

2.2 Result

2.2.1 Result of Subjective Evaluation

The result of subjective evaluation to all the 16 examinees is as follows. [Table3] It turns out that the trend of an light bulb colored to be liked more through all the replies. In a reply of the examinees in his 20's, dispersedly trend is seen for a reply to like an irradiation location and to dislike. However, examinees in his 50's set liking does not have a reply of h, and set disliking, the trend of a reply to an irradiation location is biased that a reply of l is one.

Table 3. Result of subjective evaluation

Number	Age	Like	Dislike	Number	Age	Like	Dislike
f1	28	rl	wm	5f1	53	rl	wm
f2	23	rl	wm	5f2	58	rl	wm
f3	24	rl	wl	5f3	58	rm	wh
f4	25	rm	wh	5f4	59	rm	wl
f5	21	rh	wm	5f5	57	rl	wh
f6	23	rl	wm	5f6	53	wm	rh
f7	22	rl	wl	5f7	55	wm	rh
f8	21	wh	rl	5f8	54	rl	wm

2.2.2 Analysis of Objective Evaluation

We acquired the data of the brain blood flow turn to for all the 8 stimulations from all the 16 examinees. We carried out the channel by which the near-infrared reflection was made the scanty by ETG-4000, the channel regarded as the artifact having mixed by body moving, and the channel including a blank value are exception for an analysis. The exception channel for an analysis is as follows. [Table4]

Table 4. Exception channel for an analysis

The exception channel for an analysis	
f5	2.5.
f6	22
f8	3.8.
f7	13.15.20
5f5	8.11
5f6	4.6.9.14.17

We defined that several stimulation was a comparable factor toward the result according to the age of examinees. Next we conducted the dispersion analysis of the multivariate with the level 5% to analyze the inequality of an even of Z-oxyHb of each ch, and considered the influence which the inequality of age and a stimulation has on a brain blood flow turn to. When there were two or more interactions with a statistical significance in ch, we performed the tukey after that, and performed the detailed validation of the stimulation to which the inequality was accepted. Between the factorials that the still more significant interaction occurred, whether whose regulation of which pair was large, and in order to check, we performed the Bonfwrroni method.
I set all examinees, as the reference subject, and made the interaction into the inequality of a color temperature, an irradiation location, and a photic stimulation. [Table5]

Table 5. Target for comparison and reference subject

Comparable target	Comparable factor
Group f and group 5f in result of analysis	Color temperature/Color = r,w Position/Height = 1,2,4,5 Stimulation/Light = r1,r2,r4,r5,w1,w2,w4,w5 Difference of age / f,5f

2.2.3 Result of Analysis

We conducted the dispersion analysis of the multivariate to all examinees by making the inequality of a color temperature, an irradiation location, a photic stimulation, and an era into a reference factorial. The member of a comparable factor performs a multiple comparison about light, and searching for the detailed result of the member in which the statistical significance was accepted. We show in the below a sequence. [Table6]

Table 6. Result of analysis

ANOVA to multivariate	Color	Height	Age	Light	Color*Age
0–60Sec	ch.2 r<w, ch.4 r<w, ch.8 r>w,	No statistical significance	ch.1 f>5f, ch.2 f>5f ch.3 f>5f, ch10 f<5f ch.15 f>5f, ch16 f>5f ch.23 f>5f	ch.2	ch.5,ch,8, ch.13
0–30Sec	ch.22 r>w	No statistical significance	ch.1 f>5f, ch.2 f>5f ch.3 f>5f, ch4 f>5f ch.5 f>5f, ch6 f>5f ch.7 f>5f, ch.8 f>5f ch,9 f>5f, ch13 f>5f ch.14 f>5f, ch.15 f>5f ch.16 f>5f, ch.18 f>5f ch,21 f>5f	No statistical significance	ch.8,
30–60Sec	ch.4 r<w, ch.24 r<w	No statistical significance	ch.4 f<5f, ch.5 f<5f, ch.6 f<5f, ch.7 f>5f, ch.15 f>5f, ch.20 f>5f ch.21 f<5f, ch.23 f>5f	ch.24 r<w(r4<w1)	ch.14, ch.16 ch,20

- Color
  ch that has a statistical significance in all stimulations representational time zones was accepted.
- Height
  ch with a statistical significance was not accepted.
- Age
  ch that has a statistical significance in all the stimulation representational time zones was

accepted. In 0 to 30 seconds, and 30-60 seconds, all average r is high, f, and f5 is unequal, a trend is regarded for relationship between the passage of time and an age difference.

- Light
  ch that has a statistical significance in 0 to 60 seconds and 30-60 seconds was accepted. There were stimulations to which the statistical significance was accepted by the result of the multiple comparison performed to ch.24 to which the statistical significance was especially accepted in 30 to 60 seconds.
- Interaction
  I accepted among the interactions color and age.

Since the interaction was accepted between color and age, I performed the Bonfwrroni method. [Table7]

Table 7. Result of the Bonfwrroni method to factor have interaction from result of all examinees

Bonfwrroni method.	Color*Age r,w	
	r	w
0—60Sec	ch.1 r f>5f, ch.2 r f>5f, ch.3 r f>5f, ch.8 r fa.5f, ch.23 r f>5f, ch24 r f>5f,	ch.1 w f>5f ch.5 w f>5f, ch.12 w f>5f, ch.13 w f>5f, ch.15 w f>5f, ch.16 w f>5f, ch.16 w f>5f, ch.22 w f>5f, ch.23 e f>5f, ch.24 w f>5f,
0—30Sec	ch.1 r f>5f ch.2 r f>5f, ch.3 r f>5f, ch.4 r f>5f, ch.5 r f>5f, ch.6 r f>5f, ch.7 r f>5f, ch.8 r f>5f, ch.9 r f>5f, ch.10 r f>5f, ch.11 r f>5f, ch.15 r f>5f ch.16 r f>5f, ch.18 r f>5f, ch.21 r f>5f	ch.1 w f>5f, ch.3 w f>5f, ch.5 w f>5f ch.13 w f>5f, ch.15 w f>5f,
30—60Sec	ch.4 r f<5f ch.5 r f<5f, ch.6 r f<5f, ch.7 r f<5f, ch.9 r f<5f, ch.10 r f<5f, ch.12 r f<5f, ch.15 r f<5f, ch.16 r f<5f, ch.18 r f<5f, ch.21 r f<5f,	ch.5 w f<5f, ch.9 w f<5f, ch.20 w f>5f
	Color*Age f,5f	
	f	5f
0—60Sec	ch.8 f r>w,	ch.5 5f r>w, ch.19 5f r>w ch.22 5f r>w,
0—30Sec	ch.8 f r>w, ch.10 f r>w	ch.2 5f r<w, ch.20 5f r<w, ch.23 5f r>w
30—60Sec	ch.4 f r<w, ch.24 f r<w	ch.10 5f r>w, ch.12 5f r>w, ch.20 5f r>w, ch.24 5f r<w

2.3 Consideration

From the test result, it was suggested about the color temperature for all the examinees that the relationship to the color temperature of the activated brain site and a subject changes with the variation per hour from stimulation representational start 0 second. That is, in a daylight and a daytime white bulb color, brain of examinees activity shows a difference through 60 seconds which are stimulation representational temporal. However, about 0 to 30 seconds when examinees groups was 20's, there is much ch to which the statistical significance with a high mean value of r. There is much ch to which the statistical significance with a high mean value of w when examinees group of his 50's. About further 30 to 60 seconds, in the case of examinees group of his 20's, there is much ch to which the statistical significance with a high mean value of w, and many ch with a statistical significance with a high mean value of r are accepted in the examinees group of his 50's. Actually, the temporal coherence in his 20's and his 50's can consider that the variation per hour of the same brain activity is not accepted according to the pattern of color temperature, although a brain activity changes with the variation per hour of a stimulation representation to a color temperature. If stimulations are shown, a light adaptation will start, but it is said that a light adaptation is 30 to 60 seconds until it becomes a photopic vision. [11] That is, it is thought that representational stimulation 0 to 30 seconds are in the midst of a light adaptation. Sekihara and others reports that

a valuation is high, as a color temperature becomes high in a light-adaptation status. [12] Then, about all examinees and examinees group of 20's, the result is same as an investigational of Sekihara and others. About examinees group of his 50's, examinees group of a college student and middle and old age people considered the influence that the muntin rate of a shoji has on an impression valuation of lightings by report of Hara and others. To the sequence, college student having evaluated only the shape, middle and old age people also evaluate functional surfaces, such as lighting, and familiarity, and we report that the struggling was seen by the evaluation result. [13] The difference in an accumulation of the illumination space pattern passed from birth to now affect the valuation to stimulations, and I can take that the inequality arose in the result into consideration.

About the inequality of the era for all examinees, many high mean values of average in 20's are looked at ch to which the statistical significance was accepted by stimulation representational 60 second. If it says about 0 to 30 seconds, in ch to which a statistical significance is accepted, the mean value of examinees in 20's is high. Although ch with a high mean value is seen in 30 to 60 seconds by ch to which a statistical significance is accepted by 50's, There are few to ch accepted that there is a statistical significance by 0 -30 second. Murakami and others divided examinees into the youth and the elderly, and examined the color temperature and the temporal response made the influence to clear visions by doing the reading operation. [14] The sequence, they reported the influence of the clear vision when the color temperature change was high on the youth. From this result we could also guess.

About the positions of irradiation for all examinees, we were not able to check a statistical significance. Because the human being could not reappear five steps positions of irradiation on the prior test, as for this, it is considered a delicate luminous-flux-density inequality does not have a big influence on a human being. As for the result of verification to the simply main effect in the inequality of an age and the color temperature for all examinees, many of ch which a statistical significance is accepted on both of the light bulb color and the daytime white showed high average with a statistical significance in 20's. We bring a result with more ch that has a statistical significance to the light bulb colored, and have become contents that direct the result of a dispersion analysis. When ch to which a statistical significance is accepted at 0 to 30 seconds and 30-60 seconds are checked, in 0 to 30 seconds, an average is high on the only 20's. However, in 30 to 60 seconds, an average is high on the only 50's.This considers the inequality of the valuation process of his 20's and his 50's.Furthermore about the interaction in examinees age inequality, ch that has a statistical significance in 50's are increase. A main effect is the result of being obtained only in a certain specific phenomenon. Even we could lay hold of examinees of 50's realize that it is having many conditioning from the numerousness of undergoes to the presented illumination space. From the result of having divided the examinees group of his 20's and his 50's, and having conducted the dispersion analysis of the multivariate, I can explain the inequality of the valuation process in "Acquired through Experience".

2.4 Conclusion

This experiment made the inequality of experience the distinctly by changing age of examinees age. And performing the valuation to the color temperature and positions of irradiation in lighting environment, a turn to arises in a valuation process. We performed examination from both sides of a subjectivity valuation and an object valuation, and checked whether human "Acquired through Experience" would exist in a valuation process.
As a result, the following things were suggested.

- If a color temperature changes, in evaluation process, brain activity will not show the same change.
- It is suggested that a delicate luminous-flux-density inequality would not take effect deeply, from not checked the difference in a brain activity with the inequality of the irradiation location.
  It can also guess, because of If a combination of color temperature and an irradiation location are changed.
- If examinees is divided into an age and the same illumination space is made to evaluate, the positive inequality to the result of a subjectivity valuation will not be seen, but in a valuation process, we can check an inequality.

As mentioned above, I could take into consideration that experience of human inequality affected a valuation process, and the existent of human "Acquired through Experience" was suggested to the valuation of illumination space. However, I could not explain that all the inequalities of the result obtained by the examinees in his 20's and 50's are the things originating in "Acquired through Experience".

In the valuation process over this experiment, it is because the influence of a physiological reaction was suggested to examinees in his 20's. That is, as Igarashi explains sensitivity [15] is a native property and an in-addition knowledge or the function which reacts intuitively and evaluate. There is an existent of "Acquired

Originally" to a valuation of the illumination space with which the human being is endowed beforehand. So we could consider that "Acquired Originally" and "Acquired through Experience" appear in multiplex has affected to the evaluation result. Furthermore, in a sensitivity valuation process, I have to take into consideration experience are accumulated, which behavior from both directions and experience is updated.

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Appendix 1. Group f mean, sd score

f 0-60sec

	r1		r2		r4		r5		w1		w2		w4		w5	
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
ch1	−0.045	0.272	−0.062	0.537	−0.018	0.348	−0.045	0.250	0.107	0.468	−0.027	0.453	−0.031	0.420	0.023	0.329
ch2	−0.275	0.457	−0.203	0.328	−0.166	0.290	−0.012	0.382	0.003	0.393	0.026	0.295	−0.074	0.255	−0.029	0.407
ch3	−0.024	0.425	0.095	0.450	−0.071	0.266	−0.189	0.401	−0.180	0.438	−0.176	0.439	−0.297	0.336	−0.259	0.463
ch4	−0.107	0.268	−0.123	0.398	−0.164	0.353	−0.207	0.498	−0.018	0.547	−0.078	0.294	−0.134	0.301	0.056	0.347
ch5	−0.259	0.362	−0.134	0.341	−0.242	0.304	−0.196	0.345	−0.144	0.432	0.042	0.289	−0.127	0.240	−0.107	0.485
ch6	−0.135	0.454	0.092	0.372	−0.027	0.413	−0.206	0.410	−0.173	0.462	−0.040	0.489	−0.192	0.309	−0.094	0.382
ch7	−0.094	0.326	−0.150	0.400	−0.078	0.166	−0.193	0.392	−0.256	0.326	0.092	0.375	−0.121	0.448	−0.035	0.487
ch8	0.039	0.451	0.209	0.414	0.172	0.415	0.024	0.390	−0.251	0.423	−0.140	0.570	−0.333	0.355	−0.171	0.473
ch9	−0.287	0.256	−0.258	0.303	−0.136	0.161	−0.215	0.350	−0.242	0.386	−0.084	0.383	−0.097	0.464	−0.115	0.296
ch10	−0.192	0.293	−0.281	0.379	−0.172	0.276	−0.107	0.489	−0.248	0.388	−0.101	0.343	−0.438	0.398	−0.153	0.259
ch11	−0.061	0.454	−0.093	0.319	0.033	0.342	−0.091	0.305	−0.170	0.259	0.007	0.457	−0.067	0.228	−0.100	0.550
ch12	−0.230	0.294	−0.267	0.371	−0.183	0.192	0.013	0.250	−0.126	0.302	0.059	0.261	−0.087	0.336	−0.034	0.288
ch13	−0.317	0.317	−0.306	0.159	−0.257	0.419	−0.186	0.304	−0.106	0.389	−0.121	0.322	−0.139	0.321	0.064	0.355
ch14	−0.248	0.516	−0.158	0.483	−0.199	0.535	−0.178	0.448	−0.217	0.230	−0.116	0.473	0.009	0.483	−0.045	0.231
ch15	−0.368	0.292	−0.016	0.457	−0.083	0.329	−0.189	0.393	−0.058	0.392	−0.017	0.363	−0.138	0.243	−0.109	0.347
ch16	−0.228	0.353	0.019	0.453	−0.121	0.397	−0.143	0.456	−0.168	0.481	−0.182	0.408	−0.113	0.403	0.069	0.187
ch17	−0.384	0.317	−0.196	0.408	−0.177	0.453	−0.169	0.296	−0.175	0.475	−0.193	0.415	−0.156	0.521	−0.105	0.218
ch18	−0.263	0.276	0.092	0.523	0.023	0.184	−0.065	0.372	−0.279	0.359	0.026	0.408	−0.241	0.246	−0.172	0.376
ch19	−0.255	0.402	0.053	0.545	−0.069	0.483	−0.158	0.404	−0.183	0.564	−0.081	0.344	−0.225	0.373	−0.088	0.230
ch20	−0.310	0.319	−0.013	0.589	−0.100	0.237	−0.083	0.361	−0.085	0.426	0.095	0.433	−0.257	0.576	−0.040	0.495
ch21	−0.268	0.385	0.068	0.535	−0.008	0.206	−0.040	0.370	−0.140	0.409	−0.023	0.434	−0.055	0.482	−0.047	0.403
ch22	−0.218	0.358	0.054	0.247	−0.071	0.337	−0.171	0.384	−0.105	0.545	−0.059	0.321	−0.120	0.490	−0.073	0.323
ch23	−0.268	0.191	0.098	0.511	−0.124	0.207	−0.029	0.189	−0.011	0.374	0.120	0.515	−0.094	0.466	0.128	0.328
ch24	−0.332	0.206	−0.006	0.461	−0.186	0.158	−0.060	0.346	−0.267	0.410	−0.023	0.397	−0.061	0.470	0.027	0.224

f 0-30sec

	r1		r2		r4		r5		w1		w2		w4		w5	
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
ch1	−0.236	0.400	−0.474	1.027	0.033	0.521	−0.440	0.727	−0.016	1.050	−0.023	0.791	0.049	0.746	−0.059	0.918
ch2	−0.246	1.069	−0.174	1.292	0.038	0.389	−0.151	1.047	−0.070	0.788	−0.061	0.511	−0.208	0.548	−0.227	0.707
ch3	−0.147	0.769	0.122	1.086	−0.154	0.307	−0.421	0.916	−0.303	0.696	−0.307	0.505	−0.368	0.691	−0.395	0.754
ch4	0.171	0.673	0.152	1.293	0.349	0.857	−0.067	1.094	−0.160	0.934	−0.196	1.030	−0.326	0.954	−0.078	1.160
ch5	0.021	1.123	−0.061	1.277	−0.161	0.616	−0.308	0.917	0.026	0.720	0.065	0.339	−0.034	0.704	0.131	0.549
ch6	0.004	1.237	0.245	1.055	−0.048	0.474	−0.042	0.790	−0.428	0.712	−0.238	0.827	−0.285	0.703	−0.079	0.800
ch7	−0.010	0.740	−0.148	1.030	0.196	0.453	−0.340	0.713	−0.538	0.460	−0.035	0.870	−0.151	0.832	−0.058	0.742
ch8	0.201	0.713	0.256	0.947	0.024	0.546	0.248	0.945	−0.384	0.854	−0.483	0.490	−0.447	0.779	−0.230	0.614
ch9	−0.373	0.974	−0.277	0.957	0.146	0.464	−0.428	0.692	−0.455	0.559	−0.246	0.927	−0.179	0.900	−0.147	0.942
ch10	−0.014	0.601	−0.415	0.980	0.000	0.524	−0.084	0.900	−0.633	0.680	−0.324	0.530	−0.548	0.802	−0.364	0.521
ch11	−0.015	0.802	−0.292	0.654	0.093	0.776	−0.056	1.095	−0.353	0.748	−0.372	0.577	−0.262	0.699	−0.123	0.357
ch12	−0.507	0.859	−0.734	1.096	−0.258	0.306	−0.225	0.391	−0.488	0.785	−0.125	0.362	−0.334	0.924	−0.361	0.526
ch13	−0.339	0.921	−0.592	1.086	−0.192	0.590	−0.505	0.826	−0.315	1.006	−0.287	0.977	−0.316	0.873	0.168	1.073
ch14	−0.357	0.781	−0.498	1.000	−0.213	0.557	−0.310	0.982	−0.477	1.050	−0.319	0.713	−0.308	0.929	−0.102	0.872
ch15	−0.316	0.740	0.174	1.321	0.251	0.861	−0.216	1.066	−0.181	0.788	−0.185	1.310	−0.253	0.946	−0.218	0.849
ch16	−0.148	0.760	0.225	1.391	0.191	0.826	−0.135	1.254	−0.479	1.064	−0.221	0.907	−0.364	1.065	0.053	0.815
ch17	−0.524	0.646	−0.256	1.115	−0.425	1.070	−0.148	0.908	−0.534	1.099	−0.226	0.908	−0.404	0.830	−0.523	1.118
ch18	−0.273	0.786	0.024	1.295	0.286	0.467	−0.109	1.046	−0.750	0.438	−0.112	0.969	−0.446	0.949	−0.239	0.827
ch19	−0.184	0.881	0.163	1.413	0.003	0.879	−0.202	0.896	−0.421	0.890	−0.235	0.857	−0.414	0.728	−0.413	0.752
ch20	−0.559	0.794	−0.529	1.430	−0.044	0.596	−0.452	0.761	−0.460	0.697	−0.315	0.657	−0.488	0.786	−0.462	0.685
ch21	−0.403	0.792	0.210	1.304	0.251	0.469	−0.137	1.147	−0.738	0.618	−0.080	1.055	−0.291	1.146	−0.097	0.874
ch22	−0.444	0.829	0.075	0.896	−0.006	0.569	−0.401	0.679	−0.451	0.826	−0.349	0.660	−0.397	0.730	−0.349	1.047
ch23	−0.454	0.943	−0.290	1.351	−0.141	0.775	−0.350	0.645	−0.344	0.643	−0.084	0.671	−0.357	0.967	0.012	0.523
ch24	−0.608	0.633	−0.082	1.226	0.060	0.667	−0.215	0.665	−0.926	0.606	−0.455	0.791	−0.509	0.737	−0.108	0.733

f 30-60sec

	r1		r2		r4		r5		w1		w2		w4		w5	
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
ch1	0.146	0.763	0.348	0.796	−0.069	0.520	0.348	0.537	0.229	0.861	−0.031	0.902	−0.111	0.447	0.105	1.095
ch2	−0.304	0.603	−0.231	0.750	−0.369	0.804	0.126	0.514	0.077	0.695	0.113	0.873	0.059	0.863	0.168	0.915
ch3	−0.003	0.755	0.068	0.584	0.012	0.509	0.043	0.538	−0.058	0.987	−0.046	0.792	−0.227	0.846	−0.124	1.138
ch4	−0.384	0.799	−0.397	0.575	−0.675	0.560	−0.346	0.987	0.123	0.886	0.040	0.961	0.057	0.788	0.191	1.145
ch5	−0.538	0.762	−0.206	0.681	−0.323	0.655	−0.084	0.889	−0.312	0.579	0.020	0.846	−0.218	0.790	−0.343	1.131
ch6	−0.274	1.169	−0.060	0.739	−0.005	0.728	−0.371	0.801	0.081	1.081	0.158	0.974	−0.098	0.644	−0.110	1.092
ch7	−0.178	0.699	−0.151	0.397	−0.351	0.509	−0.047	0.855	0.024	0.470	0.218	0.865	−0.090	0.998	−0.012	1.081
ch8	−0.123	0.990	0.162	0.511	0.320	0.786	−0.200	0.885	−0.118	0.977	0.203	0.727	−0.220	0.761	−0.113	0.769
ch9	−0.202	1.026	−0.239	0.682	−0.416	0.557	−0.002	0.985	−0.029	0.465	0.078	0.581	−0.016	0.867	−0.083	1.264
ch10	−0.370	0.577	−0.148	0.355	−0.344	0.341	−0.131	0.909	0.137	0.352	0.122	0.614	−0.327	0.690	0.056	0.515
ch11	−0.108	1.025	0.106	0.440	−0.026	0.954	−0.125	0.965	0.013	0.757	0.384	0.767	0.127	0.663	−0.077	1.063
ch12	0.045	0.690	0.200	0.723	−0.109	0.221	0.249	0.660	0.236	0.656	0.242	0.454	0.160	0.680	0.292	0.543
ch13	−0.295	1.085	−0.020	0.858	−0.322	0.647	0.133	0.634	0.102	1.032	0.044	0.984	0.039	0.855	−0.040	1.244
ch14	−0.138	0.961	0.180	0.840	−0.184	0.626	−0.046	0.470	0.042	1.029	0.087	0.949	0.324	0.779	0.012	1.099
ch15	−0.420	0.726	−0.205	0.646	−0.415	0.608	−0.163	0.770	0.064	0.752	0.150	0.792	−0.024	0.732	0.000	1.156
ch16	−0.308	0.961	−0.185	0.737	−0.433	0.393	−0.152	0.748	0.141	0.884	−0.143	0.766	0.136	0.723	0.085	1.001
ch17	−0.244	0.859	−0.136	0.586	0.070	0.637	−0.191	0.655	0.183	0.850	−0.159	0.603	0.090	0.716	0.311	1.183
ch18	−0.252	0.517	0.161	0.410	−0.240	0.398	−0.021	0.761	0.190	0.592	0.164	0.555	−0.038	0.725	−0.106	0.784
ch19	−0.326	0.777	−0.057	0.634	−0.141	0.383	−0.113	0.412	0.055	1.010	0.072	0.672	−0.037	0.822	0.235	1.070
ch20	−0.062	0.456	0.501	0.664	−0.155	0.865	0.285	0.646	0.288	0.574	0.503	0.559	−0.027	0.673	0.380	0.565
ch21	−0.133	0.607	−0.074	0.363	−0.266	0.547	0.055	0.788	0.456	0.651	0.034	0.476	0.181	0.628	0.003	0.757
ch22	0.008	0.639	0.033	0.608	−0.136	0.317	0.059	0.486	0.239	0.859	0.230	0.694	0.157	0.561	0.203	0.894
ch23	−0.082	0.667	0.485	0.698	−0.106	0.633	0.290	0.737	0.320	0.886	0.324	0.560	0.168	0.539	0.243	0.533
ch24	−0.057	0.479	0.070	0.495	−0.431	0.499	0.094	0.724	0.390	0.693	0.407	0.720	0.386	0.661	0.161	0.882

Appendix 2. Group 5f mean, sd score

5f 0–60sec

	r1		r2		r4		r5		w1		w2		w4		w5	
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
ch1	−0.459	0.513	−0.295	0.607	−0.546	0.519	−0.139	0.433	−0.250	0.253	−0.238	0.290	−0.172	0.183	−0.491	0.557
ch2	−0.608	0.398	−0.299	0.497	−0.425	0.473	−0.096	0.371	−0.169	0.325	−0.173	0.422	−0.291	0.275	−0.133	0.411
ch3	−0.507	0.548	−0.287	0.606	−0.614	0.392	−0.171	0.332	−0.290	0.477	−0.352	0.559	−0.334	0.357	−0.353	0.350
ch4	−0.299	0.480	−0.334	0.532	−0.475	0.328	−0.073	0.318	−0.180	0.333	0.015	0.369	−0.104	0.276	−0.169	0.531
ch5	−0.261	0.462	−0.114	0.526	−0.225	0.411	0.127	0.335	−0.323	0.242	−0.248	0.341	−0.307	0.295	−0.338	0.308
ch6	−0.206	0.422	−0.218	0.573	−0.363	0.540	0.121	0.278	−0.027	0.295	0.028	0.436	−0.233	0.303	−0.148	0.447
ch7	−0.159	0.274	−0.156	0.523	−0.178	0.482	0.015	0.348	−0.086	0.282	−0.168	0.474	−0.217	0.283	−0.141	0.409
ch8	−0.244	0.336	−0.102	0.422	−0.294	0.376	0.067	0.385	−0.137	0.498	−0.159	0.361	−0.109	0.356	−0.139	0.667
ch9	−0.232	0.288	−0.138	0.561	−0.231	0.418	0.013	0.412	−0.045	0.323	−0.118	0.243	−0.174	0.212	−0.014	0.273
ch10	−0.101	0.320	−0.103	0.412	−0.123	0.309	0.128	0.447	−0.035	0.423	−0.213	0.395	−0.219	0.251	0.079	0.375
ch11	−0.220	0.306	−0.110	0.481	−0.219	0.375	0.031	0.564	−0.108	0.248	−0.120	0.331	−0.142	0.261	0.046	0.551
ch12	−0.178	0.424	−0.203	0.468	−0.243	0.382	0.088	0.468	−0.296	0.297	−0.288	0.394	−0.314	0.228	−0.089	0.257
ch13	−0.273	0.532	−0.133	0.664	−0.357	0.418	−0.047	0.481	−0.445	0.498	−0.260	0.493	−0.452	0.395	−0.285	0.713
ch14	−0.388	0.492	−0.283	0.578	−0.342	0.411	−0.047	0.431	−0.200	0.229	−0.201	0.502	−0.231	0.307	−0.310	0.435
ch15	−0.151	0.381	−0.212	0.544	−0.411	0.473	−0.115	0.462	−0.318	0.374	−0.350	0.445	−0.468	0.410	−0.365	0.586
ch16	−0.446	0.538	−0.329	0.688	−0.405	0.387	−0.133	0.529	−0.386	0.352	−0.212	0.451	−0.260	0.330	−0.440	0.372
ch17	−0.253	0.418	−0.199	0.647	−0.206	0.502	0.074	0.397	−0.268	0.322	0.014	0.508	−0.194	0.285	−0.415	0.562
ch18	−0.182	0.362	−0.208	0.521	−0.327	0.384	0.033	0.463	−0.138	0.298	−0.210	0.492	−0.245	0.335	−0.260	0.300
ch19	−0.172	0.504	−0.002	0.725	−0.227	0.424	0.054	0.386	−0.294	0.260	−0.313	0.527	−0.312	0.402	−0.351	0.520
ch20	−0.173	0.276	−0.163	0.380	−0.341	0.282	−0.097	0.392	−0.115	0.294	−0.228	0.317	−0.288	0.260	−0.131	0.245
ch21	−0.153	0.243	−0.076	0.584	−0.257	0.375	0.013	0.413	−0.054	0.353	−0.094	0.568	−0.234	0.343	−0.140	0.278
ch22	−0.156	0.528	−0.170	0.413	−0.289	0.483	0.079	0.423	−0.289	0.342	−0.263	0.489	−0.487	0.287	−0.406	0.483
ch23	−0.321	0.258	−0.332	0.337	−0.305	0.404	−0.148	0.447	−0.009	0.195	−0.242	0.335	−0.237	0.177	−0.112	0.325
ch24	−0.240	0.347	−0.268	0.430	−0.419	0.315	−0.113	0.396	−0.028	0.454	−0.013	0.496	−0.383	0.305	−0.223	0.162

5f 0–30sec

	r1		r2		r4		r5		w1		w2		w4		w5	
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
ch1	−1.168	0.866	−0.682	1.116	−1.147	0.755	−0.403	0.872	−0.825	0.788	−0.834	0.867	−0.624	0.854	−1.008	1.190
ch2	−1.212	0.844	−0.654	1.030	−0.902	0.764	−0.489	0.499	−0.359	0.604	−0.355	0.777	−0.719	0.719	−0.156	1.134
ch3	−0.909	0.961	−0.613	1.153	−0.936	0.698	−0.503	0.467	−0.746	0.975	−0.782	0.758	−0.938	0.891	−0.724	1.034
ch4	−0.819	0.817	−0.639	0.863	−0.987	0.624	−0.433	0.779	−0.538	1.033	−0.395	0.936	−0.349	0.802	−0.338	1.302
ch5	−0.859	0.744	−0.489	1.079	−0.579	0.757	−0.243	0.570	−0.820	0.511	−0.697	0.861	−0.842	0.633	−0.848	0.971
ch6	−0.734	0.549	−0.615	0.846	−0.879	0.905	−0.341	0.846	−0.313	1.011	−0.413	0.896	−0.649	0.963	−0.389	1.337
ch7	−0.644	0.753	−0.462	0.802	−0.698	0.705	−0.381	0.572	−0.462	0.699	−0.581	0.779	−0.520	0.729	−0.279	1.098
ch8	−0.620	0.617	−0.314	0.927	−0.752	0.643	−0.422	0.683	−0.411	1.103	−0.640	0.659	−0.310	1.001	−0.122	1.517
ch9	−0.776	0.487	−0.578	0.653	−1.004	0.372	−0.325	0.721	−0.518	0.735	−0.787	0.675	−0.564	0.705	−0.240	1.103
ch10	−0.542	0.416	−0.439	0.645	−0.760	0.512	−0.359	0.560	−0.121	0.514	−0.600	0.602	−0.410	0.507	0.111	0.744
ch11	−0.696	0.659	−0.371	0.935	−0.793	0.806	−0.347	1.153	−0.298	0.901	−0.545	0.680	−0.268	0.826	0.236	1.396
ch12	−0.542	0.707	−0.757	0.541	−0.961	0.776	−0.357	0.710	−0.464	0.339	−0.716	0.725	−0.605	0.552	−0.067	0.665
ch13	−0.801	1.070	−0.505	1.061	−0.672	1.093	−0.503	1.031	−0.920	1.078	−0.815	1.051	−0.979	0.695	−0.901	1.198
ch14	−0.801	0.910	−0.536	0.974	−0.831	0.546	−0.532	0.994	−0.612	0.493	−0.672	1.194	−0.631	0.815	−0.494	1.040
ch15	−0.490	0.792	−0.742	0.505	−0.580	0.825	−0.801	0.665	−0.831	0.778	−0.826	0.906	−1.024	0.575	−0.898	0.877
ch16	−1.098	0.766	−0.804	1.013	−0.942	0.720	−0.705	0.838	−0.733	0.995	−0.702	0.970	−0.675	0.756	−0.640	1.012
ch17	−0.730	0.781	−0.463	0.859	−0.627	0.500	0.044	0.883	−0.741	1.026	−0.086	1.246	−0.755	0.851	−0.637	1.208
ch18	−0.591	0.580	−0.565	0.784	−0.667	0.743	−0.464	0.589	−0.318	0.603	−0.568	1.050	−0.666	0.495	−0.455	0.853
ch19	−0.413	0.913	−0.131	0.938	−0.484	0.946	−0.132	1.192	−0.609	0.908	−0.659	0.915	−0.715	0.804	−0.165	1.196
ch20	−0.646	0.712	−0.601	0.481	−0.750	0.454	−0.690	0.578	−0.095	0.469	−0.329	1.008	−0.514	0.594	0.088	0.715
ch21	−0.640	0.742	−0.545	0.954	−0.625	0.789	−0.672	0.576	−0.361	0.934	−0.535	1.080	−0.667	0.678	−0.155	0.731
ch22	−0.356	0.375	−0.268	0.655	−0.282	0.912	0.290	0.815	−0.662	1.174	−0.551	1.024	−1.046	0.799	−0.788	0.979
ch23	−0.487	0.796	−0.497	0.593	−0.355	0.603	−0.511	0.759	−0.157	0.450	−0.419	1.201	−0.681	0.767	0.013	1.093
ch24	−0.581	0.956	−0.476	0.778	−0.450	0.801	−0.072	0.822	−0.451	1.102	−0.400	1.284	−0.878	0.853	−0.491	0.610

5f 30–60sec

	r1		r2		r4		r5		w1		w2		w4		w5	
	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd	mean	sd
ch1	0.249	0.484	0.091	0.569	0.000	0.818	0.053	0.696	0.389	0.623	0.412	0.449	0.357	0.698	0.172	0.647
ch2	−0.006	0.288	0.054	0.446	−0.037	0.634	0.142	0.516	0.123	0.616	0.115	0.919	0.208	0.669	0.029	0.620
ch3	−0.106	0.825	0.038	0.783	−0.246	0.813	0.083	0.729	0.092	0.716	0.027	0.737	0.167	0.409	−0.015	0.477
ch4	0.220	0.485	−0.030	0.536	0.006	0.674	0.188	0.654	0.200	0.666	0.379	0.575	0.173	0.954	0.071	0.625
ch5	0.335	0.410	0.261	0.422	0.078	0.700	0.346	0.527	0.263	0.615	0.282	0.541	0.302	0.660	0.261	0.578
ch6	0.320	0.676	0.177	0.838	0.136	0.900	0.448	0.802	0.412	0.686	0.564	0.668	0.356	0.713	0.291	0.675
ch7	0.323	0.542	0.149	0.636	0.215	0.727	0.264	0.692	0.425	0.588	0.393	0.556	0.277	0.640	0.213	0.609
ch8	0.131	0.643	0.110	0.582	0.126	0.743	0.410	0.634	0.242	0.673	0.376	0.552	0.209	0.586	0.028	0.752
ch9	0.311	0.507	0.302	0.717	0.416	0.706	0.279	0.651	0.478	0.630	0.566	0.458	0.324	0.610	0.320	0.678
ch10	0.337	0.417	0.231	0.424	0.437	0.563	0.512	0.741	0.198	0.609	0.287	0.531	0.142	0.700	0.196	0.553
ch11	0.255	0.686	0.151	0.664	0.316	0.662	0.356	0.635	0.193	0.792	0.356	0.646	0.123	0.592	0.030	0.708
ch12	0.186	0.389	0.349	0.489	0.350	0.498	0.393	0.622	0.020	0.524	0.213	0.382	0.095	0.574	0.031	0.599
ch13	0.254	0.675	0.238	0.862	0.063	1.107	0.391	0.779	0.224	0.781	0.417	0.595	0.257	0.784	0.444	0.752
ch14	0.024	0.567	−0.031	0.870	−0.016	0.897	0.196	0.820	0.317	0.494	0.359	0.488	0.286	0.518	0.071	0.816
ch15	0.187	0.622	0.316	0.762	0.010	1.077	0.601	0.788	0.234	0.688	0.183	0.692	0.156	0.719	0.215	0.776
ch16	0.204	0.593	0.144	0.795	0.036	0.738	0.261	0.653	0.105	0.502	0.334	0.348	0.244	0.529	−0.043	0.618
ch17	0.223	0.654	0.065	0.912	0.105	0.951	0.026	0.746	0.288	0.715	0.222	0.766	0.406	0.458	−0.001	0.493
ch18	0.225	0.443	0.148	0.453	0.013	0.347	0.389	0.458	0.148	0.439	0.224	0.584	0.244	0.542	0.070	0.645
ch19	0.069	0.296	0.127	0.875	0.046	0.838	0.198	0.795	0.149	0.590	0.158	0.599	0.199	0.463	−0.255	0.607
ch20	0.297	0.682	0.273	0.604	0.102	0.416	0.412	0.794	−0.068	0.594	−0.063	0.780	−0.016	0.624	−0.226	0.904
ch21	0.333	0.765	0.392	0.674	0.104	0.590	0.530	0.754	0.393	0.658	0.460	0.651	0.353	0.559	0.119	0.808
ch22	0.044	0.734	−0.073	0.990	−0.243	0.685	−0.124	0.844	−0.103	0.667	−0.145	0.564	−0.111	0.522	−0.181	0.436
ch23	−0.157	0.406	−0.167	0.458	−0.309	0.536	0.032	0.599	0.150	0.684	0.002	0.737	0.199	0.634	−0.122	0.852
ch24	0.101	0.725	−0.060	0.484	−0.321	0.491	−0.151	0.554	0.233	0.828	0.218	0.605	0.028	0.468	−0.021	0.456