Subjective Evaluation on the Effect of the Blue Turban in Vermeer's "GIRL WITH A PEARL EARRING" and to Clear the Mystery of his Pictures

Tadahiro Tsujita , Jun Fukano (Konan University)
Hiroyuki Ohashi (Hitachi,Ltd)
Miwa Tsujita (Kobe Women's Junior College)

1. Introduction

In this paper, it is physically evaluated how human being's psychology changes by effect of the color of a blue turban in "GIRL WITH A PEARL EARRING" of Johannes Vermeer who is a famous realistic painter in the 17th century at Holland. Vermeer has left splendid pictures representing the shading of light as well as Rembrandt by using such scientific techniques as the camera of a scanner, perspective, film color skills, and so on.

It is generally said that the eyes, the lips, and the earring of the girl in the "GIRL WITH A PEARL EARRING" create a feeling of innocence, her naive awkwardness as a model and a feeling of speaking to people right now. [1] [2] [5] [6]

(Fig. 1. GIRL WITH A PEARL EARRING with Six Different Colors of her

Turban)

It is said as if there is not any effect from the blue of the turban, and when the turban is not blue, what effect there is, is a result of other factors.

Moreover, by changing the color of the turban, the following faces seem to appear besides the face of an intellectual and innocent woman: they were "face of a mature woman", "face of a passionate woman", "face of a nasty woman", " a mysterious face like the mask of a Noh play ‟, etc. Because these various faces seem to be momentarily concealed, the blue turban seems to emphasize her intellectual innocence. It is thought that a deep, mysterious sweetness is shown on the intellectual and innocent girl's face.

We used Osgood's Semantic Differential (SD) [3] technique for the purpose of physically estimating how human being's psychology changes due to the effect of the color of the turban in a painting by Vermeer. It was done by using two methods of the impression analysis experiment and the comparison analysis experiment to analyze these. In the impression analysis experiment we prepared six colors (red, blue, yellow, black and white) mutants with Photoshop by Adobe. A picture where the color of the girl's turban was sometimes changed was displayed to subjects. Then, the subjects answered questionnaires about their impressions of that picture using the Semantic Differential technique, choosing from 30 kinds of adjective pairs.

In the comparison analysis experiment six pictures, each with a different color turban, were simultaneously displayed to the subjects, and then they chose the picture whose color they felt most appropriate to the feeling measure shown. [4] [9]

2. Impression analysis experiment

2.1. Procedure for Impression analysis experiment

At first, the following seven steps measurement of adjective is provided**.**

Good	very	fairly	little	equal	little	fairly	very	**Bad**
	+3	+2	+1	0	-1	-2	-3	

The subjects are nine males and nine females. Their average age is 21.3 years. All subjects are right-handed.

1. One of six kinds of pictures and a feeling measure are displayed to the subjects. They choose the degree of adjective that they feel most applies to the feeling measure shown. The adjective pair is randomly changed 30 times. This measurement time is about 10 min.

2. Make the subjects solve simple numeric problems so that they will forget their previous impressions. This measurement time is about 5 min.
3. It allows a 5-minute rest for the subjects to recover from fatigue.

The picture is changed and the procedure is repeated for the experiment for each picture.

The total time of the experiment is 120 minutes for each subject.

The experimental device is a personal computer with a 21-inch flat monitor. The distance from the subject to the monitor is 60 cm. For the impression analysis experiment, the horizontal view is 5.71° and for the vertical view it is 7.58. For the comparison analysis experiment, the horizontal view is 9.46° and for the vertical view it is 8.06° .

2.2. Results of the impression analysis experiment

The results of this experiment are shown in Table 1. The numerical values are mean values that the 18 subjects selected from adjective pairs for feeling.

(Table 1. Adjective Pairs for Feeling and Results of the Impression Analysis Experiment)

	+	−	Red	Blue	Yellow	Black	Green	White
1	beautiful	ugly	1.17	1.61	0.33	0.83	0.78	0.83
2	fine	shabby	0.89	1.33	−0.56	0.00	0.17	0.22
3	desirable	repulsive	0.50	1.17	0.17	0.17	0.67	0.28
4	deep	shallow	−0.28	0.72	0.72	0.39	0.50	−0.22
5	pleasant	unpleasant	0.83	0.28	−0.11	−0.50	0.33	0.33
6	cute	provoking	1.00	0.83	0.28	0.00	0.44	0.50
7	elegant	inelegant	0.39	1.22	0.11	0.78	0.50	0.44
8	light	dark	1.11	0.33	−0.22	−1.00	0.22	0.28
9	loud	quiet	1.56	0.22	−0.39	−1.33	−0.06	0.06
10	joyful	somber	1.22	0.61	−0.11	−0.89	0.44	0.28
11	active	passive	1.28	−0.50	−0.67	−1.22	0.22	−0.22
12	noisy	silent	0.89	−0.72	−0.83	−1.22	0.00	−0.44
13	boisterous	meek	1.22	0.00	−0.44	−1.11	0.67	−0.33
14	impatient	laid-back	0.56	0.11	−0.33	−0.06	0.39	−0.28
15	stylish	uncouth	1.17	0.94	0.17	0.00	0.44	−0.11
16	hard	soft	−0.50	−0.06	−0.22	1.11	−0.22	−0.67
17	masculine	feminine	−1.11	−0.22	−0.39	−0.11	−0.44	−1.17
18	powerful	weak	1.00	0.78	−0.44	0.22	0.83	−0.22
19	positive	negative	1.11	0.56	−0.39	−0.28	0.50	0.06
20	clean	dirty	0.83	0.17	−0.06	−0.67	0.33	0.11
21	wise	foolish	0.61	1.28	0.17	0.89	0.50	0.39
22	sharp	blurry	0.56	0.72	−0.22	0.44	0.67	−0.06
23	intelligent	passionate	−1.39	1.11	0.89	0.94	0.22	0.83
24	friendly	unfriendly	0.44	0.39	−0.17	−0.56	−0.17	−0.06
25	approachable	unapproachable	0.33	0.22	−0.11	−0.72	0.17	0.17
26	relaxed	stiff	0.44	−0.78	0.17	−0.89	0.22	0.22
27	humble	aristocratic	−0.11	−0.83	0.83	0.11	0.06	0.39
28	youthful	elderly	0.94	1.17	−0.17	−1.06	0.33	−0.06
29	new	old	−0.22	1.22	0.17	0.61	0.50	0.72
30	mature	childish	−0.17	−0.78	0.33	1.17	0.56	−0.28

. (Reference: T. Iwashita's "A Fundamental Study on Formative Process for Personality Image")

2.3. Analysis and consideration for results

The formula used for this analysis is shown as follows. It is no exaggeration to say that the difference of the adjective pairs for feeling between blue and the other colors is great and the dispersion between the other colors is small.

$$f(z) = \left| y_z - \overline{x_z} \right| - \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (x_{iz} - \overline{x_z})^2}$$

Where x is the 5 colors' numeric data,

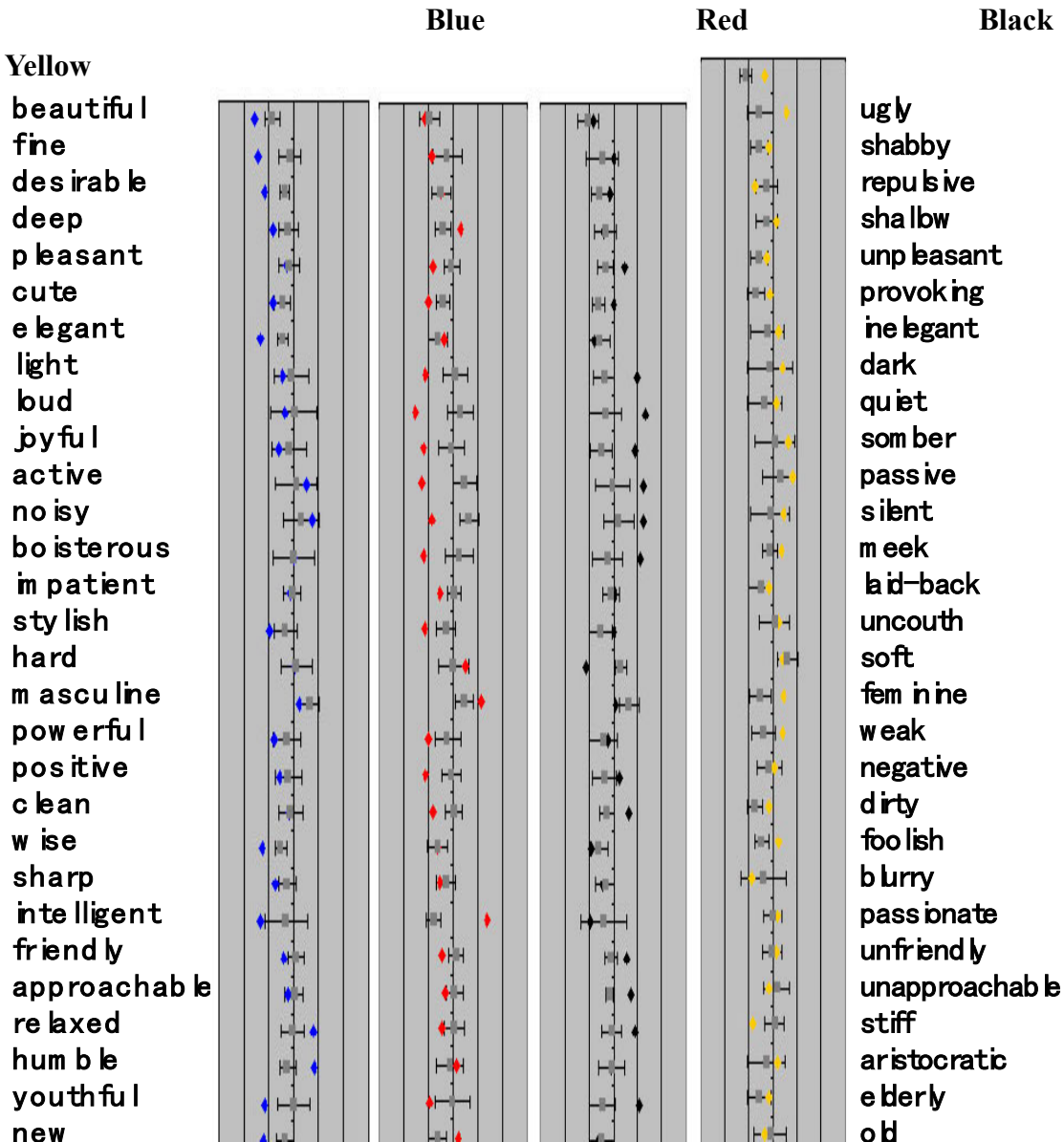
y is the numeric data of the subjects,

z is the number of adjective pairs of feeling (here 30),

n is the number of the other colors (here 5)

$f(z) \geq 0.5$

This adjective pair is the characteristic of the color.



+3+2+1 0 –1-2 -3 +3+2+1 0 –1-2 –3 +3+2+1 0 –1-2 –3 +3+2+1 0 –1-2 –3

Fig. 2 Results of the Impression Analysis Experiment

In the following Table 2 the values of f(z) that fulfilled the standard expression of 0.5 or more are shown.

(Table 2. Results of Adjective Pairs Detected)

red		blue		yellow		black	
passionate	1.89	aristocratic	0.76	shabby	0.57	hard	1.23
loud	1.30	fine	0.73	weak	0.51	stiff	0.98
active	1.28	desirable	0.61	humble	0.50	elderly	0.97
noisy	1.13	childish	0.58			quiet	0.94
boisterous	0.89	beautiful	0.56			somber	0.94
light	0.69	elegant	0.56			dark	0.91
positive	0.63	wise	0.53			unapproachable	0.73
joyful	0.62	new	0.52			meek	0.70
old	0.52	youthful	0.51			mature	0.67
clean	0.51					dirty	0.64
stylish	0.50					passive	0.55
						unpleasant	0.53

(There is no detection in green and white)

When the turban is blue, the feeling expressions into which the impression had changed are aristocratic (0.76), fine (0.73), desirable (0.61), childish (0.58), beautiful (0.56), elegant (0.56), wise (0.53), new (0.52), youthful (0.51). When the turban is red, they are passionate (1.89), loud (1.30), active (1.28), noisy (1.13), boisterous (0.89), light (0.69), positive (0.63), joyful (0.62), old (0.52), clean (0.51), stylish (0.50). When the turban is yellow, shabby (0.57), weak (0.51), humble (0.50). When the turban is black, hard (1.23), stiff (0.98), elderly (0.97), quiet (0.94), somber (0.94), dark (0.91), unapproachable (0.73), meek (0.70), mature (0.67), dirty (0.64), passive (0.55), unpleasant (0.53). There is no detection in green and white.

3. Comparison between male and female

We analyzed the difference of favorite color between men and women by using the following formula:

$$\begin{cases} \left|\overline{M}_z - \overline{F}_z\right| \geq 6. & \cdot\cdot \text{ the difference of gender-segregated average amount is large} \\ S_{Mz} \leq 1.0 & \cdot\cdot\cdot \text{ the difference of male's data is small (standard deviation is small)} \\ S_{Fz} \leq 1.0 & \cdot\cdot\cdot \text{ the difference of female's data is small (standard deviation is small)} \end{cases}$$

M is for male's data F is for female's data

z is for the number of adjective pairs of feeling (here 30)

We could detect a difference for adjective pairs only for the black turban between "cute-provoking" and "impatient--laid-back" and there was no big different between men and women.

4. Principal component analysis

We analyzed the "innocence" showing the impression of the girl in the pictures by using principal component analysis. We prepared a correlation matrix from the data which evaluated "youthful" and

(Table 3. Results of Principal Component Analysis)

subject	Sex	
A	female	○
B	female	○
C	female	×
D	female	×
E	female	○
F	female	×
G	female	○
H	female	○
I	female	○
J	male	×
K	male	○
L	male	×
M	male	○
N	male	○
O	male	×
P	male	×
Q	male	○
R	male	○

○ : Subject who knows the picture

Principal Component	I	II
A	0.3051	−0.0316
B	0.1725	−0.0779
C	0.1105	−0.2283
D	0.1844	−0.3703
E	0.2333	0.2850
F	0.2192	−0.1450
G	0.2056	0.0327
H	0.2689	−0.0228
I	0.0776	0.3513
J	0.3191	0.1910
K	0.2515	0.2914
L	0.1707	−0.2158
M	0.2629	0.3347
N	0.3108	−0.1478
O	0.2024	−0.4053
P	0.2384	−0.2804
Q	0.2142	0.0327
R	0.3226	0.1750
Eigenvalue	7.28	3.85
Contributing rate	40.43	21.40
	40.43	61.83

oks for eigenvalue and the eigenvector. All values of first principal component are in 02 or thereabout. Therefore, we understand that the first principal component evaluates "youthful" and the value of second principal component is the difference of acknowledgment of the pictures. We performed a principal component analysis based on the data of "youthful-elderly" and "known the picture-unknown the picture".

(Fig. 3. Score of Principal Component Analysis)

5. Comparison analysis experiment

The experimental device in this experiment is same as the impression analysis experiment.

The subjects are 10 males and 10 females, the average age of the subjects is 21.5 years and all subjects are right-handed.

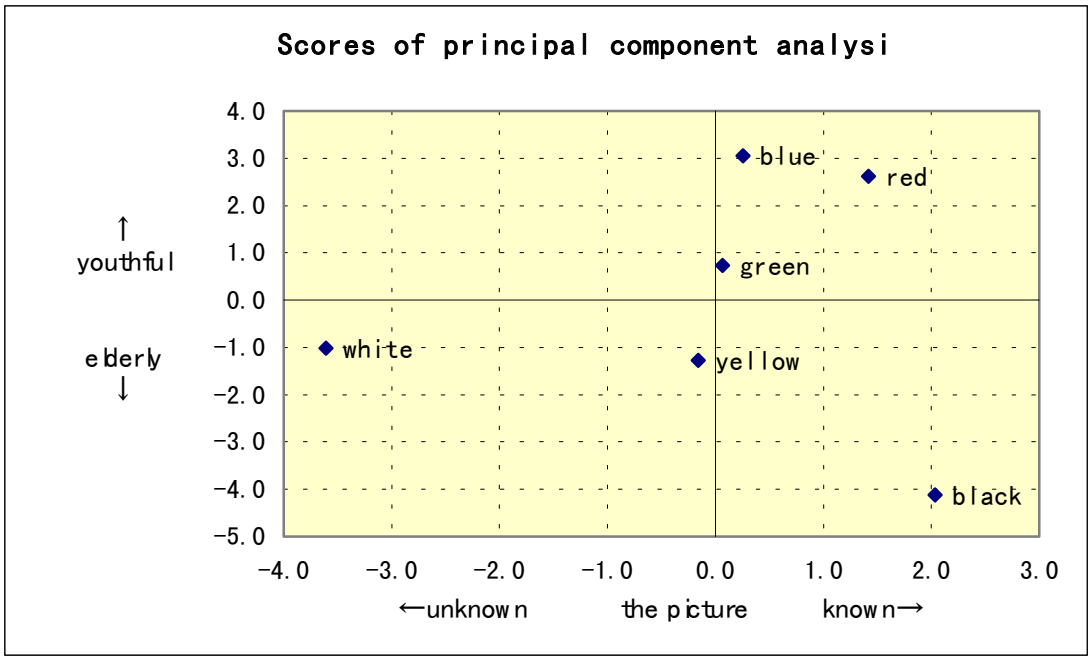
Six kinds of pictures in which the color of the turban can be changed are simultaneously displayed to the subjects, and then, they choose the picture of the color that they feel most applies to the feeling measure shown.

1. Six kinds of pictures and an adjective for feeling are simultaneously displayed to the subjects.

They choose the picture that they feel most applies to the feeling measure shown.

The adjective is changed randomly 30 times. The measurement time is about 10 minutes.

2. Make the subjects solve simple numeric problems so that they will forget their previous impression. This measurement time is about 5 minutes.



3. Allows a 5-minute rest for the subjects to recover from fatigue.

The order of six pictures is changed and the experiment is repeated three times.

The total time for the experiment is 60 minutes per subject. The results of this experiment showed no big differences from the impression analysis experiment, except

in the two new impressions “quiet” and “somber”.

6. Conclusions

The results of analysis are the following: t he blue color created an impression of “beautiful”, “brilliant” and “acceptable”. In addition, the following impressions were also created: “innocence” reflecting youth and freshness, “awkwardness” showing the formal setting, and “a feeling of speaking to people right now”, reflecting desirability and approachability. These results were not reported for the other colors.

There was not a wide difference of impression for these pictures between men and women.

According to this experiment, it turned out that the feeling measures which many chose for blue showed the same differences of impression, although there were a few differences in the first half of the experiment.

In the experiment where six kinds of pictures, in which the color of the turban was changed, were simultaneously displayed to the subjects, we found that the blue color turban created the two new impressions of “quiet” and “somber”. The difference between the two experiments was as following: in the first experiment her face, skin color, and clothes as well as the color of her turban were taken as a whole and estimated.

In the second experiment only the color of the turban in the six pictures was taken into account.

It was noted that the blue color of the turban promoted the elements of “innocence”, “the naive awkwardness as a model” and “a feeling of speaking to people right now”.

In addition, it also gave the impressions of “intelligent” and “aristocratic.”

There was not a wide difference of impression for this picture between men and women.

In conclusion, it can be said that human beings’ psychology changes according to the effects of color, and it is important that the color of the turban of the girl is blue.

Moreover, we could find the following faces were in this girl’s face besides the girl’s face of an intellectual and innocent; they were "face of a mature woman", "face of a passionate woman", "face of a nasty woman", " a mysterious face like the mask in a Noh play”, etc., as shown in Table 2 (Results of Adjective Pairs Detected). [7] [8]

References

[1] AXEL RUGER「VERMEER AND PAINTING IN DELFT」National Gallery Company (2001) pp. 21-25

[2] Hance・Coningsbelgar ”The World of Vermeer” Time Life (1971) p.139
[3] Toyohiko Iwashita ”Measurement of image by SD method the understanding and guidance ” Kawashima（1996） pp. 166-172
[4] Hiroyuki Ohashi ”Subjective evaluation on the effect of the blue turban in Vermeer’s “HEAD OF A GIRL WITH A PEARL EARRING” Konan University Department of Natural Science (Information), the paper of master degree No. 54 (2002)
[5] Genpei Akasegawa「Picture exploration of Genpei Akasegawa　Vision of Vermeer」 Kodan (1998) pp. 20-21, 62, 64
[6] Yoriko Kobayashi “The world of Vermeer” NHK Books (1999)
[7] Takayoshi Kaneko “Science of color” Iwanami Shinsho (1990)
[8] Takayoshi Kaneko “Psychology of color” Iwanami Shinsho (1988)
[9] T. Tsujita, H. Ohashi ”Subjective evaluation of the effect of the blue turban in Vermeer’s “HEAD OF A GIRL WITH A PEAL EARRING” PNC Annual Conference and Joint Meetings 2002 –PNC/ECAI/IPSJ-SIGCH/EBTI- (2002)