Analysis and Investigation on the Research for the Preference on Jewelry Amethyst and Sapphire LED Light Color

Ye-jin Hwang

Abstract Background/Objectives:*In this study, it aims to analyze the emotional response of consumers in the LED lighting environment considering the preference of users according to the types of products, and by presenting guidance on LED lighting for emotion optimized display according to the result, I want to help you with your activities.*

Methods/Statistical analysis:*As for a survey method, literature survey on LED lighting was conducted followed by emotional vocabulary extraction to evaluate emotional evaluation of LED color and product to be tested and subjective reaction to the color display of LED lighting was evaluated and analyzed.*

In this study,*emotional responses of consumers were analyzed in the lighting environment using LEDs for amethyst and sapphire of jewelry. Based on the results, we measured the color balance of Cool White, Red and Blue which are widely used in commercial space. We have studied emotional optimization using LED lighting classified as step.*

Findings:*As a result of examining the difference of preference according to the kinds of jewels in LED lighting, there was no significant difference between the types of jewels in Cool White (p = .126> .05).As for 25%, amethyst was 1.28, (P <.01). As for 50%, the amethyst was 1.11, that was higher than sapphire's -.68 (p <.01). As for 75%, amethyst was 0.76 higher than -0.25 of sapphire (p <.001). As for 100%, amethyst was -0.69, which was higher than sapphire's -1.08*

Improvements/Applications:

The objective of this study is to design the LED lighting system using LED CoolWhite, Red, and Blue LEDs for the experiment and to conduct a limited experiment and questionnaire through design experts and experts. Therefore, extraction of emotional vocabulary used in the questionnaire and general factors from them seem to be more emotionally approaching compared to ordinary people. In the future, it seems to be necessary to further refine the stage of mixed lighting and conduct various studies for the general public.

Keywords: Display, LED, Sensibility Optimization, Sapphire, Emotional evaluation

I. INTRODUCTION

The value of a product can be divided into fundamental value, derivative value, rational value and emotional value. Derivative values and emotional values are both subjective and irrational if the underlying values and derivative values are rational.

If traditional consumers have focused on rational and rational consumption in the past, people in modern era are now seeking for the rights of consumers themselves. At the same time, as consumers become more intelligent and emotional, their emotions become more and more influenced by their feelings and emotions. Emotional marketing emerges empowering brands and customers through emotional stimulation that affects them.

Emotional marketing can be said to impress consumers about products through stimulation or information that matches their emotions or their emotions. Therefore, emotional marketing shall cover every step from customer lifecycle: from attracting customers to activating, retaining customers, and reactivating. Emotional marketing is not an independent strategy but an interrelated strategy

This study has been conducted on the preference of LED lighting as a basic research to calculate systematic and emotional LED color sensibility optimization for emotion optimization of gemstone amethyst and sapphire for LED lighting display. For the research, collection of various emotional vocabulary used in purchasing amethyst and sapphire jewelry was preceded.

II. MATERIALS AND METHODS

This research is based on the assumption that LED lighting is the main factor of product sensibility reaction analyzing the emotional response of the consumer in the lighting environment realized by products and LED lighting. At the same time, this is a study of preference of LED lighting for sensibility optimization according to product to utilize in space. As a survey method, literature survey was conducted on LED lighting followed by emotional vocabulary extraction to evaluate emotional evaluation of LED color and product to be tested and subjective reaction to the color display of LED lighting was evaluated and analyzed.

2.1 Methods and conditions

Emotional vocabulary for research is extracted from literature and research data on 'LED, emotion, lighting, jewelery, color', related papers, newspaper articles, etc. and selected emotional adjectives with the highest

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frequency. Lt; / RTI & gt; Experimental environment was analyzed by using the LED lighting model designed for the purpose of the study in a laboratory without a window, and the results were analyzed. The LED lighting color of the experiment was limited by the stepwise combination of Cool_White, LED Blue, and LED Red among the white LEDs.

This paper is organized as follows.

First of all, the background and objective of the study, the research scope and method were described.

Secondly, the representative vocabulary was analyzed through emotional adjectives, and simple statistical analysis was conducted using experiments and questionnaires. This study was analyzed using statistical program SPSS / WIN.

Third, the conclusion of this study is described.

Table 1.Selected sensibility vocabulary (100)

Pitiful	Reliable	Pleasant	Haughty	Sparkling	Sophisticated	Solemn	Intellectual	Dignified	Refined
Sweet	High-end	Immeasurable	Urban	Bright	Sexy	Feminine	Provocative	clear blue	Plentiful
Good	Elegant	Clean	Flattering	Complex	Austere	Passionate	Natural	Brilliant	Modern
Intense	Antique	Sharp	Dynamic	Soft	Plain	Crystal clear	Sublime	Naïve	Engaging
Strong	Authoritative	Generous	Stiff	Lovely	Pure	Pretty	Funny	Immaculate	Splendid
Characterful	Cute	Striking	Fascinating	Luxurious	Gentle	Mild	Decent	Countrified	Gorgeous
Coarse	Precious	Easygoing	Cool	Fresh	Noble	Graceful	Delicate	Familiar	Fantastic
Healthy	Mellow	Kind	Heavy	Western	Mysterious	Magnificent	Precise	Murky	Light
High-toned	Nice	Solid	Subtle	Vivid	Practical	Mature	Virtuous	Folksy	Active
Sturdy	Metallike	Simple	Glabrous	Detailed	Wild	Flexible	Harmonious	Transparent	Entrancing

As a result of the above study, the emotional adjectives used in this study were extracted from six emotional vocabulary, 'intense, fascinating, fantastic, glittering, gorgeous, mysterious' and sapphire has' clear, transparent, vivid, precious, brilliant, mysterious 'Six emotional vocabularies were extracted and tested based on this.

2.2 Method and condition

In this study, subjects were examined in a laboratory without a window, and the experiment was conducted by observing at 150cm distance from the jewel in the LED lighting box designed for the purpose of study as shown in Fig. 1.2.

- Amethyst LED Lighting Color :Cool_White, Cool_White + Red25%, Cool_White + Red50%, Cool_White + Red75%, Cool_White + Red100%
- Sapphire LED Lighting Color: Cool_White, Cool_White + Blue25%, Cool_White + Blue50%, Cool_White + Blue75%, Cool_White + Blue100%
- LED Light Box : 550(W)×480(D)×320(H)(cm)

The subjects consisted of 20 design major and 20 experts who understood the contents of the research and the emotional adjectives, and recognized that there was no abnormality in color discrimination.

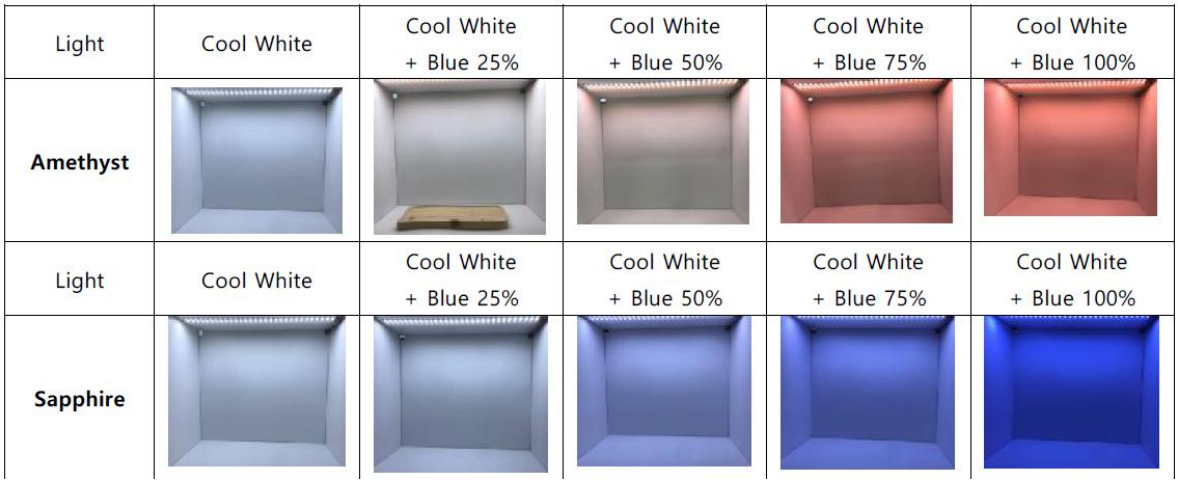


Figure 1. Implemented lighting

Lighting	Dimmer	Adapter	LED Bar
			
Size(cm) :550(W) x480(D)x320(H) White acrylic 3mm	-White LED -Blue LED -DC12 24V 8A	Input : 100~240V Output : 12V 5A	-LED Cool White (SMD 5050) 50cm 2EA -LED Blue 50cm 2EA

Figure 2. Experiment environment

III. RESULT AND CONSIDERATION

3.1 Data handling method

In this study, each item was statistically processed by scoring and analyzed using statistical program SPSS / WIN 23.0.

First of all, descriptive statistics such as frequency, percentage, mean, and standard deviation were used for general characteristics of the subjects, consumer awareness, and feelings in each illumination.

Second, one-way ANOVA was used to find out the difference of feeling according to lighting, and Scheffe method was used as follow-up test.

Third, one-way ANOVA was conducted to examine the difference in preference according to the five lighting conditions, and a corresponding sample t-test was conducted to compare the preferences of the two illuminations.

The empirical analysis of this study was verified at significance level p <.05, p <.01, p <.001.

3.2 Classification from LED light

3.2.1 General information of subjects and consumer recognition

This study has been conducted on a total of 20 design students, 14 design specialists and 6 design experts considering the characteristics of the study. As shown in Table 2 below, descriptive statistics such as frequency, percentage, average, and standard deviation were used for the subjects' general information and awareness.

Table 2. General information of subjects

		Frequency	Percent
Gender	Male	8	40.0
	Female	12	60.0
Age	30~40s	10	50.0
	10~20s	9	45.0
	Over 50s	1	5.0
Marital status	Married	10	50.0
	Single	10	50.0
Occupation	Students	10	50.0
	career in management	4	20.0
	Specialized job	6	30.0
Total		52	100.0

As for gender, 60% of the women were over 50%, and 40% of the males. In the case of the ages, most of them were in their10s-20sas 45%followed by 50% in their 30s and 40s and 5% in their 50s or over.

In the case of marriage, 50% of them were married, and another 50% of them were single, while 50.0%of subjects turned out tobe students, and 30.0% of them were professionals.

3.2.2 LED LightColor : Cool White

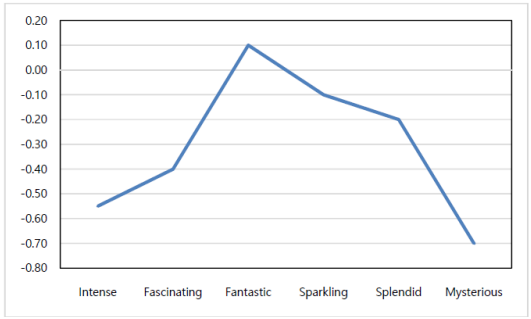
In the Cool White illumination as shown in Table 3 and Figure 3, the amethyst has the highest 'fantastic' feeling followed by the 'glitter', 'gorgeous', and 'fascinating,' and sapphire turned out to have the highest 'transparent' feeling followed by 'vivid', 'mystical', 'brilliant', and 'dodgy'.

Table 3. LED LightColor : Cool White

White		Minimum value	Maximum value	Average	Standard Deviation
Amethyst	Intense	-2	2	-0.55	1.19
	Fascinating	-2	2	-0.4	1.14
	Fantastic	-2	2	0.10	1.21
	Sparkling	-2	2	-0.10	1.25
	Splendid	-2	1	-0.20	1.11
	Mysterious	-2	2	-0.70	1.08
Sapphire	clear blue	-2	2	-0.35	1.18
	Transparent	-2	2	0.25	1.12

	Vivid	-2	2	-0.05	1.19
	Haughty	-2	1	-0.25	1.02
	Brilliant	-2	2	-0.20	1.11
	Mysterious	-2	2	-0.10	1.21

※ As the score is high, the level of receiving feeling is high.



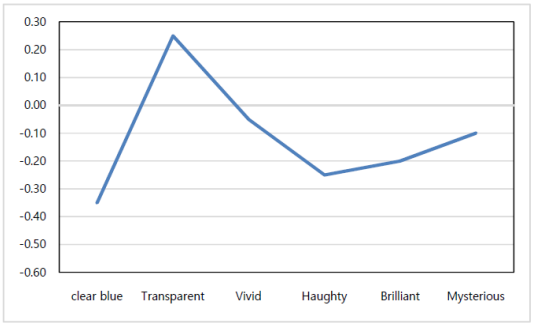


Figure 3.LED LightColor : Cool White

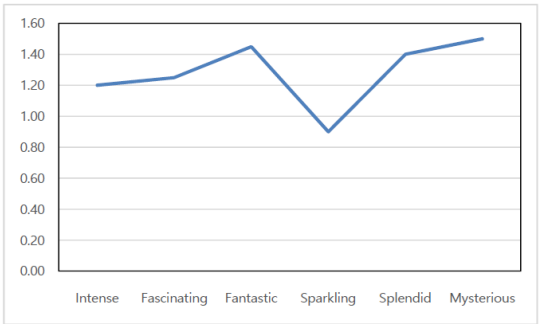
3.2.3 . LED LightColor : C-Red 25%, C-Blue 25%

As shown in Tables 4 and Figure 4 below, in the case of 25% illumination, the 'mysterious' feeling was highest in the amethyst, followed by 'magical', 'brilliant' and 'fascinating' feeling, and Sapphire turned out to have the highest 'mysterious' feeling followed by transparent,''glittering,'and 'cold' feeling.

Table 4. LED LightC-Red 25%, C-Blue 25%

C-25%		Minimum value	Maximum value	Average	Standard Deviation
Amethyst	Intense	-1	2	1.20	0.77
	Fascinating	-1	2	1.25	0.79
	Fantastic	0	2	1.45	0.60
	Sparkling	-1	2	0.90	0.85
	Splendid	-1	2	1.40	0.75
	Mysterious	1	2	1.50	0.51
Sapphire	clear blue	-1	2	1.15	0.81
	Transparen t	-1	2	0.55	0.94
	Vivid	-2	2	0.30	1.13
	Haughty	-1	2	1.00	0.97
	Brilliant	-1	2	1.10	0.79
	Mysterious	0	2	1.25	0.72

*p<.05 **p<.01 ***p<.001



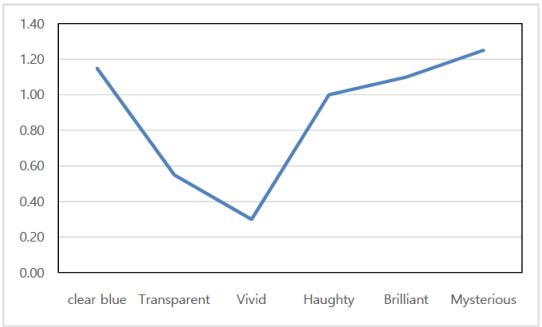


Figure 4.LED LightColor : Cool White

3.2.4. LED Light Color : C-Red 50%, C-Blue 50%

As shown in Tables 5 and Figure 5 below, the'strong' feeling was highest in the amethyst, followed by 'attractive', 'brilliant' and 'mysterious' feeling, and Sapphire turned out to have the highest 'glittering' feeling followed by 'mysterious,'

'transparent,' and 'clear' feeling.

Table 5. LED LightC-Red 50%, C-Blue 50%

C-50%		Minimum value	Maximum value	Average	Standard Deviation
Amethyst	Intense	1	2	1.55	0.51
	Fascinating	0	2	1.45	0.60
	Fantastic	-1	2	0.90	1.02
	Sparklin	-2	2	0.65	1.23
	Splendid	-1	2	1.05	1.00
	Mysterious	-1	2	1.05	1.00
Sapphire	clear blue	-1	2	0.85	0.99
	Transparen t	-2	1	-0.10	1.17
	Vivid	-1	2	0.75	1.12
	Haughty	-2	2	0.45	1.15
	Brilliant	-1	2	1.15	0.88
	Mysterious	-1	2	0.95	0.94

*p<.05 **p<.01 ***p<.001

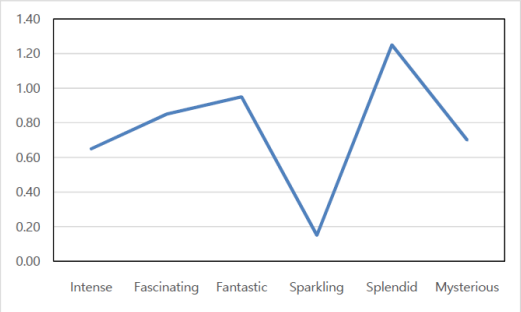
Figure 4. LED LightC-Red 50%, C-Blue 50%

3.2.5. LED LightColor : C-Red 75%, C-Blue 75%

As shown in Tables 6 and Figure 6 below, the 'brilliant' feeling was highest in the amethyst, followed by 'fascinating', 'attractive' and 'mysterious' feeling, and Sapphire turned out to have the highest 'cold' feeling followed by 'transparent,' 'brilliant,' and 'mysterious' feeling.

Table 6. LED LightC-Red 75%, C-Blue 75%

C-75%		Minimum value	Maximum value	Average	Standard Deviation
Amethyst	Intense	-2	2	0.65	1.39
	Fascinating	-1	2	0.85	1.09
	Fantastic	-2	2	0.95	1.05
	Sparkling	-2	2	0.15	1.35
	Splendid	-1	2	1.25	0.97
	Mysterious	-2	2	0.70	1.22
Sapphire	clear blue	-2	2	0.05	1.15
	Transparen t	-2	1	-0.60	0.94
	Vivid	-2	1	-0.50	1.05
	Haughty	-2	2	0.05	1.32
	Brilliant	-2	2	-0.15	1.14
	Mysterious	-2	2	-0.25	1.25



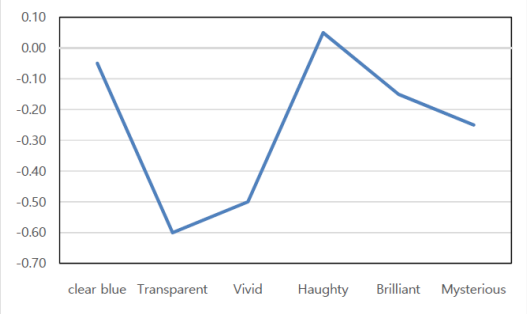


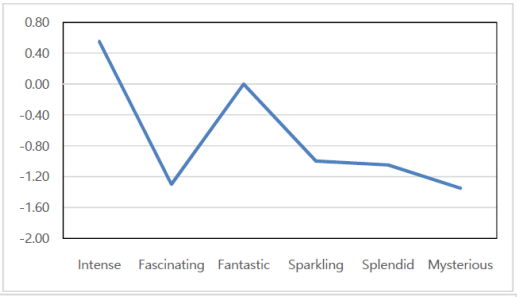
Figure 6. LED Light C-Red 75%, C-Blue 75%

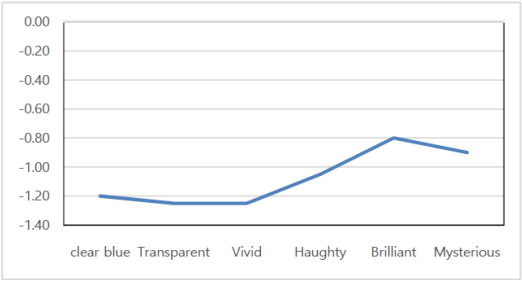
3.2.6. LED LightColor : C-Red 100%, C-Blue 100%

As shown in Tables 6 and Figure 6 below, the ‘strong' feeling was highest in the amethyst, followed by ‘fascinating', 'glittering' and 'splendid’ feeling, and Sapphire turned out to have the highest ‘glittering’ feeling followed by ‘mysterious,’ ‘cold,’ and ‘transparent’ feeling.

Table 7. LED Light C-Red 100%, C-Blue 100%

C-100%		Minimum value	Maximum value	Average	Standard Deviation
Amethyst	Intense	-2	2	0.55	1.32
	Fascinating	-2	0	-1.30	0.57
	Fantastic	-2	2	0.00	1.41
	Sparkling	-2	1	-1.00	1.03
	Splendid	-2	1	-1.05	0.76
	Mysterious	-2	1	-1.35	0.75
Sapphire	clear blue	-2	1	-1.20	0.77
	Transparent	-2	1	-1.25	0.85
	Vivid	-2	1	-1.25	0.79
	Haughty	-2	1	-1.05	0.94
	Brilliant	-2	2	-0.80	1.06
	Mysterious	-2	1	-0.90	0.91





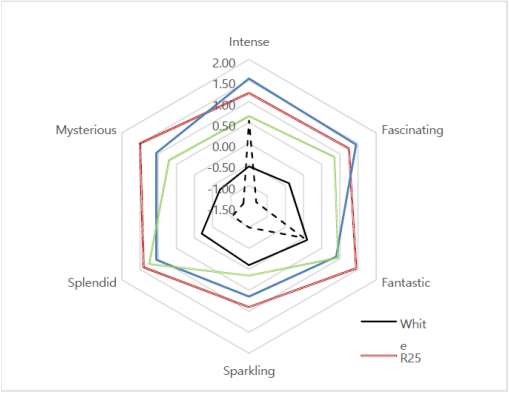


Figure 7. LED Light C-Red 100%, C-Blue 100%

3.2.7. LED Light

A graph of the adjective feelings for all lights in amethyst and sapphire is shown in <Figure 8>.

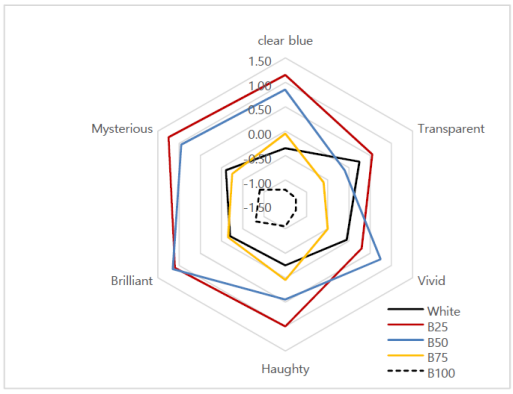


Figure 8.LED LightColor : Cool White

Amethyst was highest in C-Red 25% and C-Red 50%, and it was found low in White and C-Red 100%.

Sapphire was also highest in C-Blue25% and C-Blue50%, and lowest in C-Blue100%.

3.3. Entire feeling from the light

As shown in Table 7 and Figure 9, the overall feeling of LED lighting was as follows: Cool Red 25% was highest at 1.28, C-Red 50% 1.11, C-Red 75% 0.76, C White -0.31 , C-Red 100% -0.69, while C-Blue 25% and C-Blue 50% were the highest in the order of 0.68, 0.75 and 75% 0.25 and C-Blue 100% -1.08, respectively.

Table 7. Entire feeling from the light(N=40)

		N	Average	Standard Deviation	F	p
Amethyst	Cool White	20	-0.31	0.36	81.531***	.000
	C-Red 25%	20	1.28	0.24		
	C-Red 50%	20	1.11	0.41		
	C-Red 75%	20	0.76	0.56		
	C-Red 100%	20	-0.69	0.48		
Sapphire	Cool White	20	-0.12	0.52	66.595***	.000
	C-Blue 25%	20	0.89	0.33		
	C-Blue 50%	20	0.68	0.47		
	C-Blue 75%	20	-0.25	0.38		
	C-Blue 100%	20	-1.08	0.33		

※ As the score is high, the level of receiving feeling is high.

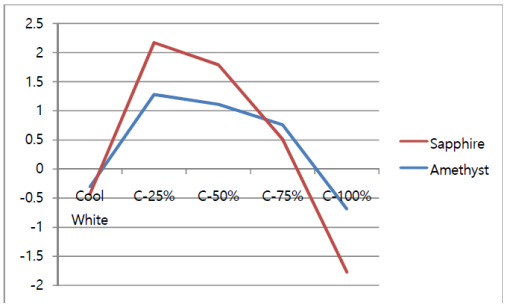


Figure 9. Entire feeling from the light

3.3.1. Verification from the preference of LED light

As shown in Table 8 below, one-way ANOVA was performed to examine the difference in preference between five lights. In order to compare the preferences of the two lights, the corresponding sample t-test was significant at p <.05, p <.01, p <.001.

Table 8. Verification from the preference of LED light

		N	Average	Standard Deviation	F	p
Amethyst	Cool White	20	-0.31	0.36	81.531***	.000
	C-Red 25%	20	1.28	0.24		
	C-Red 50%	20	1.11	0.41		
	C-Red 75%	20	0.76	0.56		
	C-Red 100%	20	-0.69	0.48		
Sapphire	Cool White	20	-0.12	0.52	66.595***	.000
	C-Blue 25%	20	0.89	0.33		
	C-Blue 50%	20	0.68	0.47		
	C-Blue 75%	20	-0.25	0.38		
	C-Blue 100%	20	-1.08	0.33		

*p<.05 **p<.01 ***p<.001

3.3.2. Difference of the preference from Cool White and light

As a result of comparing the preferences of the five lights, it was found that there was a significant difference in preference between the amethyst (p <.001) and sapphire (p <.001).

As shown in Tables 9and as shown in Tables 10 below, Cool_White and Red 25% showed a high preference of Cool Red 25% and showed a significant difference at p <.001 level. In addition, Cool_White and Red50 were at p <.05, while Cool White and Red50 were at p <.001. Red turned out to be preferable between Cool White and Red 100 at p <.001.

Therefore, as for red light, Red25, Red50, and Red75 were more favorable than White, and Red100 was less favorable than White.

Table 9. Difference of the preference from White and Blue light for amethyst

Amethyst	Average	Standard Deviation	t	p
Cool_White	-0.31	0.36	-5.244***	.000
C-Red 25	1.28	0.24		
Cool_White	-0.31	0.36	-2.093*	.050
C-Red50	1.11	0.41		
Cool_White	-0.31	0.36	8.103***	.000
C-Red75	0.76	0.56		
Cool_White	-0.31	0.36	22.453***	.000
C-Red100	-0.69	0.48		

*p<.05 **p<.01 ***p<.001

Table 10. Difference of the preference from White and Blue light for Sapphire

Sapphire	Average	Standard Deviation	t	p
Cool_White	-0.12	0.52	-18.052***	.000
C-Blue25	0.89	0.33		
Cool_White	-0.12	0.52	-11.177***	.000
C-Blue50	0.68	0.47		
Cool_White	-0.12	0.52	-6.018***	.000
C-Blue 75	-0.25	0.38		
Cool_White	-0.12	0.52	6.527***	.000
C-Blue100	-1.08	0.33		

*p<.05 **p<.01 ***p<.001

Sapphire represented higher preference at Blue25 and Blue50 than Cool White at p <.001, and Blue75 and Blue100 indicated lower preference at p <.001 level.

Therefore, Sapphirerepresented the highest preference of Blue25 and Blue50 in Blue lighting, Blue75 and Blue100 indicated the lowest preference, and White had a medium preference.

3.3.3. Difference of the preference from the brightness of light

As shown in Table 11 and 12 below, there was no significant difference between Red25 and Red50 in terms of preference difference in amethyst. As for Red 25, Red 75, and Red 100, the preference of Red 25 was significantly higher than Red 75 and Red 100 at p<.001.

The preference of Red 50 was significantly higher than Red 75 at p<.05 and also than Red 100 at p<.001. Lastly, as for Red 75 and Red 100, Red 75 seemed to be more preferable representing a significant difference at p<.001.

Table 11. Difference of the preference from the brightness in Amethyst red light

Amethyst	Average	Standard Deviation	t	P
C-Red 25	1.28	0.24	1.724	.101
C-Red 50	1.11	0.41		
C-Red 25	1.28	0.24	4.448***	.000
C-Red 75	0.76	0.56		
C-Red 25	1.28	0.24	14.536***	.000
C-Red 100	-0.69	0.48		
C-Red 50	1.11	0.41	2.135*	.046
C-Red 75	0.76	0.56		
C-Red 50	1.11	0.41	11.139***	.000
C-Red 100	-0.69	0.48		
C-Red 75	0.76	0.56	7.788***	.000
C-Red 100	-0.69	0.48		

*p<.05 **p<.01 ***p<.001

Table 12. Difference of the preference from the brightness of Sapphire blue light

Sapphire	Average	Standard Deviation	t	P
C-Blue25	0.89	0.33	2.311*	.032
C-Blue50	0.68	0.47		
C-Blue25	0.89	0.33	8.872***	.000
C-Blue75	-0.25	0.38		
C-Blue25	0.89	0.33	17.897***	.000
C-Blue100	-1.08	0.33		
C-Blue50	0.68	0.47	5.743***	.000
C-Blue75	-0.25	0.38		
C-Blue50	0.68	0.47	13.024***	.000
C-Blue100	-1.08	0.33		
C-Blue75	-0.25	0.38	6.116***	.000
C-Blue100	-1.08	0.33		

*p<.05 **p<.01 ***p<.001

As shown in Table 12 above, Blue25 and Blue50 showed higher preference at the level of p <.05, and Blue25 and Blue75 indicated higher preference than Blue75 and Blue100 at p <.001 Preference was significantly higher at the level.

Blue50 showed a higher preference for Blue50 than Blue75 and Blue100 at p <.001 level. Blue75 and Blue100 showed higher preference at the level of p <.001. That is, Blue25, Blue50, Blue75 and Blue100 showed preference in order.

3.3.4. Difference of the preference from types of jewelry

As a result of examining the preference difference according to the kinds of jewelsas shown in Table 13, there was no significant difference between the types of jewels (p = .126> .05). In 25%, amethyst was 1.28 and 0.89 in sapphire <.01). As for 50%, amethyst was 1.11, which was higher than sapphire's -.68 (p <.01). As for 75%, amethyst was 0.76 higher than -0.25 of sapphire (p <.001). As for 100%, amethyst was -0.69, which was higher than sapphire's -1.08 (p <.01).

Table 13. Difference of the preference from types of jewelry

		Average	Standard Deviation	t	p
Cool White	Amethyst	-0.31	0.36	-1.599	.126
	Sapphire	-0.12	0.52		
C-25%	Amethyst	1.28	0.24	3.784**	.001

	Sapphire	0.89	0.33		
C-50%	Amethyst	1.11	0.41	3.151**	.005
	Sapphire	0.68	0.47		
C-75%	Amethyst	0.76	0.56	8.866***	.000
	Sapphire	-0.25	0.38		
C-100%	Amethyst	-0.69	0.48	3.960**	.001
	Sapphire	-1.08	0.33		

*p<.05 **p<.01 ***p<.001

IV. CONCLUSION

As a result of the study, Cool_White, Red and Blue lights that are mainly used for jewelry amethyst and sapphire display have a high sensitivity preference. Cool White, which analyzed the preference for LED lighting in the lighting environment implemented for the experiment, (P = .126> .05). In 25%, the proportion of amethyst was 1.28, and the proportion of amethyst of 0.89 was higher than that of sapphire (p <.01) (P <.01). As for 75%, amethyst was 0.76 higher than -0.25 of sapphire (p <.001). As for 100%, amethyst was -0.69, which was higher than sapphire's -1.08

In the emotional scale, the average value of C-Red 25% was 1.50 in amethyst, and the average value was 1.55 in C-Red 50%. In sapphire case, the average value of C-Blue 25% was 1.25, and it was strong in mysterious feeling. In 50% of C-Blue, the average value was 1.15 representing strong ‘brilliant’ feeling.

In addition, the brightness was shown in the order of Red25, Red50, Red75, Red100.

The extraction of emotional vocabulary used in the questionnaire, and the general factors related to the emotional vocabulary are seen to be more emotional compared to the general public. In the future, it will be necessary to further refine the stage of mixed lighting and conduct various studies for the general public. When these studies are conducted, a systematic plan for LED lighting values for emotion optimization can be established.

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