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Color Emotion Based on CNCS Color System ⋆

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Abstract

In this study, color emotion based on CNCS color system was investigated. The research included single color preference and multi-color coordination emotion. Six themes of International Textile color traded were selected as color samples. At the first step, forty-two single colors were regarded as color samples for color preference survey. At the second step, twenty-four kinds of color coordination were made according to six color concepts, and color emotion survey for multi-color coordination was conducted. In the second part, fifteen color emotion scales such as "modern-classic", "formal-casual", "gaudy-tasteful", "lively-stiff", "intellectual-nonintellectual", "like-dislike" and so on were selected according to Semantic Differential Method. The survey was conducted among the undergraduate college students from Xi'an Polytechnic University. Color histogram was used to express the result of single color preference. It was clear that the popularity of these released colors was not average and the more favorite colors were pale chromatic colors. Factor Analysis and cluster analysis were used to conduct the data from the second part survey. Three factors were extracted and labeled "personality", "taste", and "fashion". Twenty-four multi-color combinations were classified into three groups. It indicated that the comprehensive color emotion was more important than other factors.

Keywords: Color Preference; Color Emotion; Multi-color Combination; Semantic Differential Method; Factor Analysis

1 Introduction

International Commission of Color hold the first meeting in 1963. From then on, some countries began to found their own association of color one after another. These societies were responsible for forecasting and releasing fashion color. During some decades development, the trend report was referred by more and more companies and designers. The fashionable colors were released by themes, each theme included a series of colors. There were twice (spring-summer and autumn-winter) each year [1]. Were these colors really popular? It would be confirmed in this study.

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In our previous study, color psychology for single color was investigated, and compared between Chinese and Japanese. It has been concluded that the respondents were inconsistent to abstract meaning of color and color preference, but consistent to natural color and custom [2-5]. Uravis Tangkijviwat researched the relationship between color preference and the mode of color appearance. The result showed that color preference is dominated not only by color attributes but also by the mode of color appearance [6]. Iris Bakker studied color preferences for different topics in connection to personal characteristics. It indicated that color preferences were dependent upon the topic, and personal characteristics [7].

Color preference is one kind of color emotion. Color emotion shows more complicated psychology. Many researchers had studied color emotions.

Li-Chen Ou et al. had studied color emotions for single-color and two-color, a color-appearance-based model was established for color-combination emotions. With this model one can predict color emotions for a color pair if color-appearance attributes of the component colors in that pair are known [8, 9].

In this study, one set of colors released by China Fashion Color Association were regarded as color samples. Single color preference and multi-color emotion were investigated respectively. The aim was to test the reliability of color trends and to propose better way of using color trends.

2 Method

2.1 Stimuli and Questions

In this study, the colors in six themes of International Textile color trades were regarded as basic colors. The six themes were sublimation, filtering, gradation, natural blue tone, roadway, hanging. There were forty-two colors in total and each color was expressed by CNCS color system. These colors were renamed respectively according to their themes in order to facilitate the description. For example, the first theme "sublimation" included seven colors, and the first color of the first theme was named "T1-1". The color names and color rectangles were showed in Table 1 with color values in RGB and CIE 1976 L∗a∗b∗ system together. From these color rectangles we could see most colors were grayish or similar to gray. It indicated that it was more possible to become popular for achromatic colors and colors similar to achromatic color.

Semantic Differential Method was used in this study. Semantic differential is a type of a rating scale designed to measure the connotative meaning of objects, events, and concepts. The respondent is asked to choose where his or her position lies, on a scale between two bipolar adjectives. Semantic differentials can be used to measure opinions, attitudes and values on a psychometrically controlled scale. According to Semantic Differential Method, stimuli for investigation and some bipolar adjectives for questionnaire were prepared firstly.

In the released six themes, there were several kinds of color coordination. According to the color coordination, twenty-four multi-color combinations were made as the appearance of Chinese Jiugongge shown as Fig. 1, which could express the main color and secondary color. In the aesthetics of fashion color coordination, contrast must exist which may be various aspects, such as lightness, saturation, hue, area.

Fifteen pairs of color emotion words were used in the second part of survey: modern-classic, vulgar-elegant, formal-casual, fresh-stale, gaudy-tasteful, lively-stiff, implicit-flaunty, gorgeous-

plain, fashionable-dated, individual-popular, powerful-powerless, rural-urban, warm-cool, intellectual-nonintellectual, like-dislike. These were the most frequently used words in these studies. For each pair of words, five scales were used. These color emotion words and five scales were printed in answer sheets.

The stimuli were generated by a computer and displayed by a projector in 3500 lm with a resolution of 1024 × 768 pixels. The screen was shown to the respondents by about 13° (vertical direction) and 17.5° (horizontal direction) visual angle from a distance of 10 meters. The respondents with common vision were gathered in a dark room with just enough light for reading the questionnaire. The respondents were asked to watch the stimuli and answer the questionnaire.

2.2 Respondents and Survey Period

The survey was conducted in 2015. A total of 204 undergraduate students were surveyed at Xi'an Polytechnic University. All the students were aged from 20 to 24, and with normal color vision.

2.3 Analysis Methods

Color histogram and the Semantic Differential Method were used in this study, and the data from the survey were conducted by using the factor analysis and cluster analysis.

Table 1: The names and value of selected colors in different color system

Color Item	Number in CNCS	R	G	B	L	a*	b*
T1-1	008 70 00	182	174	175	71.84	2.54	0.84
T1-2	024 65 07	189	160	147	67.99	8.69	10.61
T1-3	128 60 00	147	148	151	61.22	0.61	−1.76
T1-4	152 35 02	99	84	89	37.21	7.42	−1.03
T1-5	032 65 07	183	157	136	66.61	6.27	14.53
T1-6	032 75 07	214	187	162	77.53	5.58	16.21
T1-7	088 60 00	148	152	151	62.60	−1.78	0.04
T2-1	048 90 00	233	230	226	91.51	0.41	2.32
T2-2	024 55 02	150	133	126	56.87	4.90	6.31
T2-3	024 85 02	234	220	210	88.56	3.25	6.63
T2-4	048 60 17	170	148	61	61.84	−2.19	47.91
T2-5	048 80 12	224	209	148	83.88	−3.76	32.11
T2-6	056 60 02	150	151	134	62.06	−3.68	8.75
T2-7	056 30 02	73	76	65	31.72	−3.20	5.94

continued

Color Item		Number in CNCS	R	G	B	L	a*	b*
T3-1		152 25 02	71	58	67	26.02	7.45	−3.15
T3-2		152 25 07	76	55	69	25.90	11.79	−4.70
T3-3		160 35 17	126	65	81	35.52	28.51	2.18
T3-4		002 30 27	126	43	64	30.74	37.95	6.64
T3-5		007 50 32	215	75	80	51.92	54.82	27.56
T3-6		010 60 27	233	115	108	62.26	44.71	25.63
T4-1		120 20 02	43	52	61	21.09	−0.97	−7.35
T4-2		104 35 12	24	96	108	37.19	−16.97	−13.25
T4-3		088 65 02	149	169	165	67.55	−7.53	−0.41
T4-4		000 90 00	233	232	232	92.20	0.14	0.37
T4-5		120 75 07	186	196	207	78.60	−1.16	−6.99
T4-6		112 55 07	116	137	147	55.74	−5.12	−7.83
T4-7		112 25 12	30	66	83	26.25	−7.33	−13.69
T4-8		119 40 22	26	105	150	41.90	−6.59	−31.08
T5-1		144 75 12	211	184	204	77.50	13.28	−6.50
T5-2		144 45 12	129	101	126	46.30	15.91	−9.52
T5-3		160 25 07	76	55	63	25.68	10.95	−1.33
T5-4		144 25 12	76	53	78	25.57	15.42	−11.14
T5-5		024 20 02	60	49	47	21.50	4.44	3.16
T5-6		112 75 12	161	202	218	78.95	−9.64	−12.57
T5-7		039 75 37	254	172	0	76.29	19.18	93.94
T6-1		080 85 07	198	231	215	88.98	−13.77	3.97
T6-2		103 45 17	0	121	138	45.77	−24.04	−18.30
T6-3		104 65 07	143	170	174	67.69	−8.06	−5.39
T6-4		136 25 02	59	58	68	24.93	2.72	−6.06
T6-5		048 90 12	241	232	163	91.24	−6.78	34.68
T6-6		032 85 17	252	201	137	83.99	10.25	38.57
T6-7		032 75 17	236	178	114	76.74	13.76	40.75

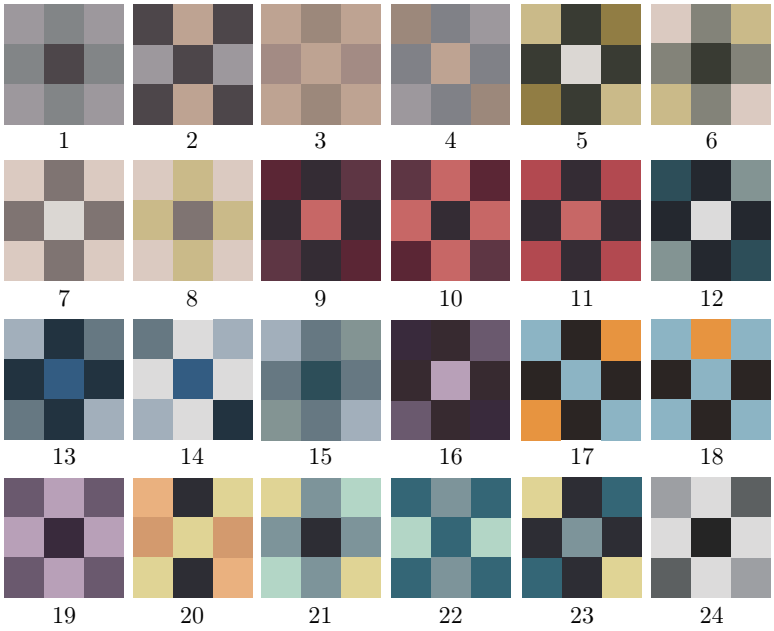


Fig. 1: The color stimuli for the survey of multi-color emotion

3 Result and Discussion

3.1 Result of Single Color Preference

In the first part of this study, forty-two single colors were regarded as samples to investigate color preference. Each respondents were asked to choose five favorite colors from the forty-two samples. The result was expressed by color histogram shown as Fig. 2. From Fig. 2, the most popular colors were 36, 34, 40, 29, which corresponded to T6-1, T5-6, T6-5 and T5-1 which belonged to the fifth and sixth themes. They were pink purple, soft blue, light green and pale yellow. They had several similar features: chromatic, soft, bright. Some colors were not chosen at all. They were 9, 18, 31, 32, 33, 42, which corresponded to T2-2, T3-4, T5-3, T5-4, T5-5, T6-7. Half of them came from the fifth theme. These unpopular colors also had some common characters, such as very low saturation, dull.

At the theme point, the first theme had a relative balance in the popularity. The most popular color and the most unpopular color didn't exist. Each color had supporter, but not so much. The feature of the first theme was its tone. All the colors had the lowest saturation. Their saturation were smaller than 10 in CNCS (China National Color System) color system, and three colors had 0 saturation. The fifth and sixth themes were extreme. The most popular and unpopular color existed side by side. It can be conferred that there may have strong contrast.

3.2 Basic Statistic of Multi-color Combinations

The second part of this study was multi-color emotion. According to released color trend, twenty-four multi-color combinations were made and regarded as color stimuli. There were three to five kinds of color coordination in each theme. Semantic Differential Method was used in this part. The average of each color stimuli to each adjective pair can be obtained firstly, which

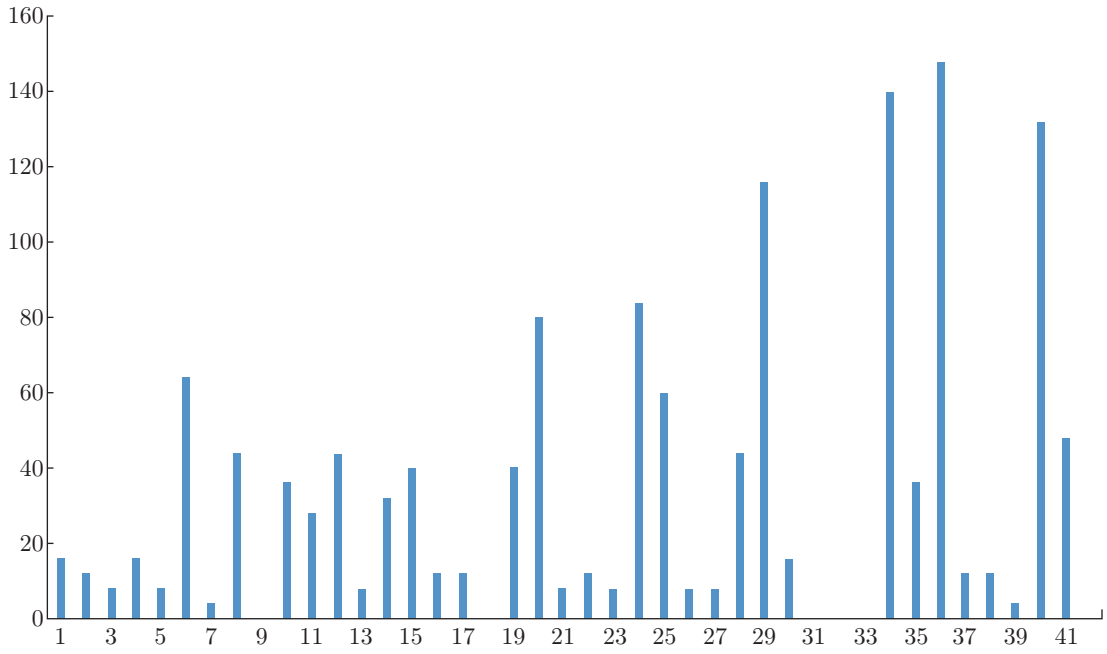


Fig. 2: The result of single color preference in color histogram

shown as Table 2. "Multi-color" was abbreviated as "MC". Each adjective pair was expressed by capitalizing their initial letters.

From the averages in Table 2, color emotion of each multi-color combination was clear. MC-1 was combined by T1-1, T1-4, T1-7, and its emotion showed more stale, tasteful, flaunty, plain, and intellectual. MC-2 was combined by T1-1, T1-4, T1-6, and its emotion showed more modern, urban and elegant. MC-3 was combined by T1-2, T1-5, T1-6, and its emotion showed more stale, stiff, flaunty, plain and powerless. MC-7 was combined by T2-1, T2-2, T2-3, and its emotion showed more elegant, tasteful, and intellectual. MC-8 was combined by T2-2, T2-3, T2-5, and its emotion showed more casual and lively. MC-9 was combined by T3-1, T3-3, T3-4, T3-6, and its emotion showed more stale, gaudy, gorgeous, powerful and urban. MC-10 was also combined by T3-1, T3-3, T3-4, T3-6, but the main color was T3-6, and its emotion showed more gaudy, implicit, gorgeous, powerful and warm. MC-11 was combined by T3-1, T3-5, T3-6, and its emotion showed more gaudy, implicit, gorgeous, powerful, urban and warm. MC-20 was combined by T6-4, T6-5, T6-6, T6-7, and its emotion showed more modern, casual, lively, implicit, fashionable, individual and warm. MC-21 was combined by T6-1, T6-3, T6-4, T6-5, and its emotion showed more casual and tasteful. MC-22 was combined by T6-1, T6-2, T6-3, and its emotion showed more tasteful and flaunty. MC-23 was combined by T6-2, T6-3, T6-4, T6-5, and its emotion showed almost no deviation. MC-24 was combined by black, white and gray, its emotion showed elegant, tasteful, flaunty and urban.

Fig. 3 shows the scatter plots of color emotion of MC-11, MC-14 and MC-20 as examples.

3.3 Multi-statistics and Discussion

In order to investigate the emotion space of consumers to the released color and color coordination, factor analysis was used to reduce the dimensions of consumer's impression. In the software SPSS (version 15.0), PCA (principal component analysis) and cluster analysis were selected. KMO test

Table 2: The average of each multi-color stimuli to each adjective pair

Items	M-C	V-E	F-C	F-S	G-T	L-S	I-F	G-P	F-D	I-P	P-P	R-U	W-C	I-N	L-D
MC-1	3.13	3.51	2.81	4.01	4.04	3.90	4.07	4.10	3.47	3.34	3.21	3.23	2.96	2.99	2.10
MC-2	2.19	3.80	2.89	3.27	3.63	2.94	3.41	3.09	2.88	2.60	2.29	3.96	2.66	2.39	2.26
MC-3	3.37	3.01	3.53	4.19	3.64	3.76	3.83	3.83	3.12	3.39	3.89	2.93	2.47	3.70	3.20
MC-4	2.97	3.20	3.04	3.81	3.74	3.60	3.76	3.66	3.14	3.00	2.83	3.41	2.97	3.36	2.84
MC-5	2.17	3.51	3.11	2.79	3.17	2.64	2.83	3.17	2.79	2.53	2.27	3.80	2.61	2.49	2.64
MC-6	2.50	3.54	3.36	2.81	3.80	2.91	3.51	3.51	2.96	2.91	3.10	3.17	2.90	2.66	2.70
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
MC-10	2.89	3.53	2.93	3.40	2.11	2.67	2.24	2.13	2.99	2.54	2.16	3.83	2.21	2.61	2.71
MC-11	2.60	3.33	2.90	3.29	1.87	2.45	2.00	2.07	2.84	2.50	2.10	3.91	2.23	2.83	2.86
MC-12	2.59	3.44	2.50	3.36	3.73	3.61	3.90	3.74	3.51	3.11	2.94	3.76	3.51	2.74	2.57
MC-13	2.51	3.11	3.04	3.46	3.53	3.54	3.57	3.57	3.14	3.01	2.81	3.67	3.67	3.09	3.11
MC-14	2.07	3.73	3.43	1.96	3.99	2.83	3.51	3.81	2.81	2.93	2.90	3.59	3.91	2.31	2.49
MC-15	3.01	3.33	3.23	3.76	3.76	3.67	4.01	4.01	3.38	3.41	3.20	3.53	3.50	2.99	2.99
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
MC-19	3.51	3.80	2.76	3.44	3.71	3.44	3.89	3.31	3.47	3.09	2.91	3.56	3.03	2.60	2.31
MC-20	2.00	3.14	4.00	2.36	2.70	1.89	2.06	2.51	2.21	1.97	2.41	3.06	2.11	2.37	3.06
MC-21	2.34	3.39	3.84	2.41	3.79	2.41	3.07	3.31	2.57	2.53	3.00	3.06	3.00	2.43	3.01
MC-22	3.14	3.53	2.91	3.20	3.91	3.49	3.91	3.71	3.37	3.13	2.97	3.51	3.74	2.91	2.63
MC-23	2.40	2.87	3.26	3.37	3.10	2.81	2.79	3.12	2.76	2.53	2.53	3.67	2.84	3.21	3.26
MC-24	2.57	3.83	2.60	2.80	4.03	3.27	3.74	3.71	3.57	3.29	2.89	3.79	3.70	2.30	2.33

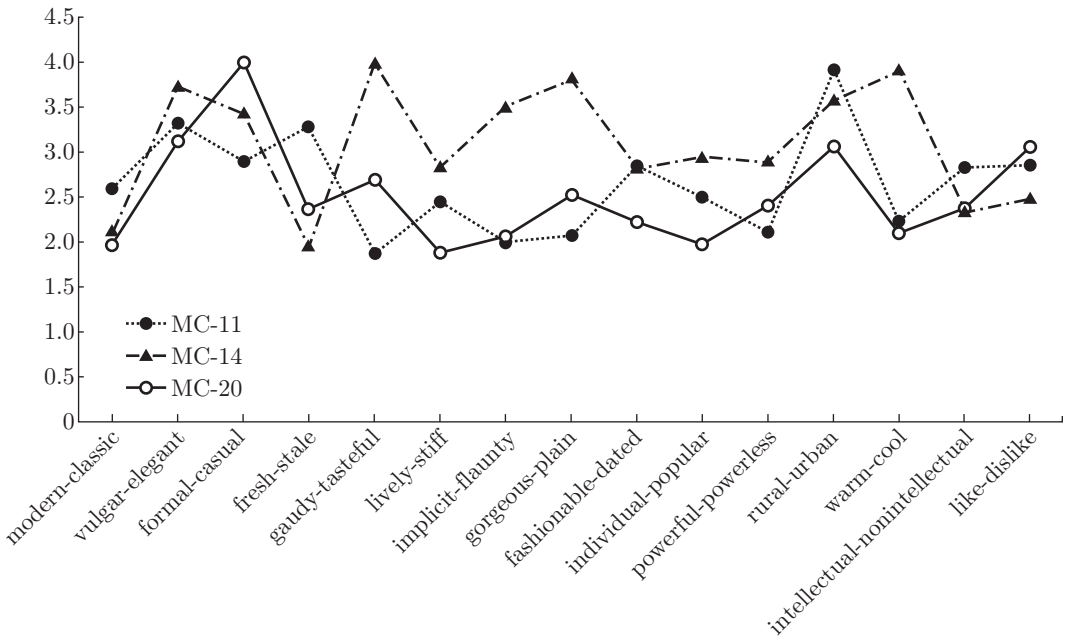


Fig. 3: The scatter plots of color emotion of MC-11, MC-14 and MC-20

was performed firstly, the result 0.696 meant factor analysis was available. Eigenvalues were set

over 1, and three factors were extracted which were shown in Table 3. The variance of the first factor was 37.566 and the total variance was 88.900. The factor rotation method was varimax, and the rotated results are also shown in Table 3. The factor plots of multi-color emotion scales in rotated space are shown in Fig. 4.

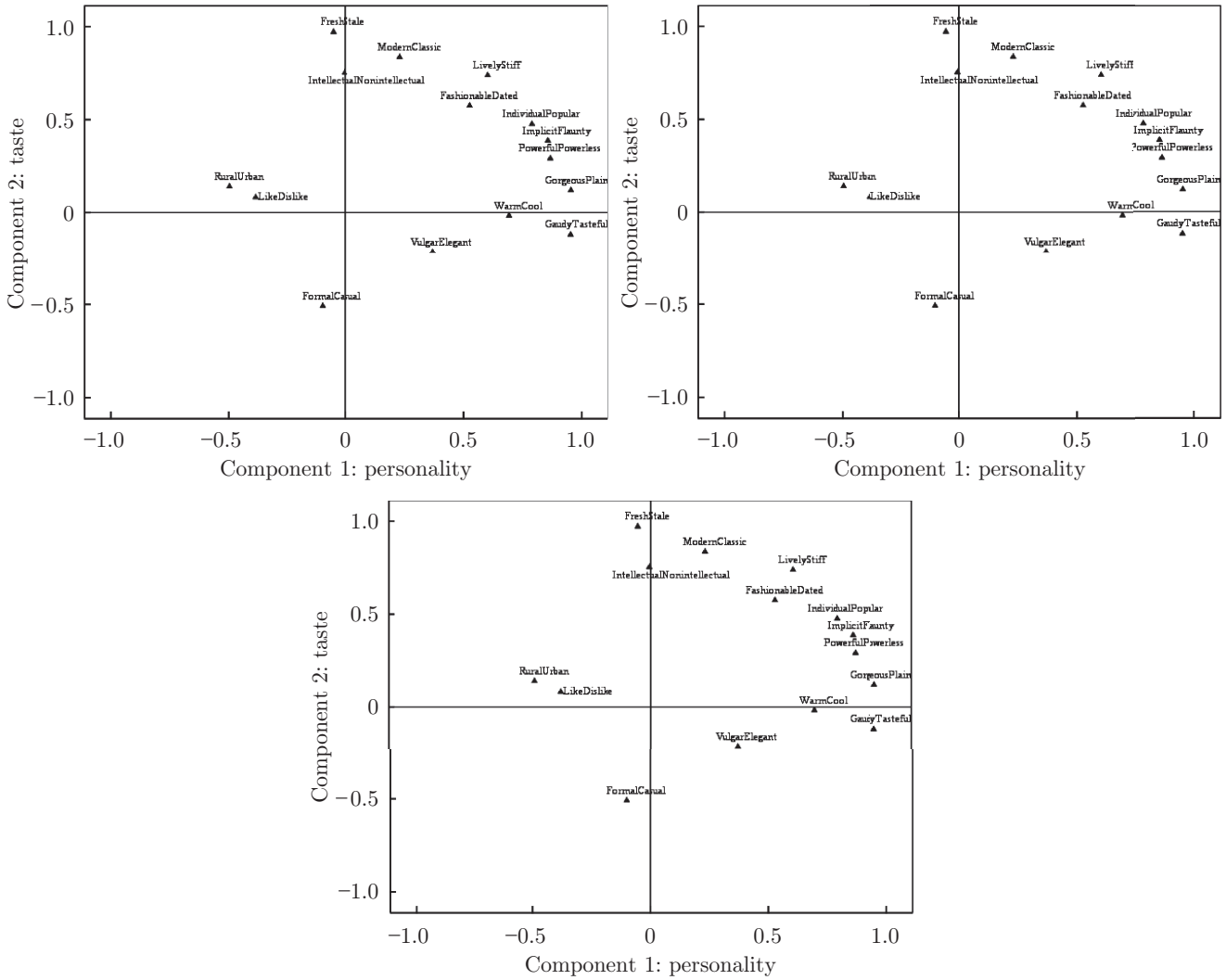


Fig. 4: Factor plots of multi-color emotion scales in rotated space

From Table 3 and Fig. 4, the first factor included “Gorgeous-Plain”, “Gaudy-Tasteful”, “Powerful-Powerless”, “Implicit-Flaunty”, “Individual-Popular”, “Warm-Cool”. These adjectives were connected with character, so this factor was named “personality”. The second factor included “Fresh-Stale”, “Modern-Classic”, “Intellectual-Nonintellectual”, “Lively-Stiff”. These words expressed the aspects related to education, so it was named “taste”. The third factor included “Vulgar-Elegant”, “Like-Dislike”, “Formal-Casual”, “Rural-Urban”, “Fashionable-Dated”. These words expressed the feeling of time, so it was named “fashion”.

It indicated that color emotion of multi-color coordination was relative to personality, taste and fashion. Fashion is always main point of consumer demand. Personality has become an identification of one person different from the other, which is also a special expression of clothing. Taste of clothing can show artistic appreciate.

In order to obtain the response of consumers to the released color coordination, cluster analysis

Table 3: Rotated factor matrix of color emotions

Phase	Component 1	Component 2	Component 3
Gorgeous-Plain	0.953	0.121	0.080
Gaudy-Tasteful	0.952	−0.118	0.174
Powerful-Powerless	0.867	0.292	−0.318
Implicit-Flaunty	0.856	0.387	0.293
Individual-Popular	0.789	0.476	0.313
Warm-Cool	0.692	−0.016	0.357
Fresh-Stale	−0.055	0.971	−0.048
Modern-Classic	0.230	0.835	0.103
Intellectual-Nonintellectual	−0.005	0.753	−0.592
Lively-Stiff	0.602	0.738	0.268
Vulgar-Elegant	0.369	−0.213	0.836
Like-Dislike	−0.385	0.083	−0.830
Formal-Casual	−0.100	−0.508	−0.827
Rural-Urban	−0.496	0.140	0.700
Fashionable-Dated	0.526	0.574	0.596
% of variance	37.566	26.003	25.331
Cumulative (%)		88.900	

was used to conduct the data analysis. The factor scores of all the stimuli to each factor were regarded as variables, and a hierarchical cluster analysis was performed. A tree graph of cluster analysis was shown in Fig. 5. From the graph, twenty-four stimuli can be divided into three groups.

One group included MC-9, MC-10, MC-11. The three color coordination showed wine tone which combined by different red and dark color. Red is striking, powerful and warm. Different red occurred at the same time and the feelings such as gaudy, gorgeous, implicit will be easy brought.

The second group included MC-4, MC-15, MC-13, MC-16, MC-1, MC-19, MC-7, MC-24, MC-2, MC-22, MC-12 and MC-3. These color coordination almost fastens with color. For example, MC-3 was combined by T1-2, T1-5 and T1-6. The hue number in CNCS of T1-5 and T1-6 was same, which was 032. MC-7 was combined by T2-1, T2-2 and T2-3. The hue number in CNCS of T2-2 and T2-3 was same, which was 024. It's very easy to obtain good harmony for this kind of color coordination, which naturally showed intellectual, flaunty and tasteful. Especially, MC-24 was combined by black, white and gray which were popular forever. The achromatic tone showed more intellectual and tasteful.

The third group included MC-17, MC-20, MC-8, MC-21, MC-6, MC-18, MC-23, MC-5 and MC-14. Most of these color coordination had strong color contrast or a strong color. For instance, MC-17 and MC-18 had the same color coordination which were combined by T5-5, T5-6, T5-7. Among them, T5-5 was close to black, T5-6 was grayish blue, and T5-7 was vivid orange. Black and blue were classic, intellectual, soft color coordination. Orange added power and energy to black-blue, and it made them younger, more fashionable. MC-5, MC-6 and MC-8 had another similar color emotion and had one same color T2-5. T2-5 is pale yellow, and its value in CNCS

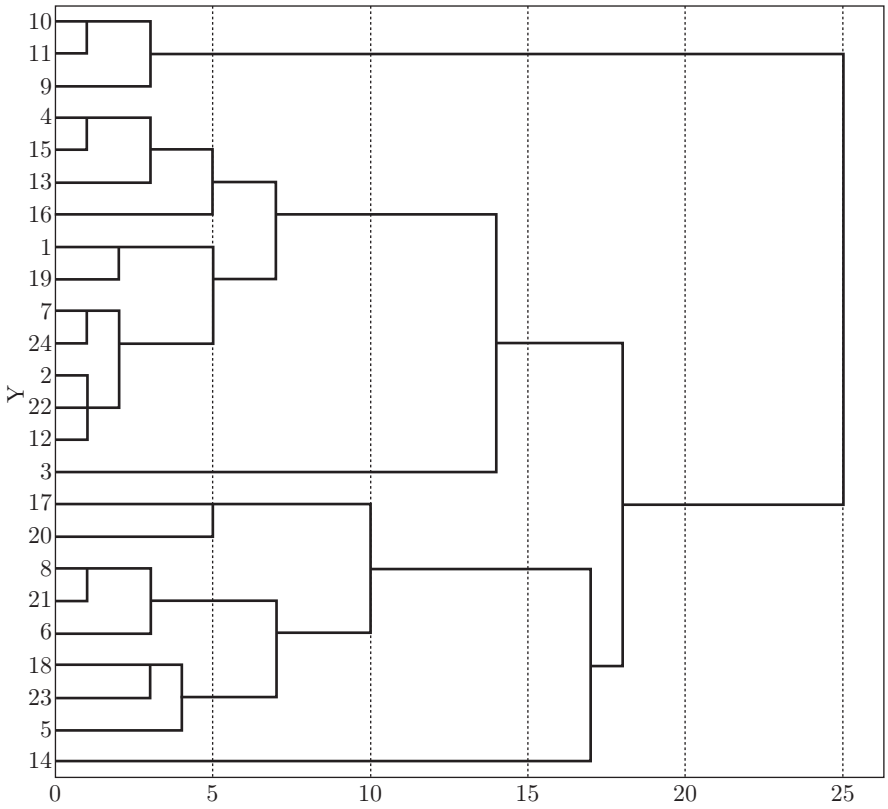


Fig. 5: The tree graph of cluster analysis

is 80. This color with high lightness occurred in these color coordination at different proportion. It was spring tone which brought vitality, hope, and light-soft feeling.

Through the survey of single color preference, the popularity of forty-two single colors was not average at all. Some colors were very popular, but some colors were not. This meant that designers could not select these single colors only. These single colors appeared as groups with other colors. In other words, releasing colors should be used in groups.

When two or three or more colors combines, not only color property influences the effect of color combination, location, area, proportion are all the impact factors. From the above results, although color components were the same, color emotion changed as adjusting color proportion.

After factor analysis and cluster analysis, three factors were extracted and twenty-four multi-color stimuli were classified into three groups which were different from six released themes. It indicated that multi-color emotion and the way of color construction were more important than single color property. Multi-color emotion was a comprehensive feeling, which involved to color property of main color, color area, color construction, and so on.

4 Conclusion

In this study, two parts of survey were performed. One was single color preference. The other was color emotion of multi-color combination. Forty-two single colors were selected and twenty-four multi-color combinations were prepared. Color histogram was adopted to process single color preference. Semantic Differential Method was used to conduct the survey of multi-color emotion,

and factor analysis and cluster analysis were used to analyze the data. From these results, some conclusions could be obtained.

(1) The popularity of released colors was not average, so designers couldn't propose design plan based on some single colors merely.

(2) Three factors were extracted from the survey of multi-color emotion, and these factors were labeled "personality", "taste", and "fashion".

(3) Multi-color emotion and the way of color construction were more important than single color property.

(4) Designers must focus on the comprehensive color emotion, which combined by main color property, color area, and color construction.

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References

[1] History of Intercolor. http://www.intercolor.nu/history.html

[2] Xue Y, Imaoka H. Comparison of color psychological aspects for single color between Chinese and Japanese. J. Jpn. Res. Assn. Text. End-Uses: 50, 2009, 141-147

[3] Xue Y, Imaoka H. Comparison of color preferences for two-color combinations between Chinese and Japanese. J. Jpn. Res. Assn. Text. End-Uses: 50, 2009, 309-316

[4] Xue Y, Imaoka H. Comparison of color preferences for three-color combinations between Chinese and Japanese. J. Jpn. Res. Assn. Text. End-Uses: 50, 2009, 687-694

[5] Xue Y, Zhang MY, Guo BJ, Imaoka H. Survey of Single color Preference and Multi-color Emotion. TBIS Proceedings 2016, 734-742

[6] Uravis T, Kitirochna R, Hiroyuki S. Color preference affected by mode of color appearance. Col. Res. Appl, 35, 2010, 50-61

[7] Iris B, Theo van der V, Peter V, Jan de B, Conne B. Color preferences for different topics in connection to personal characteristics. Col. Res. Appl, 40, 2015, 62-71

[8] Ou LC, Luo MR, Woodcock A, Wright A. A study of colour emotion and colour preference. Part I: Colour emotions for single colours. Col. Res. Appl, 29, 2004, 232-240

[9] Ou LC, Luo MR, Woodcock A, Wright A. A study of colour emotion and colour preference. Part II: Colour emotions for two-colour combinations. Col. Res. Appl, 29, 2004, 292-298