

AN EMPIRICAL STUDY ON ASSOCIATION OF COLORS WITH ADJECTIVES

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ABSTRACT

The objectives of this study are: (1) to understand the strength of association between adjectives and colors; (2) to analyze the volume of distribution of different adjectives in the CIELAB color space; (3) to analyze the correlation between adjectives and their volume of distribution in the CIELAB color space. Eighty adjectives were selected for the main experiment by a focus group. Twenty-two participants assessed the score for each of the given adjectives which could be associated with a color. The other thirty participants assessed the related single color with each of the given adjectives. A substantial amount of color values were distributed and calculated in the CIELAB color space. The findings of this study showed that the strength of association between eighty adjectives and their respective colors can be clearly divided into four groups, namely “extremely strong,” “strong,” “medium,” and “weak.” The intensity of an adjective indicated a significant negative correlation with the distribution volume of its associated color. In other words, adjectives with a clear meaning were often associated with similar colors by different participants. The colors associated with adjectives such as warm, sunshine, passionate, shine, and cool were more uniform; conversely, the colors associated with adjectives such as modern, graceful, steady, restful, and exalted were relatively variable. The results of this research can serve as reference for product designers in the selection of colors using adjectives.

INTRODUCTION

Frequent discussions and communication are necessary processes in the initial stage of a product design proposal. In the early product development stages, the designer and his/her client need to have repeated discussions in order to determine the product users and market positioning strategies. The use of adjectives is one of the practical ways to facilitate such discussions and communication in the product design process. Color is one of the most important design element for a product designer. A significant amount of studies indicate that color corresponds to human emotions. The selection of colors used in a product often has a corresponding relationship with the target market. Selecting the right adjectives can assist the designer to establish associations with a suitable color, eventually settling on the final color to be used in the product [1, 2, 3, 4]. Manav (2007) figured out that emotional responses to colors change with value and saturation levels [5]. Kaya and Epps (2004) indicate that positive emotional responses were highest in primary hues, followed by intermediate and achromatic colors [6]. The color green mainly evoked positive emotions such as relaxation and comfort. In view of this, this study aims: (1) to understand the strength of association between adjectives and colors; (2) to analyze the volume of distribution of different adjectives in the CIELAB

color space; (3) to analyze the correlation between adjectives and their volume of distribution in the CIELAB color space.

RESEARCH METHOD

Selection of the adjectives. The adjectives applied in this experiment were selected from a substantial amount of surveys in the product design field. In the first round, a total of 133 adjectives were selected. In the second stage, for the main experiment, the adjectives were reduced to 80 (see Table 1) by the focus group. The selection criterion included the adjectives which could be used in the practice of product design. The five members of the focus group were one senior product designer, one associate professor with a major in graphic design, one assistant professor of visual art and design, one senior graphic designer, and one senior project manager in product design.

Table 1: The list of 80 adjectives

No.	adjectives	No.	adjectives	No.	adjectives	No.	adjectives	No.	adjectives
01	Warm	17	Shine	33	Ornate	49	Showy	65	Mysterious
02	Intimate	18	Austere	34	Amiable	50	Graceful	66	Manmade
03	High tech	19	Wild	35	Vivid	51	Leisure	67	Steady
04	Professional	20	Happiness	36	Captivating	52	Agreeably	68	Youthful
05	Local	21	Prestige	37	Stable	53	Colorful	69	Dream
06	Cool	22	Sacred	38	Fascinating	54	Imagination	70	Sexy
07	Refined	23	Exalted	39	Leisurely	55	Populous	71	Purity
08	Artistic	24	Pure	40	Majestic	56	Funky	72	Joyful
09	Refreshing	25	Romantic	41	Antique	57	Clear	73	Dapper
10	Temperate	26	Nostalgic	42	Traditional	58	Light and pale	74	Sunshine
11	Heavy	27	Restful	43	Natural	59	Animated	75	Dry
12	Peaceful	28	Calm	44	Old	60	Active	76	Country
13	Ecological	29	Simple	45	Happy	61	Earnest	77	Fresh
14	Full of life	30	Complex	46	Modern	62	Rich	78	Brightness
15	Urbane	31	Friendly	47	Unadorned	63	Pastoral	79	Airy
16	Freedom	32	Classical	48	Passionate	64	Quiet	80	Feminine

Assessment of the adjectives. Concurrently, the research studied the strength of association between adjectives and colors by conducting an experiment with another group of 22 participants. The participants assessed the score (from 0 to 10, with 10 as the highest) for each of the given adjectives which could be associated with a color. The participants in this group included a senior product designer, one associate professor with a major in graphic design, 12 bachelor students from the department of visual art and design, and 8 bachelor students from the department of product design.

Volume calculation in the CIELAB color space. Using the experimental method, 30 participants were asked to select a single color in the calibrated monitor for each of the given adjectives. The task focused on “each adjective could associate with a single-color base according to the participant’s intuition.” The interface of color selection was the Adobe Photoshop CC software color palette (see the left side of figure 1). When each participant selected a single color, the $L^*a^*b^*$ value for each of the given adjectives was automatically recorded. In order to analyze the volume of distribution of different adjectives in the CIELAB color space, a substantial amount of color values were collected and calculated (see the right side of figure 1). Each adjective corresponded to 30 CIELAB effective values from 30 participants. The group center point was established from the 30 CIELAB values by applying a median analysis in the

CIELAB color space. The volume of 30 points was calculated by the sum of delta *E*, which is the sum of color difference values between each point and the center point, using the Visual Basic programming development platform. Although the *L*a*b** values were displayed in CIE *a*b** two dimension figure and each color point in RGB, which was transformed from CIELAB, the CIELAB values were also used to calculate the color difference. For example, a relatively small volume indicated that the colors associated with the 30 participants were extremely close to each other. Conversely, if the 30 participants selected different colors, the volume would be relatively large in the CIELAB space.

Data analysis. In order to understand the strength of color association between adjectives and colors, data were collected from an assessment of 22 participants. These participants assessed the integer score from 0 to 10. The average of each adjective was categorized as the first 10%, 11% to 25%, 26% to 50%, and 51% to 75%. For example, the first 10% group indicated “extremely strong,” while the 51% to 75% signified “weak.” The volumes of distribution of different adjectives were also analyzed in the CIELAB color space. The four groups were used to analyze the relative magnitude of volume. For example, the first 10% group indicated a “smaller” volume. On the other hand, it also indicated that the participants had selected similar colors for the same adjective. Finally, this study analyzed the correlation between adjectives and their volume of distribution in the CIELAB color space, based on the results of the descriptive statistics of the assessment and volume calculation data. This study further analyzed the degree of expressiveness of adjectives and its correlation with color volume (see figure 2).

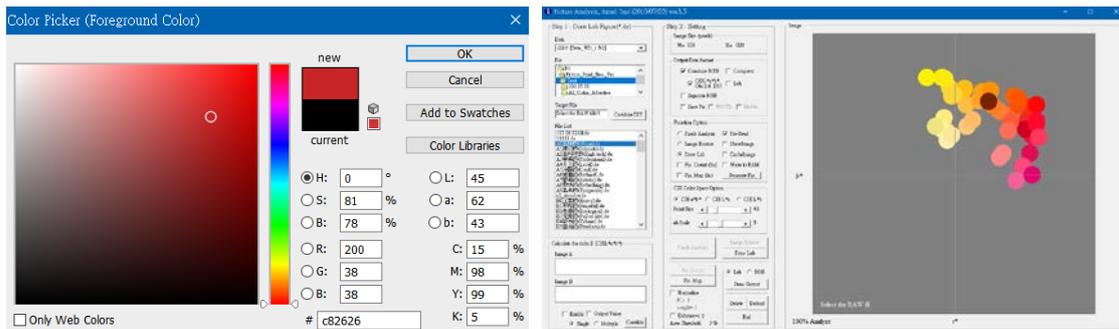


Figure 1: The interface of color selection (left side) and the distribution analysis on the CIELAB color space (right side)

Table 2: The four groups of different adjectives

Group	No.	Adjective	Average	Volume	Group	No.	Adjective	Average	Volume
Extremely strong (The first 10%)	01	Warm	9.318	3.183	Medium (26%~50%)	18	Austere	7.273	9.585
	74	Sunshine	8.864	4.842		03	High tech	6.182	3.540
	48	Passionate	8.455	3.244		72	Joyful	6.091	10.698
	17	Shine	8.045	3.028		10	Temperate	6.136	11.083
	06	Cool	8.045	5.216		76	Country	6.500	9.795
Strong (11%~25%)	11	Heavy	7.318	6.744	70	Sexy	7.318	13.841	
	44	Old	7.864	4.440	42	Traditional	6.955	9.754	
	43	Natural	7.909	9.974	Weak (51%~75%)	46	Modern	5.318	13.504
	13	Ecological	7.500	8.399		50	Graceful	5.318	12.189
	55	Populous	7.500	5.237		67	Steady	5.773	13.688
	41	Antique	7.455	7.488		27	Restful	5.727	10.370
	75	Dry	7.909	7.892		23	Exalted	5.182	12.302

RESULTS OF RESEARCH

The research findings showed that the strength of association between the 80 adjectives and their respective colors could be clearly divided into four groups, namely “extremely strong,” “strong,” “medium,” and “weak.” This association was further analyzed. Table 2 indicates the four groups of the different adjectives as well as the results of the average score and volume values. The first 10% indicate the “extremely strong” effects between adjectives and their respective colors, as well as pointed out the participants’ similar color selection for the same adjectives (see figure 3). The 51% to 75% group points out the “weak” effects, meaning the participants selected different colors for the same adjectives (see figure 4).



Figure 2: The distribution of 80 adjectives on the CIELAB color space

Using the Pearson’s correlation analysis, the table also indicated the intensity of an adjective, demonstrating a significant negative correlation ($r=-.72, p<.01$) with the distribution volume of its associated color base. Adjectives such as warm, sunshine, passionate, cool, and shine were extremely strong in the results of smaller volume and higher assessments. In other words, adjectives with a clear meaning were often associated with similar colors by different participants. The strong adjectives were heavy, old, ecological, populous, natural, and antique. The medium group included austere, high tech, joyful, temperate, sexy, country, and traditional. The weak group included modern, graceful, steady, and restful.

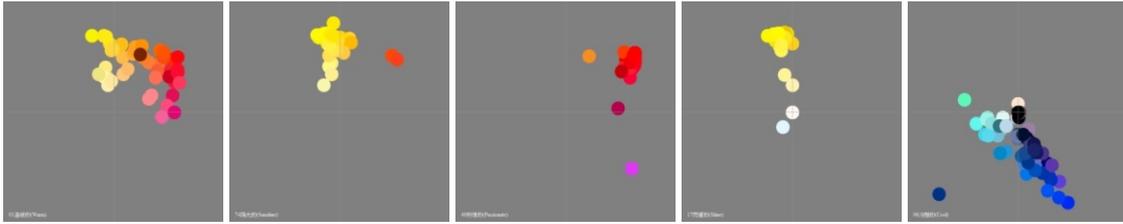


Figure 3: The distribution of the first 10% group of adjectives on the CIELAB.
(from left to right is warm, sunshine, passionate, shine, and cool)

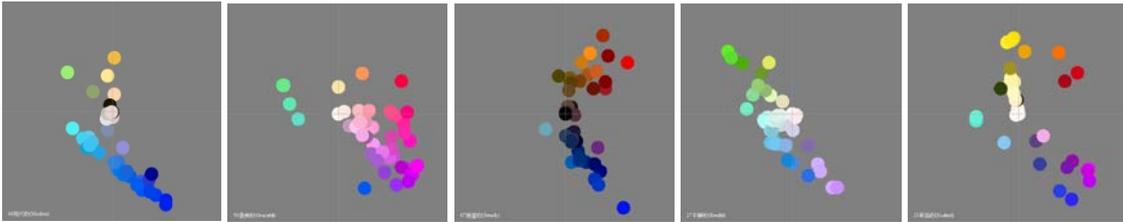


Figure 4: The distribution of the 51%~75% group of adjectives on the CIELAB.
(from left to right is modern, graceful, steady, restful, and exalted)

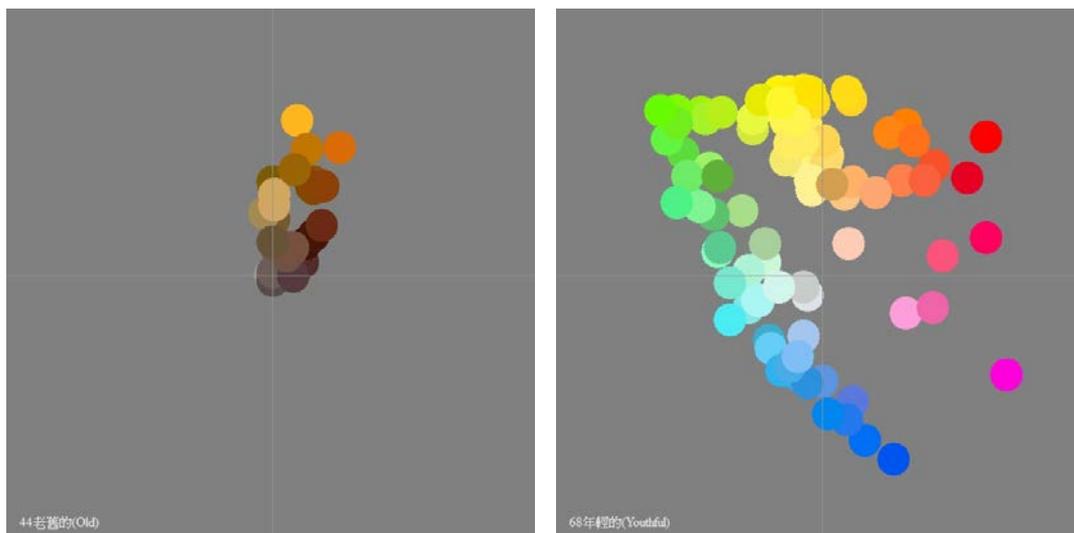


Figure 5: The distribution of two different adjectives on the CIELAB.
(The left is old, and the right is youthful)

The results also indicated the two different distribution shapes between old and youthful adjectives in the CIELAB color space. These two adjectives also indicated the differences with regards to semantics (see figure 5). The distribution of ‘old’ demonstrates a similar hue of variable lightness while “youthful” is a variety of hues with similar lightness levels. In other words, the adjective “old,” with a clear meaning, is often associated with similar hues by different participants while the adjective “youthful” is associated with a different kind of daily life, thinking, variety, and so on. The features of variable hues include colorful (no. 53) and artistic (no. 08). The features of a similar hue include ecological (no. 13), shine (no. 17), high tech (no. 03), passionate (no. 48), populous (no. 55), sunshine (no. 74), antique (no. 41), and romantic (no. 25). The above adjectives are often associated with different colors.

DISCUSSION

The results of this research can serve as reference for product designers in the selection of colors using adjectives. For example, the colors associated with adjectives such as warm, sunshine, passionate, shine, and cool are more uniform; conversely, the colors associated with adjectives such as modern, graceful, steady, restful, and exalted are relatively variable. Human beings experience emotion through perception and cognition. They also construct meaning through color. Adjectives are one of the best ways to find suitable colors. Both the experienced and inexperienced product designers are required to undertake the responsibility of a product's color selection. For example, the results of the “youthful” adjective indicated the selection of a variety of colors for the same adjective in this study. The product designer could use a variety of colors in a series of product appearances. Discussions and communication on product design are means of understanding and establishing suitable color selections. Hopefully, the results of this study will provide a foundation to the product designers and a simpler way to achieve their work requirements.

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