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RESEARCH INTO THE EMOTION DIMENSIONS REVEALED BY THE COLORS OF BEVERAGE PACKAGING

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ABSTRACT

This study aims to explore the factors in distinct light colors of fluorescent lamps in stores that affect color presentation of the printing on beverage packaging, and conduct a first-stage survey of market. According to the survey result, two pilot tests are later conducted in stage two on the two design properties, "color temperature of LED white light" and "color scheme of packaging", and how they affect test participants' emotional cognition. After observing and analyzing the existing design samples, we had three findings: (a) For the trend of colors presented on beverage packaging in "color temperature of fluorescent white light", "high color temperature" (61.65%) is in the majority; in "color scheme of packaging", "analogous hue" (61.12%) is in the majority. (b) For the pilot tests of emotions for the colors presented on beverage packaging in "color temperature of LED white light", "medium color temperature" can best create positive valence (medium > low > high). For those in "color scheme of packaging", "analogous hue" can best create positive valence (analogous > contrast > complementary). (c) The comparison of current quantity and emotion survey shows the color presentation of existing beverage packaging is roughly consistent to consumers' emotional reactions.

"Color temperature of LED white light" and "color scheme of packaging", proposed in this study as criteria for categorization on beverage packaging, will be able to clearly present design trend in the market. We hope this paper will make a contribution to the studies of presented colors on beverage packaging and consumer emotions.

Keywords: *color scheme of packaging, hue, white-light LED, color temperature, emotion*

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1. INTRODUCTION

At present, some stores have reduced the number of lamp tubes for saving energy, whereas color presentation of the products in a retail outlet is often affected by light color cast, caused by the raised heat of the fluorescent lamps. However, even if a fixed color temperature is applied in the outlet, beverages with complementary hue, contrast hue or analogous hue are commonly displayed on the shelf at the same time. Interaction of the two properties may create distinct effects of color presentation on the package and affect the consumer's decision. The presentation of printed colors is greatly connected to the type of light source, and white-light LED, categorized as a cold light source, is proved to have boosted product visibility and consumer satisfaction [1]. Since this study aims to explore the actual applications of both "color temperature of white light" and "color scheme of packaging" in the colors presented on beverage packaging and consumer emotions toward them, the purpose of this study is threefold: (1) by reference to related literature, to present "color temperature of white light" and "color scheme of packaging" as important factors in affecting the colors presented on beverage packaging; (2) to observe the color temperature of white light and color scheme of beverage packaging in some physical stores in Wanhua District of Taipei, Taiwan, and accordingly analyze and categorize the actual applications of "color temperature of fluorescent white light" and "color scheme of packaging"; and (3) to survey the relations of "color temperature of LED white light" and "color scheme of packaging" to the arousal of consumer emotions.

1.1. Definitions

1.1.1. Emotion dimensions

Colors with high wavelength like red, orange, and yellow are warm colors, green and blue are cold colors. Warm color is associated with arousal and higher levels of anxiety, whereas cool colors have been found to reduce arousal levels and elicit such emotions as peacefulness, calmness, and love [2]. Emotion, also named "affect", refers to an internal feeling state and represents a general term used to refer to the collection of moods (low intensity, diffuse affective states) and emotions (differentiated, intense affective states with clear causes) [3]. The emotions aroused by sensation and perception of the individual self are closely related to the nature and strength of objective matters, and subjective consciousness of the person concerned. The emotions may be pleasant or unpleasant; the strength of stimulus may be mild or strong; the target pointed may be active and positive or passive and negative [4, 5]. The "positive to negative side" and "strong to weak in degree" are the polarities of emotions. Emotional intensity, continuity and stressfulness are divided into different states by emotion dimensions, according to multidimensional depiction. Emotion dimensions are commonly composed of two dimensions: (1) valence (or "pleasure"); (2) arousal (or "activation") [6]. In the Circumplex Model of Affect presented by Russell [7], emotion category — valence (pleasure) is vertically crossed with emotional intensity — arousal. Distributed in circle around this crossing structure are 28 types of emotions, all of which represent the degrees of pleasure and arousal. Russell categorized the types of emotions on the Circumplex Model of Affect into 8 major emotions, called "Core Affect" [8]. On the other hand, International Affective Picture System (IAPS), developed by Lang et al. [9], is generally used in the present studies on emotion. Valence levels in this system range from "repulsive (-)" at low valence to "attractive (+)" at high valence; for arousal levels, from relaxing (R) at low arousal

to activating (A) at high arousal, with neutral (N) in the middle; for the degrees of "valence" and "arousal": A+ (positive valence, high arousal), A- (negative valence, high arousal), N (neutral), R+ (positive valence, low arousal), and R- (negative valence, low arousal).

1.1.2. Color temperature of fluorescent and LED white light

The color and appearance of an object or image will vary with the medium or light source [10]. Under changing illumination, consumers tend to remember the reference color as more saturated [11]. Fluorescent lamps are mostly used for indoor lighting on present days, and their blue and green waveband energy will be distributed with the increase of temperature [12], and affect the color presentation of the products. On the other hand, white-light LED, categorized as a cold light source, has such advantages as energy-saving, long life, mercury-free, weatherproof, fit for mass production, quick response, etc. Take Wal-Mart for example, the application of white-light LED in refrigerators has been proved to be able to boost product visibility and consumer satisfaction [1]. CIE divided the color temperature in indoor illumination into three classes: (1) light source with a warm hue and color temperature at 3,300K. The light is yellowish and feels warmer; (2) light source with a middle hue and color temperature at 3,300K-5,000K; (3) light source with a cold hue and color temperature at 5,000K and over. The light is pale green and gives colder feel [13]. According to Chang, Shie, Fong, Chang, & Lai's research results [14], people prefer color temperature at 3,000K as it suits indoor illumination for all kinds of psychological states. Whitish color (4,000K & 6,500K) is influential to the functions of human organs like the heart, tongue, eyes, spleen, pancreas, stomach, brain, and blood vessel [15]. Viénot, Mahler et al. [16] defined color temperature 3,000 K as LED warm light color, and 6,500k as cold light color. In this study, we will discuss in related literature the recorded model numbers and factory default values of the lamp tubes in the store, and the connections between the colors presented on beverage packaging and color temperature of fluorescent white light are explored in three classes: high color temperature (7,500~5,000K), medium color temperature (3,300-5,000K), and low color temperature (under 3,300K); the connections between those and color temperature of LED white light are divided into three classes: high color temperature (6,500K), medium color temperature (4,500K), and low color temperature (3,000K), as shown in Figures 1, 2, and 3.

Figure 1: High (6,500K)

Figure 2: Medium (4,500K)

Figure 3: Low (3,000K)

1.1.3. Color scheme of beverage packaging

The illumination in a retail store and consumers' color perception will affect their emotions (like pleasure & arousal), and then prompt them to either get closer to buying desire or conduct avoidance behavior like leaving the retail store [17]. As 70% of purchase decisions are made in the store, the colors and styles of packaging determine whether a deal will be made once a consumer intends to buy something [18]. Chroma, value, and hue are important factors that affect color harmony [19]. A color scheme that features hues is easy to recognize and catch attention. This way of design is the easiest one to make differences [20]. In the color-related studies of modern time, color spaces such as HSV, CIE-Luv, CIE-Lab, CIE94, and CIEDE2000 and color systems like NCS, Munsell, Ostwald, P.C.C.S, and JIS are more complex for most designers, and they are not as easily understandable as the theory of color

wheel. Besides, the theorems of complement and contrast hues both appear inconsistent with all theories of color space and system, we therefore base color scheme on the idea of color wheel. Based on two-color combinations, we investigated some related literature and actual applications for this study. We used larger-area color as the major hue, and the rest as minor hues [21, 22, 23]. Judging by the included angle between major hue and minor hues on the color wheel, we divided the color scheme of packaging into: "complementary" (180 degrees), "contrast" (120-150 degrees), and "analogous" (30-90 degrees), as shown in Figures 4, 5, and 6.

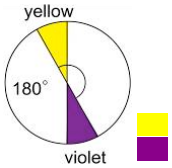

Figure 4: Complementary hue

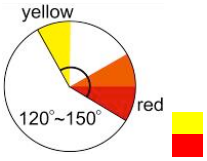

Figure 5: Contrast hue

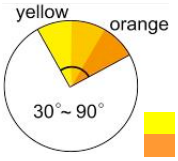

Figure 6: Analogous hue

2. METHOD

2.1. Questionnaire

A total of 9 (3×3) collocations of color presentation on beverage packaging were produced for the questionnaire, according to color temperature of LED white light (6,500K, 4,500K, 3,000K) and color scheme of packaging (complementary, contrast, analogous), as shown in Table 1. The 9 mock situations, along with emotion category – valence (pleasure) and emotion intensity – arousal in emotion dimensions, is assessed by the most widely used numerical scale for emotion measurement in the world. Due to the feedback from test participants, a 7-point scale was offered to them to make assessment. After viewing the color presentation of the samples for mock situation test, the participants have to mark on the degrees of "valence" and "arousal", as shown in Table 2.

Table 1: Mock situations of color presentation on beverage packaging

Color presentation on beverage packaging		Color temperature of LED white light		
		6500K	4500K	3000K
Color scheme of packaging	Complementary hue			
	Contrast hue			
	Analogous hue			

Table 2: Scales in the questionnaire for emotion dimensions

	**Emotion category (negative←→positive)**	L	←——		M	——→		H
		□	□	□	□	□	□	□
		1	2	3	4	5	6	7
	Emotion intensity (weak←→strong)	L	←——		M	——→		H
		□	□	□	□	□	□	□
		1	2	3	4	5	6	7

2.2. Collecting beverage samples

In this study, we observed 9 stores, categorized as convenience store, supermarket, and hypermarket, located in Wanhua District of Taipei, and 50 vending machines around CKS Memorial Hall, by means of purposive sampling, from May to November in 2009, and collected 270 PET bottles with a volume of 300~900 ml for each and 90 Tetrapaks from the stores and vending machines respectively, totaling 360 samples. We recorded the model numbers and factory default values of the lamp tubes used in the refrigerators of the 9 stores and 50 vending machines, observed their beverages, took photos of them with a digital camera and keep them on file.

2.2.1. Categorization of samples

In this study, "color temperature of fluorescent white light" and "color scheme of packaging" defined in the related literature were used both as criteria for categorization and for analysis of white light color temperature in those stores and design of the 360 beverage samples. Among the three types of color scheme, one that had the greatest number available in the market was regarded as representative sample, and was designed with a ratio of 1:1 in area (see Table 3). Combined with the color temperature of LED white light, 9 mock situations of color presentation were worked out for two pilot tests. The 9 collocations were finally used as samples for a total of 46 test participants to measure their emotion dimensions.

Table 3: Samples representative of color scheme of packaging

Color scheme of packaging	**Comple-mentary**		**Contrast**		**Analogous**	
Samples of color scheme	G/R 		R/Y 		YG / G 	
CIE L*a*b value	G L29 a-21 b16	R L52 a75 b57	R L52 a75 b57	Y L82 a13 b98	YG / G L68 a-28 b67	G L29 a-21 b16
Quantity (percentage)	22 (46.80%)		11 (13.92%)		43 (18.14%)	
Mock samples						

3. RESULTS

3.1. Market-based analysis of the colors presented on beverage packaging

The categorization by the two variables of "color temperature of fluorescent white light" and "color scheme of packaging" has shown that "high color temperature"(61.65%) is in the majority among the classes of color temperature of fluorescent white light, "medium color temperature"(33.98%) in the second, and "low color temperature"(4.38%) in the rear. Among the types of packaging color scheme, "analogous hue"(61.12%) is at the top, "contrast hue"(25.21%) the second, and "complementary hue"(13.66%) in the rear, as shown in Table 4.

Table 4: Design details of the colors presented on beverage packaging

Number of samples / Ranking Percentage		Color temperature of fluorescent white light		
		High 7500~5000K	**Medium 3300-5000K**	**Low 3,300K and under**
		352/1 61.65%	194/2 33.98%	25/3 4.38%
Color scheme of packaging	**complementary hue**	 a	 b	 c
	78/3 13.66%	46/5 8.06%	27/6 4.72%	5/9 0.87%
	Contrast hue	 d	 e	 f
	144/2 25.21%	86/3 15.06%	49/4 8.58%	9/8 1.58%
	Analogous hue	 g	 h	 i
	349/1 61.12%	220/1 38.53%	118/2 20.66%	11/7 1.93%

3.2. Analysis of emotion dimensions by questionnaire

Referring to Circumplex Model of Core Affect (see Fig. 7) presented by Russell [8] and the emotion dimensions in IAPS [9]: emotion category — valence (pleasure) and emotion intensity — arousal, we made an evaluation of emotion dimensions for the 9 representative samples, numbered a ~ i, in this paper, and then a statistical analysis of their data, as shown in Table 5.

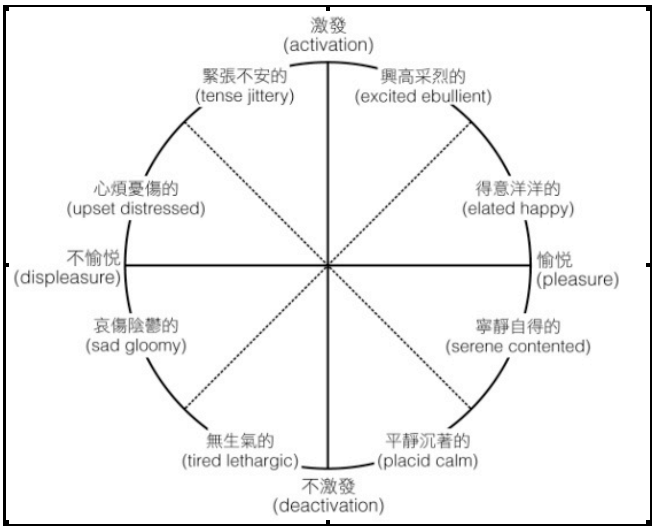

Figure 7: Core affect [8]

Table 5: Statistics of emotion dimensions for the colors presented on beverage packaging

Feature combination of the colors presented on beverage packaging	Valence		Arousal		Attribute in IAPS
	Mean	Standard Deviation	Mean	Standard Deviation	
a (high color temperature + complementary hue)	3.10	1.45	4.60	0.70	A-
b (medium color temperature + complementary hue)	3.50	1.51	4.80	1.40	A-
c (low color temperature + complementary hue)	3.70	1.77	4.70	1.49	A-
d (high color temperature + contrast hue)	4.20	1.81	4.80	1.14	A+
e (medium color temperature + contrast hue)	4.40	1.51	4.30	1.06	A+
f (low color temperature + contrast hue)	4.40	1.58	4.70	1.06	A+
g (high color temperature + analogous hue)	4.60	1.51	4.50	1.08	A+
h (medium color temperature + analogous hue)	4.80	1.23	3.70	1.34	R+
i (low color temperature + analogous hue)	4.00	0.94	4.40	1.26	N

According to the categorization of coordinates in IAPS, for those with "high color temperature" in color temperature of LED white light, sample a is A-, sample d is A+, and sample g is A+; for "medium color temperature", sample b is A-, sample e is A+, and sample h is R+; for "low color temperature", sample c is A-, sample f is A+, and sample i is N (neutral). These results show that "high color temperature" produced negative valence, high arousal and positive valence, high arousal; "medium color temperature" produced negative valence,

high arousal, positive valence, high arousal, and positive valence, low arousal; and "low color temperature" produced negative valence, high arousal, positive valence, high arousal and neutral emotion. Only "low color temperature" produced neutral emotion. A comparison of the three types of color temperature in arousing positive valence shows "medium color temperature > low color temperature > high color temperature".

For those with "complementary hue" in color scheme of packaging, samples a, b, c are A-; for "contrast hue", samples d, e, f are A+; and for "analogous hue", sample g is A+, sample h is R+ and sample i is N. These results show that samples with "complementary hue" in color scheme of packaging produced negative valence and high arousal; those with "contrast hue" produced positive valence and high arousal; and those with "analogous hue" produced positive valence, high arousal, positive valence, low arousal and neutral emotion. "Analogous hue" was prone to produce neutral emotion. A comparison of the three types in arousing positive valence shows "analogous hue > contrast hue> complementary hue".

In further analysis of "color temperature of LED white light" with "color scheme of packaging", "high color temperature with analogous hue" in sample g is a combination that best aroused the test participant's positive emotions, while combination of "high color temperature with complementary hue" best aroused the test participant's negative emotions.

It is learned from the above that changes in both color temperature of LED white light and color scheme of packaging will make differences in the participant's emotional reactions. Viewed from the characteristics of color temperature of LED white light, "medium color temperature" gives a steady and cozy feel [13], so it is able to create positive emotions. In the aspect of color scheme of packaging, "analogous hue" offers a feeling of pithiness and simplicity liberty, and is the best standard to create harmony in the hues [19, 21]. It is prone to create a feel of cleanness and purity and therefore easily arouses participant's positive emotions.

In the comparison of the number of existing samples, high color temperature (61.65%) and analogous hue (61.12%) are in the majority in their respective variables. Sample g, which ranks 1st in market share (38.53%), is able to create positive valence and high arousal of the participant to a highest degree. The ranking of the three types of color scheme in market sales agrees with that in emotion dimensions, both shown as "analogous > contrast > complementary"; the above-mentioned situations suggest that the color presentation on the packaging of popular beverages is roughly consistent with consumers' emotional reactions.

4. CONCLUSION AND SUGGESTION

After discussion by related literature, "color temperature of white light" and "color scheme of packaging" act as important factors in affecting the colors presented on beverage packaging and the viewer's perception for them. Application of both in the market shows the difference in the design of presented colors on beverage packaging. The combination largest in number is "high color temperature" with "analogous hue" (38.53%), and this high color temperature for fluorescent white light combined with an analogous hue in beverage packaging is the mainstream in the market. The smallest in number is "low color temperature" with "complementary hue" (0.87%). "High color temperature", close to the

daylight at noon of a cloudy day, is used by the retail outlet as the mainstream design to exhibit various beverages. In addition, the "medium color temperature" with a stable, cozy feel or "low color temperature" that produces a relaxed, steady, and pleasant atmosphere is applied by stores to create a different atmosphere, which will provide consumers with a more leisurely, comfortable shopping environment and provoke their buying desire.

Although "analogous hue" has the greatest market share, "contrast" and "complementary" both visually differ from "analogous" to a great extent. A striking difference in size will create a design that shows a full sense of beauty [24]. Therefore, in designing the color scheme of packaging, the designer should not only take into account the uniqueness of color scheme, but make use of the combination of "color temperature" of LED white light and "color scheme" of packaging. Since the light color of fluorescent lamps and LED (with RGB tubes contained) tends to turn blue-green [12, 16]; this property may be applied to create a different meaning and image for the beverage packaging. Furthermore, blue-green or green color, favorable for color presentation in high color temperature, can be applied as the major hue in tea drinks and fruit and vegetable juice, both the largest in number (47.5% & 19.44%) in the survey of design trend. Application of "contrast hue" or "complementary hue", when combined with red or orange, will help the beverage look bright and lively, and when combined with blue-green or green for "analogous hue", will help it look refreshing and purified, and become visually tasty.

A set of questionnaires on how "color temperature of LED white light" and "color scheme of packaging" affect consumers' emotion dimensions show that "high color temperature with analogous hue" and "medium color temperature with contrast hue" both fall on "elated happy" core affect area; "low color temperature with contrast hue" and "high color temperature with contrast hue" both fall on "excited ebullient" area. They can all produce positive valence and high arousal, and are the top four combinations to best arouse consumers' positive emotions. This means "contrast hue" can more easily produce positive emotions; "high color temperature with complementary hue", "medium color temperature with complementary hue", and "low color temperature with complementary hue" fall separately on "tense jittery" and "upset distressed" areas. They can all produce negative valence and high arousal. This means "complementary hue" can more easily produce negative emotions.

The packaging of existing samples actually covers all kinds of beverages. Any difference in the motif of design, presentation technique of picture, use of font, color temperature of display light, and color scheme of packaging will affect the test participant's judgment. Therefore, we suggest control over variables other than "color temperature of white light" and "color scheme of packaging" for future studies, in order to provide more objective guidelines on the design of the colors presented on beverage packaging for designers to follow. The perceptual orientation—positive valence and high arousal—is expected to promote visual effects and commercial value of beverages.

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