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THE INFLUENCE GIVEN BY THE MATCHING CONFLICTS BETWEEN CHINESE COLOR NAMES AND COLORS ON READABILITY OF COLOR NAMES

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ABSTRACT:

There are many color names in Chinese characters. The connectivity between color names and colors varies and matching conflicts affect readability of color names. The contradiction between English color names and color words can create 'Stroop effect' to reading (Stroop, J. R. 1935). This study focuses on the difference between the matching of color names and colors and also the influence on readability. Experimental design was adopted and then twenty color words in Chinese were selected. The discordance/conflict of colors was designed and the method 'Seeing patterns & naming colors' was conducted. Time spent between seeing & naming was recorded and data was analysed quantitatively. This study discovers that response for Chinese color words varies. Generally, response to word groups of red, yellow and blue is quick. Also, common words and non-common words create different results. Therefore, Stroop effect brings constructive flourish and polysemy to Chinese color words. This study shows a different result from English color words and serves as guidelines for the further research of color expression with Chinese characters.

Key word: color words, colors, Stroop's effect

1. INTRODUCTION

1.1 BACKGROUND INFORMATION

Human beings' sense processes are complex procedures and the differentiae of sense result vary greatly. The illusion from contradictions or conflicts caused by vision and sensation is called visual illusion, which is very common in our daily lives. For example, blind points, complementary phenomena, colored shadows…etc. (Caocang, 1985).

In paintings, many examples of visual illusion can be found as well. For instance, many painters in Renaissance started applying 'perspective' which is a skill has been regarded as a paradigm by many modern painters in the twenty first century since then. However, early in the nineteenth century, scientists discovered that what people can see in fact is a bit different from what presents in the real world. In other words, perspective does not show the visual reality. In fact, the world through people's eyes is deformed and partly enlarged (Wang, 2001).

The similar situation could happen in reading Chinese characters. When people are reading newspapers or magazines, the cognitions to original meanings expressed in articles would be influenced by vision. It could be the expressions of word fonts or the presentations of colors in Chinese characters create the differences between sense experience and visual perception.

Lin (1990) states that there are four elements of well-balanced visual aesthetic of words: correct word fonts, easy-reading texts, good appearance and creativity. Word messages are the most frequently used information in human beings' lives. Whether the conveyed effects of words can deliver the originally expected meanings? Hence, the readability of characters and presentation design play important roles in conveying messages.

The mechanism of Chinese words builds on the function of conveying messages. The best convey requires the accurate word fonts and an accurate word font itself presents readability. He (2006) points out that the color names/phrases in Chinese, in terms of imagery, easily give the solid impression, thus they are an eye-catching part of visual effects. The color names/phrases are not only the simple word characters, but also include symbols denoting color imagery. This is why when reading color names/phrases, people can sense the indicated colors. Early in 1935, Stroop effect was mentioned in American psychology and proved that the interplay between English words and print colors had impact on readers' visual perceptions. Lin and Xie (2001) mention that if colors of words are shown in computers, the visual perceptions of those colors at the two ends of the visible spectrum are weak, and white words have the best visual perception of accuracy. Therefore, the choices of colors for Chinese words can affect visual perception and it should not be underestimated (Table 1).

Word attributes of visual perception	References
(1) Zhongheiti and Ximingti have better rate of perception accuracy	Zhang & Zheng (1996)
(2) Horizontal reading is better than vertical reading	Cai,Yan and Wang (2005)
(3) Warm colors are better perceived than cold colors	Chen (2001)
(4) Stronger color contrast is, better readability is	Chen (2001)
(5) Stronger color contrast is in the word background, clearer the vision	Chen and You (1997)

Source: sorted for this study

Table 1: Good word attributes of visual perception in several literatures

1.2 AIMS AND OBJECTIVES

This study aims to discover the relations between the meanings of Chinese color words and the appearance features of colors. For those people in Chinese-spoken areas, the Chinese color words have become a kind of expressive symbols and people have already possessed certain aesthetic experience for them. Hence, when the color expression in Chinese is opposite to its symbolic image, whether this may differ people's visual perceptions? If color names/phrases are added with appropriate appearance features of colors, can this increase the readability to readers? Furthermore, the influence brought by the inappropriate appearance features of colors on reading meanings of articles is discussed in hopes of developing accurate visual effects of color presentation and of Chinese word imagery.

Along with the passing new century, comparing to the trend of nationalism of the twentieth century in the past, nowadays we feel strongly the emergence of diversified cultures. It is an era of multi-cultures. Rather than following the world trend, many designs focus more on 'local cultural values'. Besides, many experts predict that Chinese language will become an international language in the future. People living in the Chinese-spoken areas are supposed to cherish the cultural properties and develop more research theories of Chinese words. Therefore, the five thousand year's culture can be broadened and deepened and also richer knowledge can be nurtured. The main objective of this paper is hoping the most common minor phenomena in our surroundings – features of sense and visions, which are often overlooked, can be utilized. Aiming to this goal, further discussion in this study includes:

(1) Collect the development and general usage of color words at present

(2) Investigate the condition of matching color words to color list

(3) Discuss the influence on readers while color words and color appearance features are

different

(4) Discuss the influence on visual perceptions while color words match colors perfectly

2. LITERATURE REVIEW

2.1 THE ORIGIN OF CHINESE COLOR WORDS

Lu (1989) states that Chinese has gradually formed the concepts of five colors after the sixth century BC. The five colors are black, red, white, blue and yellow that present the five elements – water, fire, gold, wood and earth. The five elements also symbolize directions – the north, the south, the west and the east. The concepts of five colors were often recorded in ancient literatures. Besides, 'five virtues flourish with each other[1]' or symbols, the interactions or matching of five colors were recorded as well. Lu also cited 'five hues embed in five colors' from *Shangshu* (尚書). Chinese people have long valued manners and believed that manners are the foundation to build a country. In the chapter Yueling of *Book of Rites* (禮記月令篇) and the twelfth period (chapter) of *Lushichunqiu* (呂氏春秋), what colors are supposed to be used for the emperor's diet, clothes, palace and travel are precisely recorded. We can find that the colors in Chinese lives were regulated meticulously at early era. In other words, colors played important roles at that time.

Presumably, at least as early as in Zhou dynasty Chinese have given meanings to colors. The way in which Chinese color words being created is taking objective things as tropes and the targets of interpretations. Color naming is a way to distinguish one color from another. In China,

[1] It is a mysterious concept of the historical cycle. It is to win five virtues relations shows dynasty turnover sequence : the order is Soil, Wood, Gold, Fire, Water in cycle; Then after Water, it's Soil again.

the earliest meticulous color segmentation was found in garment and dyeing industry. This is why the Chinese character '糸', which means 'silk' is widely used as the radicals for many Chinese color words (Jian & Zeng, 1998).

Liu (2004) points out that single words were used to express color at an early stage and color expressions were not 'colorful' so that most color expressions are the linguistic phrases/idioms, which express color meanings by words. Linguistic phrases/idioms can offer supplement to the single word expressions of colors.

2.2 THE RANGE OF CHINESE COLOR WORDS

Lu（1994） lists the categories of Chinese color names divided by J.P. Kornerup and H. Wanscher (Zeng, 2003). The categories are:

(1) Primary color names: red, yellow, green, blue, black and white. The Chinese five main colors are in this group.

(2) Secondary color names: grey, brown, purple, orange, gold, magenta, olive, rosy, turquoise, ruby, beige, blond, lilac, pale and violet. The Chinese middle colors are in this group.

(3) Basic color names in combination: yellow-green, blue-black. In Chinese, blue-black and flame-red-white are in this group.

(4) Basic color names with modifiers: light blue, pastel-green, deep black, greenish blue. In Chinese, dark ink mentioned in *The Works of Mencius* (孟子) is in this group.

(5) Basic color names with objects: In Chinese, flame-red and green spring onions are in this group. There are many other categories as well:

a. Plants-related color names

b. Minerals-related color names

c. Artifacts-related color names

d. Animals-related color names

e. Places-related color names

f. Nature phenomena-related color names

g. Theme-related color names (e.g. calypso, infrared)

The deviations of color names are not just presented in different periods. Color names can be interpreted differently for different combinations.

Lin (2006) reveals the statistic of the common colors used in four primary novels of Ming dynasty. In these four primary novels, color names of red series are used most often and phrases/idioms are used in abundance. For Chinese people, red color usually symbolizes positive and pleasant meanings, i.e. wealth, auspiciousness, felicitousness and nobleness. Lu mentions that the Chinese word '紅' used to present red colors was earliest shown in around 450 BC (Lin, 2006). 'A gentleman does not wear colors of cerulean blue or black as decoration and does not wear red or purple as underwear.' in the chapter of Xiangdang of *Confucian Analects (*論語鄉黨篇*)*. 'Red, the color of silky-flame-white' in *Shuowenjiezi (*說文解字*)*. Earlier Chinese usually used '朱' (about 820 BC) and '赤' (about 770 BC) to describe the red colors we see often at present.

Liu (2004) states the following situation about black color. 'For hua-hui（畫繢）[2], five colors are mixed. Blue is the east, red is the south, white is the west, black is the north, xuan (玄) is the

[2] A Chinese tradition skill, it means painting on the clothes or textiles

sky and yellow is the earth.' These 'five colors' are used to describe hua-hui. But six colors – blue, red, white, black, xuan and yellow are used to explain hua-hui. Zhengxuan, says, 'these six colors present colors of hua-hui'. Therefore, in hua-hui, 'five colors' are the six colors of 'blue, red, white, black, xuan and yellow'. Jiagongyan[3] explains the confusion over five colors or six colors. He says, 'Tianxuan (天玄, means deep black color) and Northern black are similar black colors, but when describing the sky, you can only say deep sky (玄天), but not black sky (黑天), If describing the north, then both deep (in Chinese, it's '玄' - xuan) and black are acceptable. This is why that the northern star is called Xuanwu (玄武)'. In the chapter of Liyun of *Book of Rites* (禮記禮運篇), it says, 'five colors, six phenomena and clothes for twelve months in a year, all turn the appearances back to essences'. Kongyingda[4] explains that five colors are blue, red, yellow, white and black and also believes that these five colors are derived from the five directions. Six phenomena are the five colors added with deep sky color. Because deep sky color is the same color as black, this is why six phenomena are generally called five colors. Based on the explanations given by Jiagongyan and Kongyingda, five colors include six colors, i.e. blue, red, yellow, white and black. However, when describing the sky, another synonym 'xuan' is adopted.

In Shuowenjiezi, more than sixty words with color meanings are recorded. They include chi (赤), tong (赨), xi (赩), cheng (赬), he (赫), zhu(赭), jiang (絳), zhu (朱), fei (緋), jin (縉), qing (綪), zhuo (絀), xun (纁), hong (紅), gan (紺), zao (繰), zi (紫), zou (緅), quan (縓), juan (絹), zong (緫), yin(殷), piao (縹), li (綟), gao (縞), lu (綠), zi (緇), su (素), qi (綦), dan (丹), tong (彤), huang (黃), qing (青), lan (藍), cang (蒼), hei (黑), an (黯), tan (黮), yan (黤), can (黲), qian (黚), you (黝), zi (兹), zao (皂), xuan (玄) , bai (白), jiao (皎), xiao (曉), xi (晰), ai (皚) and po (皤), etc (Liu, 2004).

[3] A Tang Dynasty person who wrote Zhouli (周禮).
[4] A Tang Dynasty classicist who wrote Ujingzhengyi (五經正義).

Lu's research 'color names and color tests – the study on color standardization' collects color phrases/idioms in books. Nine categories of books are randomly surveyed. In those fifty-five books, black and white color series are used greatly. In terms of colorful usage, color names of red series appear most often. The series of orange, yellow, green, blue and purple come up afterwards (Shen, 1995).

Reviewing the literature mentioned above and referring to *Common Words dictionary* issued by the Ministry of Education (1983), *Ciyuan* (辭源, Lei, 1988) and *Shuowenjiezi* (Xu, 1995). I have deleted some dead words and non-color words. Table 2 shows the sorted color words.

Word Group	Color Words	Primary Selected Words
Red	hong（紅）, chi（赤）, tong（赨）, xi（赩）, he（赫）, zhe（赭）, cheng（赬）, xia（赮）, nan（赧）, fei（緋）, jin（縉）, xun（纁）, jiang（絳）, qing（綪）, zuan（纂）, zou（緅）, wei（煒）, sia（霞）, mei（韎）, zhu（朱）, dan（丹）, tong（彤）, qian（蒨）, yin（殷）	hong（紅）, chi（赤）, zhu（朱）, yin（殷）, zhe（赭）
Orange	cheng（橙）, ti（緹）, he（褐）, yun（縕）	cheng(橙), ti(緹), he(褐), yun（縕）
Yellow	huang（黃）, tou（黈）, xiang（緗）, quan（縓）, xi（黊）, tian（黇）, hui（黃有）	xiang（緗）, xi（黊）, huang（黃）, tian（黇）, hui（黃有）
Green	lu（綠）, li（盭）, li（綟）, lun（綸）, guo（緺）, piao（縹）, cong（蔥）, bi（碧）, ping（艵）, cui（翠）	piao（縹）, lu（綠）, li（綟）, bi（碧）
Blue	dian（靛）, dian（澱）, lan（藍）, qing（青）, cang（蒼）	qing（青）, cang（蒼）, lan（藍）
Purple	gan（紺）, zi（紫）, zao（繰）	gan（紺）, zi（紫）, zao（繰）
Black	hei（黑）, qi（綦）, an（黯）, tan（黮）, yan（黤）, can（黲）, qian（黚）, you（黝）, zao（皂）, xuan（玄）, hui（灰）	
White	su（素）, bai（白）, jiao（皎）, ai（皚）, po（皤）	
Deleted Words	zong（棕）, fen（粉）, cha（茶）, tao（桃）, jhuo（絀）, jyuan（絹）, zong（總）, gao（縞）, zi（緇）, zi（玆）, xiao（曉）, xi（晰）, qing（清）, ping（頩）, yin（蔭）, kong（硿）, zhu（絑）, wan（綰）, shan（縿）, qin（綅）, hui（繢）, tun（炖）, syu（煦）, hui（煇）, tuan（煓）, wo（渥）, chu（褚）, qi（祇）, ni（霓）, yun（韞）, huo（臒）, shi（奭）, xi（歙）, fan（蕃）, cheng（竀）, hu（盿）, wan（綩）, rong（絨）, sia（煆）, jiao（絞）, xiang（纕）, yun（熉）, tou（斛）, chen（沈）, chan（纏）	

Source：sorted for this study

Table2: Color Words in Various Color Groups

3. RESEARCH DESIGN

3.1 RANGE AND METHODS

This study explores the influence on readability when there is a contradiction between the meaning of color words and color expression. Variation analyses are conducted and research methods are explained in the following sections.

(1) Variation Analysis

The color usages in Chinese are set to be independent variable. Testee's time required to read are set to be dependent variables. Testee's reading habits, age range, gender, education and religions are intervening variables.

Through the correct options of color words chosen by testees and the influence created by images of colors on visual recognition, this study discusses the relation between color words and images of colors, especially when both items are not matching. Whether the contradictions would affect reader's reading speed is discussed as well. Figure 1 shows the structure of research evaluation.

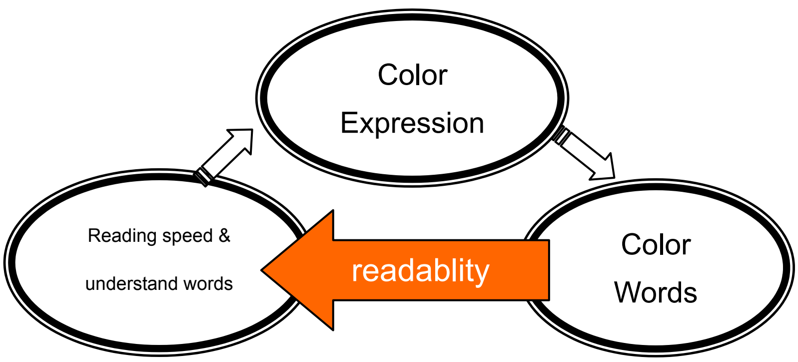

Figure1: The Structure of Research Evaluation

(2) Study Range

'Color words' are those traditional Chinese words that are used commonly nowadays (according to the word list issued by the Ministry of Education website-[5]).

3.2 DESIGN OF EXPERIMENTAL METHODS

3.2.1 NAMING AND TOOL

Experimental design was adopted for this study. The samples of combinations that matched color words with colors were designed. Also this research was divided into two stages. The first stage was choosing samples and the second stage was experimental study.

(1) At the first stage, literature on color words were collected and sorted. Some outdated color words and those are not used often or words with changed meanings were omitted. Then the color names were collocated with CMYK digital color chart (Yang & Wei, 2006) and the matching of colors and words in three books – *Shuowenjiezi* (Xu, 1995), *Ciyuan* (Lei,1988) *and Common Words dictionary* (the Ministry of Education, 1983) are referred. In total, there were 24 colors and color words were selected. Through test and the primary statistic, four color words of high rate of wrong answer (low rate of visual recognition) were deleted. These four color words were tian (黇), zao (繰), hui (黃有), yun (縕). Table 3 shows the 20 color words kept for this experiment.

hue \ tone	dark-deep	deep	deep-vivid	vivid	dull	soft	light	pale
ref	zhe（赭） （128,0,0）	yin（殷） （170,0,0）	zhu（朱） （213,0,0）	chi（赤） （255,0,0）			hong（紅） （255,85,85）	
redish orange				yun（縕） （250,85,0）				
orange		he（褐） （170,85,0）			ti（緹） （213,128,43）			

5 Common Word List on the website of Ministry of Education http://www.edu.tw/index.htm(2007/06/20)

yellowish orange		cheng（橙） （255,170,0）		huang（黃） （213,170,85）		
yellow	hui（黃有） (170,170,0)	xi（黊） （255,255,0）			xiang（緗） （255,255,85）	tian（黇） （255,255,170）
green	li（綟） （0,170,0）	lu（綠） （0,255,0）				
bluish green			bi（碧） （43,213,128）			
blue green		qing（青） （0,255,255）				piao（縹） （170,255,255）
blue	cang（蒼） （0,0,170）	lan（藍） （0,0,255）				
bluish purple			zao（繰） （128,43,213）	gan（紺） （170,85,213）		
purple		zi（紫） （255,0,255）				

p.s.: the numbers below color words are RGB numbers Source：sorted for this study

Table3: Color Words Collocated With RGB Digital Color Chart

(2) The written sample of questionnaire was drafted by the software Adobe Photoshop CS. The experimental procedures were partly made by Macromedia Flash MX. In order to avoid the word disposition or the order of showing words not to affect experimental results, the order of showing words was arranged to be at random. The programme language Actions of Flash MX was used to record experimental data and then Microsoft Office Excel 2000 and SPSS 12.0 carried out the data analysis.

(3) The font, the tool of experimental word sample, was set to be ‘standard Kai character’, which is widely used in Taiwan and contains Chinese writing features. Compared to written words, this setting can avoid the recognition failure caused by different handwritings. The background of font was the grey color (C-0, M-0, Y-0, K-50) so that the color of words was not disturbed. Snydr & Taylor (1979) suggest that the font size in computer monitor should be at least 12 pixels. Calculated by the formula of visual angle and distance, the size 72 pixels (font height: 3 cm; font width: 3 cm) was adopted. The distance between the testee and the monitor was about 60 cm. Through calculation, the visual width of the testee was about 2.865 degree.

(4) Before the experiment, the brief teaching of matching color words with colors was

conducted. It took about 30~60 minutes to teach testees the pronunciations of color words and the color meanings. After teaching, a test was held, thus testees' memory could be enhanced. The rate of correct answers should over 70% so that next experimental procedure could be carried out. Figure 3 shows the teaching paradigm.

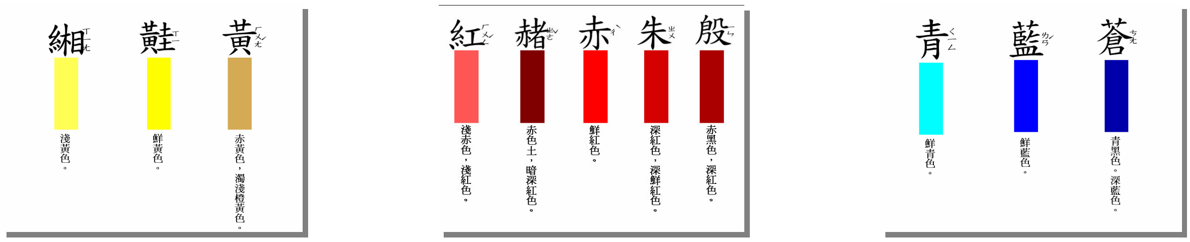

Figure3: Teaching Paradigm of Color Words and Matching Colors

(5) In Stroop's experiment (1935), he managed two main variation tests. One was called RCN[6], which was 'color reading test'. Attendants were required to repeat the literal meanings and word presentation in different colors. The other test was NCW[7], which was 'color recognizing test'. Attendants were required to identify what colors those printed color names belonging to. In the first stage of our study, 24 colors words and colors were obtained. Therefore in the second stage, both colors names and colors arranged at random were used in designing questionnaire. The questionnaire was divided into several groups and marked. The switch of colors was made in turns. Testees should give the relevant recognizing and reading response to the stimulation. Figure 4 shows the operating interface of this experiment.

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[6] Reding Color Names
[7] Naming Color of Words

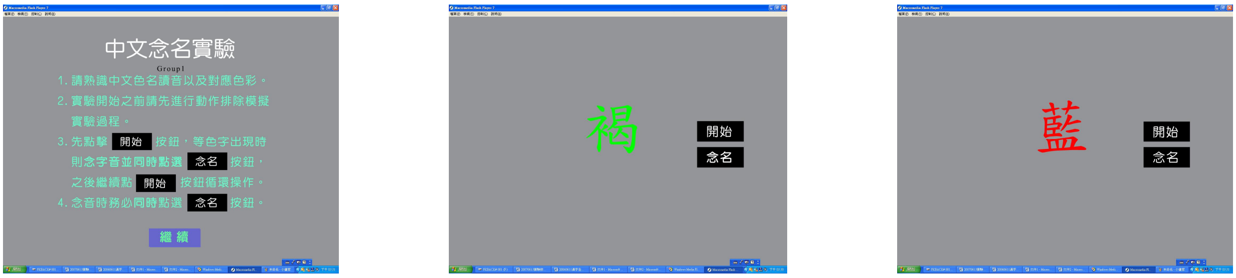

Figure 4: the experiment operating interface

3.2.2 EXPERIMENTAL EQUIPMENTS

The test interface was designed by software Macromedia MX Flash 2004. The experimental environment was a dark room. The distance between the testee and the monitor was about 60 cm. The monitor was a 17” LCD (Liquid Crystal Display) with the resolution of 1024x768 and the display colors were adjusted. All the equipments, i.e. the table and the chair, were maintained the same in the same laboratory.

3.2.3 EXPERIMENTAL TARGET

There were 74 students at National Taiwan University of Arts being enlisted: male – 18 persons and female – 56 persons. The age was in the range of 18~40. All these testees’ vision was inspected by Ishihara color vision test. After being corrected, their vision was in good condition while the experiment was conducted.

3.2.4 EXPERIMENTAL METHOD

(1) The selected 20 color words were matched with the seven colors – red, orange, yellow, blue, green, purple and black. There were140 combinations grouped as the

experimental samples.

(2) 140 samples were divided into four groups by hierarchy grouping. The order of samples was arranged at random and the testee chose two groups of samples at random to do the test.

(3) During the experiment, beside the responsive time of testees was recorded; audio recording was also used to verify the accuracy.

3.3 PILOT TEST

In the pilot test, when the combination of different colors and color words was showing up, testees had different responsive time due to the Stroop Effect. Time spent was recorded by a formula so that the responsive speed to the color words and the deviation of color change could be observed. Based on statistical data, samples were modified (as stated above).

4. RESULT ANALYSIS

The testees were the male students 18 persons and female students 56 persons (in total 74 persons) at the National Taiwan University of Arts. Samples were the calculated standard deviation minus mean, deviation values and the failure 59 answers (the readability results which were not coordinated with sample presentations). After sorting and calculating, we found that the number of acceptable samples in total were 5041 from these 74 testees. On average, each person had 68.12 samples and each experimental color word received 252.05 responses (i.e. each single time spent on giving response to one question).

4.1 STATISTIC OF DESCRIPTION AND ANALYSIS OF RELIABILITY

After the experiment, recorded data were sorted and calculated. The mean was listed in Appendix 1. Among all samples, the shortest responsive time was the word 'huang (黃)' in green color; it took about 0.86". The longest responsive time was the word 'gan (紺)' in red color; it took about 1.71". The difference between the shortest time and the longest time was 0.85". For the groups of color words, red word group: hong (紅), chi (赤), zhu (朱), yin (殷), zhe (赭) obtained the average 1.073" for each color sample; orange word group: cheng (橙), ti (緹), he (褐) obtained the average 1.121"; yellow word group: xiang (緗), xi (黊), huang (黃) obtained the average 1.217"; green word group: piao (縹), lu (綠), li (綟), bi (碧) obtained the average 1.159"; blue word group: qing (青), lan (藍), cang (蒼) obtained the average 0.998" and purple word group: zi (紫), gan (紺) obtained the average 1.268". Also, the average time of all color samples (not including black) was 1.127 second and the standard deviation was 0.511 second.

In order to have reliable data, testees were divided into two groups: one was odd group and the other one was even group. Then the inspection of split-halves reliability was made. The Alpha coefficient was 0.895 and it was a reliable coefficient. Besides, P was less than 0.000 (<.05) which indicated that the reliability coefficient had patency and the data was coherent. Therefore, the data of this experiment was very reliable.

4.2 ANALYSIS OF MONOCHROMATIC WORD

4.2.1 RESPONSIVE ANALYSIS OF EACH COLOR WORD

Red word group included these five kinds of red color words: hong (紅), chi (赤), zhu (朱), yin

(殷), zhe (赭). When they were shown in six different colors, the responsive time to green and blue were the longest. They took 1.176” and 1.084” respectively. However, the responsive time to orange and purple were the shortest. Orange word group included these three kinds of orange color words: cheng (橙), ti (緹), he (褐) and when they were shown in six different colors, the shortest responsive time was 1.146” for green. For yellow word group, the shortest responsive time was 1.295” for blue. For green word group, the shortest responsive time was 1.195” for red. For blue word group, the shortest responsive time was 1.024” for green. For purple word group, the shortest responsive time was 1.395” for yellow. Table 4 shows the mean of responsive time spent on recognizing color words in different colors.

Groups / Colors	Red	Orange	Yellow	Green	Blue	Purple	Average
Red word group	1.046	1.038	1.058	1.176	1.084	1.033	1.073
Orange word group	1.127	1.121	1.060	1.146	1.137	1.135	1.121
Yellow word group	1.185	1.214	1.243	1.236	1.295	1.131	1.217
Green word group	1.195	1.143	1.113	1.189	1.122	1.194	1.159
Blue word group	0.986	0.999	0.985	1.024	0.995	1.003	0.998
Purple word group	1.336	1.238	1.395	1.188	1.220	1.231	1.268

Remark: red number represent the most second in this row.

Table 4: The Average Time of Matching Colors and Color Word Groups

4.2.2 COMPARISON OF READABILITY

(1) Readability of common words

Given the distinctions of Chinese character itself, the recognizable degree of the 20 color words may differ from one to another. Therefore, the color words were categorized into common words and non-common words, according to the Common Words Dictionary by the Ministry of Education (1983). Meanwhile, the recognizable degree of black color words was set to be the criteria for readability (mean 1.10” and standard deviation 0.17”) of color words. If the recognition time does not exceed the mean 1.10”, then the color words are common words; if the recognition time exceeds the criteria, then the color words are non-common ones.

The experimental result showed the 12 common words: hong (紅), chi (赤), zhu (朱), yin (殷), cheng (橙), huang (黃), lu (綠), bi (碧), qing (青), lan (藍), cang (蒼), zi (紫), and the 8 non-common words: zhe (赭), ti (緹), he (褐), xiang (緗), xi (鮭), piao (縹), li (綟), gan (紺).

Also, when the non-color (black) was used as the criteria of readability, the combination of words and colors can be compared for same color matching and contrast color matching. The result showed that the average responsive time was 1.053” for contrast colors; 1.014” for same colors and 0.995” for black colors (criteria). Through calculation, the difference between same colors and black colors was 0.019”; the difference between contrast color and black was 0.58”. And the difference between same colors and contrast colors was 0.039”. Table 5 and Figure 5 show the comparison of readability of common color words.

Colors / Words	Black 0	Same color 1	Contrast Color 2	Difference 1-0	Difference 2-0	Difference 1-2
Red/ hong (紅)	0.98	0.99	1.00	0.01	0.02	-0.01
Red/ chi (赤)	0.87	1.04	1.21	0.17	0.34	-0.17
Red/ zhu (朱)	1.09	1.04	1.05	-0.05	-0.04	-0.01
Red/ yin (殷)	0.99	0.88	1.16	-0.11	0.17	-0.28
Orange/cheng (橙)	0.85	1.05	1.05	0.20	0.20	0
Yellow/ huang (黃)	1.07	1.05	1.00	-0.02	-0.07	0.05
Green/ lu (綠)	1.05	0.99	0.98	-0.06	-0.07	0.01
Green/ bi (碧)	1.03	0.92	1.05	-0.11	0.02	-0.13
Blue/ qing (青)	1.05	0.94	1.09	-0.11	0.04	-0.15
Blue/ lan (藍)	1.06	1.05	0.92	-0.01	-0.14	0.13
Blue/ cang (蒼)	0.85	1.16	0.99	0.31	0.14	0.17
Purple/ zi (紫)	1.05	1.06	1.13	0.01	0.08	-0.07
Average	0.995	1.014	1.053	0.019	0.058	-0.038

Remark: Black color word is taken as the criterion for other color words (mean: 1.10; standard deviation 0.17).

Table 5: The Comparison of Readability of Common Color Words

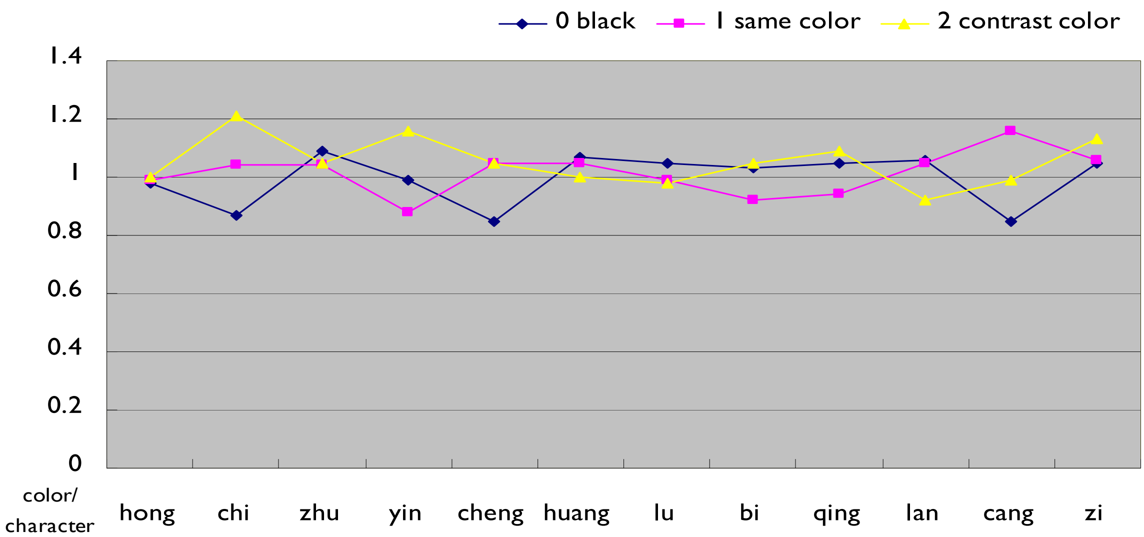

Figure 5: The Readability of Common Color Words When Colors Changed

(2) Readability of non-common words

For the non-common color words, i.e. those samples over mean, the result shows that the average responsive time was 1.268” for black colors; 1.315” for same colors and 1.331” for contrast colors. Same colors took 0.047 second more than black colors. Contrast colors took 0.063 second more than black colors. The difference between same colors and contrast colors was 0.016”. Table 6 and Figure 6 show the comparison of readability of non-common color words.

Color / Words	Black 0	Similar color 1	Contrary Color 2	Difference 1-0	Difference 2-0	Difference 1-2
Red/ zhe (赭)	1.23	1.28	1.46	0.05	0.23	-0.18
Orange/ ti (緹)	1.12	1.08	1.43	-0.04	0.31	-0.35
Orange/ he (褐)	1.26	1.23	0.94	-0.03	-0.32	0.29
Yellow/ xiang (缃)	1.30	1.44	0.95	0.14	-0.35	0.49
Yellow/ xi (黊)	1.33	1.24	1.44	-0.09	0.11	-0.2
Green/ piao (縹)	1.12	1.34	1.15	0.22	0.03	0.19
Green/ li (綟)	1.32	1.51	1.61	0.19	0.29	-0.1
Purple/ gan (紺)	1.46	1.40	1.67	-0.06	0.21	-0.27
Average	1.268	1.315	1.331	0.048	0.064	-0.016

Remark : Black color word is taken as the criterion for other color words (mean: 1.10; standard deviation 0.17).

Table 6: The Comparison of Readability of Non-common Color Words When Colors Changed

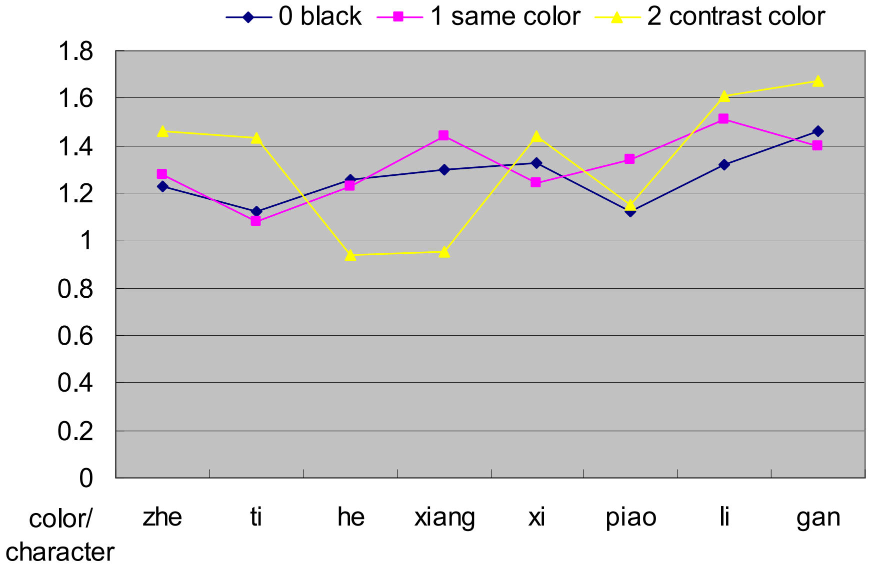

Figure 6: The Readability of Non-common Color Words When Colors Changed

(3) Comparison of common words and non-common words

When comparing all the average numbers/means of common words (Table 5) and non-common words, we found that the both groups for black colors have the difference 0.273” and 0.301” for same colors; 0.278” for contrast colors. Table 7 shows the comparison of readability of common words and non-common words.

Color / Words	Black 0	Same color 1	Contrast color 2	Difference 1-0	Difference 2-0	Difference 1-2
common words general average	0.995	1.014	1.053	0.019	0.058	-0.038
non-common words general average	1.268	1.315	1.331	0.048	0.064	-0.016
average difference (non-common words —common words)	0.273	0.301	0.278	0.029	0.006	0.022

Table 7: The Comparison of Readability of Common and Non-common Words

We adopted 't inspection' while doing the analysis and found that when color words were shown in black, the patency (P=.000<.001) existed between easy-reading words and hard-reading words. Similarly, for same color series, the patency between easy-reading words and hard-reading words existed (P=.000<.001). For contrast colors, the patency was P=.005<.05. Hence, the responsive disparity was very obvious between easy-reading words and hard-reading words. Table 8 shows the disparity inspection.

	t-test for Equality of Means						
	t	df	Sig. (2-tailed)	Mean difference	Std. Error Difference	95% Confidence Interval of the Difference	
						Lower	Upper
black color words	-6.023	18	.000	-.27250	.04524	-.36755	-.17745
same color words	-6.367	18	.000	-.30083	.04725	-.40010	-.20157
contrast color words	-3.166	18	.005	-.27125	.08567	-.45123	-.09127

Table 8: '[T]-test' of Common Words and Non-common Words

4.2.3 INSPECTION OF THE READABILITY OF MONOCHROMATIC WORD

As mentioned in previous chapters, there are five red color words: hong (紅), chi (赤), zhu (朱), yin (殷), zhe (赭) in red group. When we just compared these five red color words with each other and used the six colors – red, orange, yellow, green, blue and purple (except non-color, black) and then calculated the responsive order with Kendall's coefficient of concordance, we found there was a patency (P=.03<.05). This means that red colors in the red group have an obvious order and in the order of fast responsive speed to slow responsive speed, they are hong (紅), zhu (朱), chi (赤), yin (殷), zhe (赭). Table 9 shows the readability of each red word in six different colors.

Color \ word		hong（紅）	chi（赤）	zhu（朱）	yin（殷）	zhe（赭）	Average	Kendall's Coefficient of Concordance	
red	Average	0.99	1.04	1.04	0.88	1.28	1.05	N	6

	Order	2	3	3	1	5	3	Kendall's W(a)	0.45
orange	Average	0.90	1.05	1.00	1.23	1.02	1.04	Chi-Square	10.75
	Order	1	4	2	5	3	1	df	4
yellow	Average	1.03	0.96	1.03	1.06	1.21	1.06	Asymp. Sig.	0.03*
	Order	2	1	2	4	5	4		
green	Average	1.00	1.21	1.05	1.16	1.46	1.18		
	Order	1	4	2	3	5	6		
blue	Average	1.02	1.16	1.03	0.93	1.28	1.08		
	Order	2	4	3	1	5	5		
purple	Average	0.90	0.98	1.02	1.20	1.08	1.04		
	Order	1	2	3	5	4	1		
Sum	Average	**0.97**	**1.07**	**1.03**	**1.08**	**1.22**	**1.07**		
	Order	**1**	**3**	**2**	**4**	**5**			

Table 9: 'Red' Word Group with Kendall's Coefficient of Concordance

With the same conditions and calculated by Kendall's coefficient of concordance, yellow word group obtained an obvious result (P=.02<.05), thus the order of yellow word group was coherent. Green word group, blue word group and purple word group all had obvious results (they were P=.002<.05, P=.002<.05 and P=.014<.05 respectively), hence the order of these three word groups was in coherent, too. However, the coefficient of concordance of orange word group was not obvious, the result was 0.31 (P>.05).

4.3 DISCUSSION

From the analysis made above, we found that due to color conflicts Chinese color words receive different responsive time. The responsive time of color groups of red, yellow and blue are shorter. On the other hand, the responsive time of color groups of orange, green and purple are longer. This is probably related to the familiarity to color words. Also, the Chinese color words vary in recognizable degree. For common words, the difference between contrast colors and same colors is bigger than it of hard-reading words. Therefore, the influence of colors may be reduced by the readability of color words and the variation of responsive time of color words in different colors is not obvious. When the recognition speed is reset to be observed by rank order, and to be inspected by Kendall's coefficient of concordance, the fact that color words are in array is clear.

In terms of common words and non-common color words, there are more common words in the red color word group. In another word, red color words are still common and they are expressively flourished. Blue color word group is the second group with most easy-reading words. But other groups, orange, yellow, green and purple have less common Chinese color words and it is asserted that red color is very important in Chinese culture. According to Berlin & Kay's research (1969), a study of combination of colors and color names in several races, they state that the evolution of color phrases/idioms started from non-color, black. Then the first color expression was a red color word and then the following words were green or yellow and then blue. Afterwards, the color phrases/idioms of non-basic colors were derived. The finding of this study, that is the responsive time of three color word groups: red, yellow and blue (word group), is shorter than other word group, echoes Berlin & Kay's statement.

However, with respect to Chinese words, the Stroop effect given by colors to Chinese color words is not in accordance with the conclusion of color-naming experiment in 1935. Stroop used English color words in his experiment. In contrast to English, Chinese characters are ideographic, but not phonetic. There are six types of Chinese characters: pictograph, picture of action, ideograph, phonetic symbol, figurative extension and borrowing. And most color words are made up by the type of 'picture of action'. Zeng (2003) believes that the color expression of Chinese mainly began from single words and has gradually developed to double words, triple words or even quadruple or quintuple compound words. Also, in terms of word meanings, it has developed from 'one-sense words' to 'multiple-sense words' and has brought more freedom and more prosperity to color expressions. However, it would bring some confusion and difficulties in communication. From this study, we found that people's received messages are not in accordance with the presentation of Chinese color expression. This confusion would create other interference. As for English, it color expression is more simplified and has some explicable indication of colors. This was why the English experiment had a clearer result.

The result of this study shows that with long history, the Chinese color words have complicated varieties and usage and these features indeed create some difficulties in communication, either orally or visually. The gap between the degree of common words and non-common words is huge, in another word, the readability of these two word groups - common color words and non-common color words – is very different. As time goes by, the culture of color words can fail in inheritance or even being phased out and this would be a great loss in art, in language and in history. The long phrase and short phrase of color expression and the category of definition can be taken into consider to control the complexities for the relevant study in the near future.

5. CONCLUSION

Referring to much literature and under scrutiny, some important issues are found in this study:

(1) In the conflict matching of color words and colors, red, yellow and blue color word groups obtain faster responses than other word groups. However, the difference is not very big.

(2) Because the character structures of Chinese words are distinctive, the influence of colors on the Stroop effect of Chinese color words is not obvious and this situation does

not mirror the original Stroop's experiment. It also indicates that Chinese color words have unique complexities and polysemy.

(3) Chinese characters are ideographic and they are different from other phonetic words, thus the experiment result is different. How the disparity between Chinese words and English words could be explored in further study.

(4)

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Appendix 1

color / word	red	orange	yellow	green	blue	purple	**Average**	Black
Hong (紅)	0.99	0.90	1.03	1.00	1.02	0.90	**0.972**	0.98
Chi (赤)	1.04	1.05	0.96	1.21	1.16	0.98	**1.064**	0.87
Zhu (朱)	1.04	1.00	1.03	1.05	1.03	1.02	**1.027**	1.09
Yin (殷)	0.88	1.23	1.06	1.16	0.93	1.20	**1.077**	0.99
Zhe (赭)	1.28	1.02	1.21	1.46	1.28	1.08	**1.222**	1.23
Subtotal	1.046	1.038	1.058	1.176	1.084	1.033	1.073	1.032
Cheng (橙)	1.08	1.05	0.88	1.13	1.05	1.01	**1.034**	0.86
Ti (緹)	1.32	1.08	1.15	1.03	1.43	1.09	**1.184**	1.12
He (褐)	0.98	1.23	1.15	1.27	0.94	1.31	**1.145**	1.27
Subtotal	1.127	1.121	1.060	1.146	1.137	1.135	1.121	1.079
Xiang (緗)	1.16	1.16	1.44	1.28	1.26	0.96	**1.208**	1.30
Xi (黊)	1.38	1.45	1.24	1.56	1.56	1.44	**1.439**	1.33
Huang (黃)	1.01	1.04	1.05	0.86	1.07	1.00	**1.005**	1.07
Subtotal	1.185	1.214	1.243	1.236	1.295	1.131	1.217	1.232
Piao (縹)	1.15	1.30	1.14	1.34	1.08	1.24	**1.207**	1.12
Lu (綠)	0.98	0.89	1.08	0.99	1.00	0.90	**0.974**	1.05
Li (綟)	1.61	1.37	1.23	1.51	1.29	1.52	**1.422**	1.32
Bi (碧)	1.05	1.01	1.00	0.92	1.12	1.11	**1.035**	1.03
subtotal	1.195	1.143	1.113	1.189	1.122	1.194	1.159	1.130
Qing (青)	0.89	1.09	0.96	1.00	0.94	1.13	**1.002**	1.06
lan(藍)	0.99	0.92	1.10	0.99	1.05	0.89	**0.990**	1.06
cang(蒼)	1.08	0.99	0.90	1.08	0.99	0.99	**0.983**	0.86

Subtotal	0.986	0.999	0.985	1.024	0.995	1.003	0.998	0.991
Gan (紺)	1.71	1.31	1.67	1.32	1.52	1.40	**1.489**	1.46
Zi (紫)	0.97	1.16	1.13	1.05	0.92	1.06	**1.048**	1.05
Subtotal	1.336	1.238	1.398	1.188	1.220	1.231	1.268	1.255
Average	1.129	1.112	1.120	1.166	1.131	1.111	**1.127**	**1.105**
							standard deviation：	0.511

Appendix 1: The Average Time of readability of Color Words in Colors