科技部補助專題研究計畫成果報告

（□期中進度報告/■期末報告）

色彩的認知研究-色彩的詞彙與概念研究

計畫類別：■個別型計畫　□整合型計畫
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本計畫除繳交成果報告外，另含下列出國報告，共 1 份：
□執行國際合作與移地研究心得報告
■出席國際學術會議心得報告

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中　華　民　國　103 年　10 月　31　日

目錄

中文摘要

「色彩」所指稱的現象可謂包羅萬象；在學界針對色彩所進行的研究，大致由色彩設計與心理以及色彩科學與應用兩個取向出發(例如中華色彩學會主辦，已逾十屆之「色彩學研討會」)。然而無論由美學設計或是科學應用出發的色彩研究，都指出人類對色彩的感知，在不同層面具有不同的意義。要認識什麼是色彩，所牽涉到的乃是由視覺到心理，乃至文化層面的問題。

在為期二年的計畫執行期限中，作者依照近年系列研究計畫內容，一方面接續前期研究計畫中未竟之處，補充色彩色塊與色彩相關詞彙對色彩再認效率之促發實驗資料，另一方面則著手進行台灣地區中文色彩語彙與分類的調查。研究採用 Solso & Short(1979)之實驗程序，除了在中文條件下成功複製其實驗結果外，並進一步以反應時間探索不同色彩關聯文字對色塊辨識刺激的促發效率。在接下來的研究中，則採用 NCS 色票為材料，輔以電腦程式，針對台灣地區的中文使用者進行 Berlin and Kay (1959)型式的中文色彩詞彙色域調查。本研究廣泛採用 32 個不同詞彙，結果分析後發現 12 個基本色域類別，說明了中文使用者的基礎色彩分類與世界色彩調查(WCS)的發現吻合，只是過去因中文色名的不統一而被誤導。原計劃再進行的下一階段的色域類別之促發效率實驗不及於計劃執行期限內完成。

關鍵字：色彩、分類、再認、反應時間

英文摘要

Color is usually considered as a dimension of visual stimuli, and perceptual issues are of central interest. However, the present study focuses on cognitive issues about color, in which color is treated as a kind of visual information. The present study can be divided to three parts, which are corresponding to the recent three years of the author's projects, respectively.

Park I is consisted of three serial experiments. In the first experiment, we adopted the priming paradigm used by Solso and Short (1979) to investigate the perceptual and semantic color codes used by local Mandarin Chinese speakers. Color patches and color words (in Chinese) were presented simultaneously with the matching stimuli, or displayed after either a 500 msec or 1500 msec stimulus-onset-asynchrony. The matching stimuli were color patches, color terms, or color-related words, and subjects were asked to respond to whether the stimulus pairs would match, by pressing a button as quickly as possible. The recorded reaction time replicated Solso and Short's findings in a Mandarin Chinese context, where the findings could be explained with a parallel processing of the perceptual and semantic codes generated by color stimuli. In the second experiment, we added Mandarin words which represented color-related psychological images and emotional metaphors into test pairs to explore additional possible codes activated by color patches. The obtained data suggested other parallel codes, with slower timing, for emotion and image color codes. Based on the findings of the two experiments, the third experiment was designed to explore the perceptual and semantic priming effects on color identification, in which a color identification task of four colors, with primes of matched or mismatched words, color patches were used. Color-related emotion words show significant priming effects on color identification

In part II of the present study, we investigate basic color categories among local native Mandarin speakers living in Taiwan. Comparable color samples as those used in the Berlin and Kay's color survey stimulus arrays are chosen from a collection of NCS color papers to make sample arrays. The survey is conducted by using a PC computer and a touch-screen monitor with a neutral gray cardboard mounted on it, in a X-Rite SpectraLite Junior booth (D65). Thirty-four target color terms used in this survey are chosen from a local public Chinese word-usage database based on high frequency. For each word surveyed, the subject is asked to pick up the color chips that match the word by pressing a virtual button on the touch screen presented under each color chip. The results, when displayed in naming arrays used in Berlin and

Kay (1959), show that some of the terms have concentrated term maps comparable to the data of WCS, with other show wide spreads of term maps and inconsistent among subjects. The results suggest twelve basic color categories in Mandarin Chinese, which were not appropriately demonstrated before.
Part III of the present study will apply the color-word matching paradigm of the part I, to investigate the focal colors for each color category found in the part II survey. However, this study does not yet begin to date.

Keywords： Color, Category, Recognition, Reaction Time

1. 前言

Color is a term that carries multiple meanings among different disciplines. It can be considered as a perceptual quality of light, surface properties of objects, an element of visual design, or signs of an emotional mood. All possible meanings suggest that color is a kind of visual information, and could be studied by following the information processing paradigm in cognitive psychology. The cognitive meanings color carries can be simply described as basic perceptual categories as revealed in color lexicons across different languages (Berlin & Kay, 1999), or psychological images such as warm-cold (李天任, 2002). Researchers also found that ”color” was often used to describe emotions (陳學志, 詹雨臻, 曾千芝, & 梁庚辰, 2009). Color survey studies frequently show multiple meanings carried by color, as a broadly defined term (Solso, 1971; Solso & Short, 1979).

2. 研究目的

The purpose of the present research is to investigate the concept and semantic categorization of color. Part I of the present report suggests a color lexicon and perception task which explores the question about color lexicon and typicality effect of colors. Part II of the study is trying to find the basic color categories among Mandarin speakers, rather than to find the basic color names used in the language.

3. 文獻探討

Rosch suggested the use of priming technique to study the field of mental representation through color (Rosch, 1975). In her classical research, basic color terms (names) served as priming stimuli, and the stronger facilitation for matching identical color pairs chosen from good color examples than for poor examples in a color category has been frequently cited as evidence for the prototype structure of color categories. However, the study revealed that priming technique could be useful to study mental representations generated by color stimuli, perceptual or semantic.

Solso and Short adopted semantic and visual priming techniques to investigate how perceptual, lexical, and semantically associated codes for a color stimulus were generated during color information processing (Solso & Short, 1979). They used color patches and color names serving as priming stimuli, and tested the priming effects by measuring the recognition reaction time for paired and unpaired color patches, color names, and color associative words. Priming effects were found for all kinds of pairs, but for some kinds of pairs, the effects showed

up with different breaks of delay between the presentation of primer and primed stimuli (Stimulus-onset-asynchrony, SOA). Their findings suggested that parallel processing of perceptual colors, color names, and color associate codes took place after subjects saw a color, but with different temporal parameters. A perceptual color code came out first, then the color name code, and then the associative terms about the presented color. All processing occurred in parallel, and there might have been more possible codes activated by a color stimulus. The notion that color stimuli automatically generate multiple perceptual and cognitive codes has been verified recently with color discrimination tasks (Marangolo, PACE, & Pizzamiglio, 1993) and with lexical decision tasks (Nijboer, van Zandvoort, & de Haan, 2006).

In regarding to the basic color categories, Berlin and Kay suggested that there are only six Mandarin basic color terms in their classical book. Lü, Ching-Fu (1997) suggested that basic color terms in Mandarin may exceed the number of eleven. Lin, Luo, MacDonald, & Tarrant (2001) showed that the basic and secondary color terms used in Taiwanese Mandarin and British English languages are similar. However, those studies relied on the collection of color terms generated by informants, and subsequent linguistic categorization of them. In fact, characters used to refer to colors in Mandarin Chinese cannot be clearly defined.

In the present study, part I, we first replicated Solso and Short's experimental procedures in a Mandarin Chinese context. In the second experiment, we added Mandarin words which represented color-related psychological images or emotional metaphors into test pairs, to explore additional possible codes activated by a color patch presented. The third experiment was designed to explore the visual and semantic priming effects on the RT of color identification, in which an identification task of four colors, with primes of matched or mismatched words, color patches, and drawings was used. Part II of the report is about a color survey done with our newly developed technique.

4. 研究方法

Part I

Subjects

The subjects were 3 students recruited from Chinese Culture University. All subjects had normal or corrected to normal vision, and were screened by Ishihara Test for normal color vision. They were not aware about the purposes and the design of the study before joining the experiments.

Materials

Five color samples chosen from the Natural Color System (NCS), corresponding to those samples used in Solso and Short (1979), were chosen for the experiments. The six samples respectively represented Red (S1080-Y95R), Yellow (S1070-Y), Blue (S3050-R90B), Green (S2060-G), and Brown (S6020-Y30R). Each of the colors was assigned a Mandarin color name based on a study by Lü (1997) on Mandarin basic terms, an associative word, psychological image words, and an emotional metaphor word. The corresponding associative, psychological image, and emotional metaphor words were all chosen based on related color survey studies in Taiwan.

All stimuli were displayed on an ViewSonic 19" CRT monitor (ViewSonic PF795, sRGB mode, 100 hertz refresh rate), with a viewing distance of 0.7 meter, which made each color square patch a viewing size of 5° in visual angle. Chinese characters were presented within a framed white square the same size as the color patches. All stimuli were displayed on a neutral gray background which subtended 20° by 15° in visual angle. The colorimetric specs of the stimuli are listed in Table 1. A PC computer and Cedrus SuperLab 4.5 software were used to control the whole experiment and collect data.

Procedures

Experiment One: A visual priming task similar to those used in Solso and Short (Solso & Short, 1979) was applied. The subject pressed a button to start a trial. In each trial, a fixation cross of 1° size was first presented in the center of the monitor for 500 msec, then a priming stimulus (color patch or name) was presented on the left side of the fixation. After a varying delay of zero, 500, or 1500 msec from the onset of the priming stimuli (SOA), another color patch or a Mandarin color name was displayed on the right side of the fixation (Figure 1). The subject was asked to use a button box to respond as quickly as possible on whether the patch color/name matches the primer. The reaction time for each trial was recorded.

Experiment Two: The procedures of the second experiment were similar to experiment 1, but with the color associated, image, and emotion metaphor words instead of the color names as the matching targets. The procedures were similar to the second condition of Solso and Short (Solso & Short, 1979). Only color patches were used as the priming stimuli in experiment two. The Chinese Mandarin words used in experiment 2 and their corresponding meanings in English were listed in Table 2.

Experiment Three: Experiment 3 was designed to explore the visual and semantic priming effects of color identification. For each trial, a subject was asked to identify the color of a patch displayed on the monitor as quickly as possible by

pressing a corresponding button on a Cedrus RB-834 response box. Only the red, yellow, blue, and green color patches were used to match the configuration of the response box. A priming stimulus was displayed for 20 msec, followed by a 480 msec masking pattern, before the presentation of the color patch to be identified in each trial. The priming stimuli were composed of the related or unrelated color patches, names, associated, image, and emotion metaphor words, as used in the experiments 1 and 2, in addition to 5 b/w fruit figures and 5 unrelated symbols. All the stimuli were displayed on the center of the monitor in sequence. (Figure 2)

Part II

280 color chips cut from the Natural Color System (NCS) color papers were selected to match the 320 color samples used by the World Color Survey (Kay et al, 2009). The color chips were split into three groups and glued on three neutral grey cardboards. A touch-screen and PC computer were used to collect the subjects' responses. Thirty-three Mandarin characters were chosen based on usage frequency and their popular denotations and connotations to color. There were totally 63 subjects joining the survey, with ages ranging from 20 to 30. The subjects were recruited either from National Taiwan University, or from Chinese Culture University, and the surveys were respectively conducted in the two campuses.

5. 結果與討論

Part I

For the experiments 1 and 2, the reaction times for different combinations of stimulus pairs, with different SOA, were compared to check the hypotheses about different codes activated by color stimuli. For the experiment 3, the reaction times for color identification were recorded with the related and unrelated priming stimuli, to check the possible priming effect of various visual and semantic stimuli on color identification.

The median reaction time for each subject on each condition was used to get the mean reaction time of all subjects in experiment 1 and 2. The results were plotted as shown in Figure 3. The reaction time measured under similar conditions of Solso and Short (1979) varied with the SOAs in a similar way. However, the reaction time for matching color patches to color image words and to corresponding emotion metaphors show longer reaction time at 0 SOA, and the reaction times never drop the same level as for other matching items. The results suggest that an emergence of color-related emotion and image codes takes longer than the color perception, lexical, and directly associated terms (such as red to

blood). Anyway, the parallel processing model of color coding by Solor and Short (Solso & Short, 1979) is basically re-confirmed in the present research.

The results of experiment 3 are shown in the Figure 4. Averaged reaction time of all trials for all subjects is shown as the first plaided bar and extended horizontal line, with a 95% confidence interval range shown as the error bar. Vertical solid bars show the mean reaction time of all subjects measured with effective priming trials under each condition, as the labels. Generally, shorter than average reaction time found for most conditions except for the color image words, suggests positive priming effects. The results show that emotional corresponding priming words have shortest reaction, and that reveals a strong priming from emotional metaphor words to perceptual color identification tasks.

Heurley et al. applied black-and-white line drawings and words of nature objects as the priming stimuli for color patch identification (Heurley, Brouillet, Chesnoy, & Brouillet, 2013), and found priming effects for drawings and words. The results of experiment 3 are comparable to their findings, and suggest semantic representation of color perception. However, the strong priming effect for emotion words may reveal an arousal-charged path than merely semantic priming for color recognition. Since the priming stimuli in the present study were only displayed for 20 msec, which is usually beyond subjects conscious awareness, we can consider the priming effects as implicit (Marcel, 1983). However, further analysis and investigation are necessary for a full understanding of this phenomenon.

Part II

Data from 59 subjects (out of the 63 surveyed) were collected, summed together, and represented on a WCS stimulus palette. The corresponded samples cluster around those universal categories for most color names surveyed. However, repetitive clusters and wide-spread volumes are also evident.

There are twelve basic color categories among the Mandarin Chinese speakers in Taiwan. The basic categories that may be translated into basic color terms in English have concentrated term maps comparable to the result of WCS. Color names that are less consistent to certain basic categories show wide spreads of term maps and are inconsistent among subjects. The variety of color terms used in Mandarin clouded the search for basic color terms.

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7. 計畫成果自評表

科技部補助專題研究計畫成果報告自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現（簡要敘述成果是否有嚴重損及公共利益之發現）或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估

□ 達成目標

■ 未達成目標（請說明，以 100 字為限）

□ 實驗失敗

□ 因故實驗中斷

■ 其他原因

說明：計劃分二年進行二段實驗，在第一階段隻資料收集完成後，使用其成果以設計第二階段實驗材料。計劃執行中第一階段的色彩詞彙色域空間之調查，於色板製作中遭遇困難，嘗試數種方式後始達成，致使第一階段實驗完成及成果發表研製 2014 年始達成。目前正在進行第二階段實驗之預備。

2. 研究成果在學術期刊發表或申請專利等情形：

論文：□已發表 □未發表之文稿 ■撰寫中 □無

專利：□已獲得 □申請中 □無

技轉：□已技轉 □洽談中 □無

其他：（以 100 字為限）

Sun, V. C., & Chen, C. C. (2014). Color terms and basic color categories in Mandarin Chinese characters. Paper presented at the The 10th Asia-Pacific Conference on Vision, Takamatsu, Kagawa, Japan.

Sun, V., & Lee, T.-R. (2013). Color recognition and semantic priming of color identification. Paper presented at the The 22nd Symposium of the International Colour Vision Society, Winchester, UK.

3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性），如已有嚴重損及公共利益之發現，請簡述可能損及之相關程度（以 500 字為限）

1.本研究在探討色彩訊息被理解及收錄的認知歷程，在計劃執行期間完成了色彩語意促發實驗以及色彩詞彙調查之實驗，使用科學方法研究色彩認知之問題，研究成果亦正在撰寫論文待投稿發表中。

2.在技術創新上，本研究採用反應時間隻促發實驗以及色票樣本結合電腦觸控屏進行色名調查，為本研究領域之創新技術。

3.社會大眾前對本研究所知不多，但科學研究的成果與影響並非一時能見。

4.本研究並無損及公共利益之發現。

附表附圖

Table 1. Colorimetric Specifications for the color patches

Color	Luminance (cd/m^2)	Chromaticity CIE1931(x, y)
Red	18	0.624, 0.330
Green	19.3	0.243, 0.487
Blue	10.3	0.180, 0.226
Yellow	60.7	0.460, 0.454
Brown	9.35	0.512, 0.400
Gray(background)	14.6	0.338, 0.345

Table 2. Mandarin words used in the Priming matching task(Exp 1 and Exp 2) and the priming-color identification

Categories corresponding English	Mandarin characters
Color Names Red, Yellow, Blue, Brown	紅 黃 藍 綠 褐
Color Associate Blood, Sun, Sky, Grass, Wood	血 日 天 草 木
Color Image Hot, Active, Cold, Spring, Dirt	熱 活 冷 春 濁
Color Emotion Metaphor Angry, Happy, Sad, Calm	生氣 外樂 悲傷 平靜

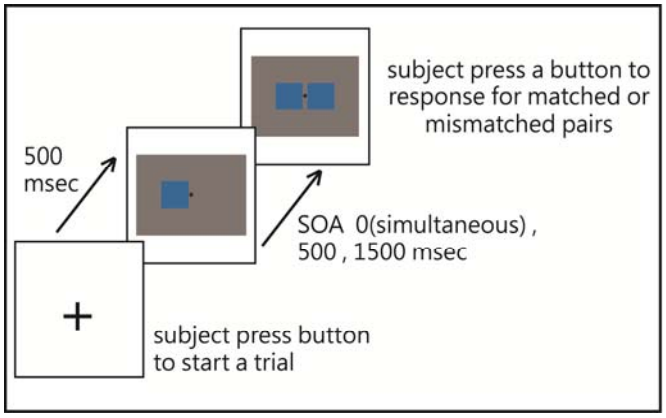

Fig. 1. A single trial sequence of the experiment 1 and 2.

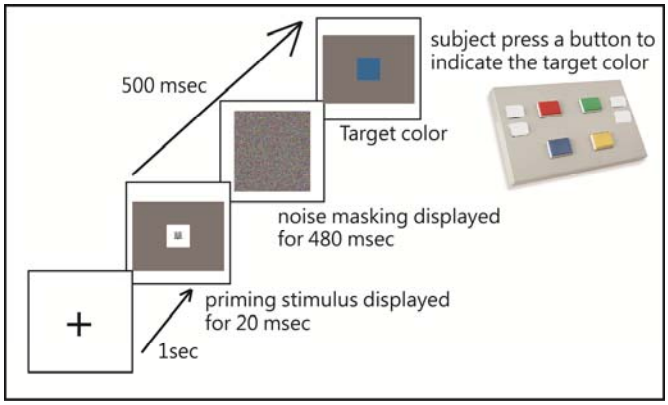

Fig. 2. A single trial sequence of the experiment 3.

Fig. 3, The reaction times for matched trials plotted against the three SOA.