ISSN 1799-2591
Theory and Practice in Language Studies, Vol. 15, No. 9, pp. 2837-2848, September 2025
DOI: https://doi.org/10.17507/tpls.1509.05

The Focus and Boundary of Mandarin Chinese Basic Color Terms: An Empirical Study

Dai Shunbo
Department of English Language, Faculty of Languages and Linguistics, Universiti Malaya, Kuala Lumpur, Malaysia;
School of Foreign Languages, Sichuan University of Arts and Science, Dazhou, China

Azlin Zaiti Zainal*
Department of English Language, Faculty of Languages and Linguistics, Universiti Malaya, Kuala Lumpur, Malaysia

***Abstract*—This survey investigated the focus and boundaries of basic color terms (BCTs) in Mandarin Chinese. The primary aim of this experimental study was to systematically analyze the characteristics of focal colors and category boundaries in Chinese BCTs. Ninety native Chinese speakers participated in the survey, with a mean age of 22 (age range 18-26; 45 females and 45 males). The survey is a mapping-task-involved focus mapping (best example) and uses boundary mapping tasks. The findings revealed that the foci and boundaries of Chinese BCTs are generally similar to those of English BCTs, although there are minor variations. Moreover, the study also found that Mandarin Chinese categorizes color in ways that reflect its unique characteristics, with synonymous color terms exhibiting overlapping category boundaries but not sharing identical focal points. Notably, the color term qing/青 ("cyan") demonstrated significant variability and dispersion in focus, covering a broad spectrum of hues that includes a large portion of both blue and green. The results support the universal existence of basic perceptual color categories, as proposed by Paul and Kay.**

***Index Terms*—basic color terms, boundary, Chinese, focus, survey**

I. Introduction

The investigation into color terminology represents an interdisciplinary research domain, drawing on insights from linguistics, psychology, and anthropology. The seminal theory of Basic Color Terms (BCTs) introduced by Berlin and Kay (1969) established a foundational framework for examining color naming across languages, stimulating extensive discussions on how diverse linguistic systems categorize and conceptualize color. According to Berlin and Kay (1969), BCTs are usually represented by single lexical units with stable and consistent meanings. They stand out in people's cognitive organization and function independently, without being subordinate to other color categories (Berlin & Kay, 1969). Although there is ongoing debate among scholars regarding the precise definitions of basic color terms as proposed by Berlin and Kay, researchers generally agree that Chinese possesses a core set of basic color terms, which include the following: *hong*/红 ("red"), *huang*/黄 ("yellow"), *lan*/蓝 ("blue"), lu/绿 ("green"), *hei*/黑 ("black"), *bai*/白 ("white"), *hui*/灰 ("gray"), and *zi*/紫 ("purple") (Dai & Zainal, 2025; Gao & Sutrop, 2014; Sun & Chen, 2018; Xie, 2008).

There are several synonyms for each hue in Mandarin Chinese, which allows for a greater degree of customization in the naming of colors (Sun & Chen, 2018). As a result, it is possible that different respondents will use various names to refer to the same color. Color terms in Classical Chinese are less codified than those in Mandarin. Historically, *qing/*青 ("cyan") has encompassed a broad spectrum of hues, including both blue and green, complicating its status as a prototypical BCT (Bogushevskaya, 2015; Tao & Wong, 2019; Zhao, 2012). The classification of *qing*/青 ("cyan") as a BCT remains debatable. Comparative studies of ancient and modern Chinese color terminology indicate that variations in color terms, influenced by the evolution of human cognitive processes, have significantly contributed to the ongoing expansion and refinement of the color lexicon (Lai, 2019; Xie, 2008). Moreover, cross-cultural comparative studies suggest that the Chinese color lexicon differs from those languages such as Spanish, English, and Russian in its classification patterns (Davies & Corbett, 1994; Sun & Chen, 2018; Xu et al., 2023; Xue, 2014).

The focus of a color term refers to the best representative shade of that category. Previous research has demonstrated the universality of human color perception, with speakers of different languages consistently selecting specific "focal colors" when describing colors (Gibson et al., 2017; Regier et al., 2005; Roberson et al., 2005). These focal colors exhibit high perceptual salience and cross-linguistic consistency within the color space (Cook et al., 2005; Kay et al., 2009). Although the number of BCTs varies across languages, their focal points tend to align across linguistic systems. However, this consistency in focal colors does not necessarily extend to the boundaries of color categories (Rosch & Mervis, 1975; Rosch Heider, 1972). Even within a single language, dialectal variations may lead to discrepancies in category boundaries. Consequently, the boundary of color terms across languages is not fixed but exhibits a degree of fuzziness (Zadeh, 1996). Scholars have suggested that these inconsistencies in color category boundaries may be shaped by cultural, environmental,

* Corresponding Author. Email: azlinzainalum.edu.my

and linguistic influences (Ji et al., 2004; Xie et al., 2019). For instance, Russian distinguishes more finely between shades of blue, whereas other languages may categorize them under a single term (Andrews, 1994; Davies & Corbett, 1994; Paramei, 2005). Furthermore, cross-linguistic research on bilinguals has found that the focal colors of bilingual speakers may shift under the influence of their second language, supporting the hypothesis of cognitive adaptation (Athanasopoulos, 2009; Athanasopoulos et al., 2011).

Extensive research has examined the focal points and boundaries of various color categories across different languages (Davies & Corbett, 1994; Hardin, 2011; Panitanang et al., 2022; Sturges & Whitfield, 1995; Valdegamberi et al., 2015). However, there is a dearth of empirical research focusing on the focal colors and category boundaries of color terms in Mandarin Chinese, and empirical research on Chinese BCTs is limited. To address this gap, the present study aims to systematically analyze the characteristics of focal colors and category boundaries of BCTs in Mandarin Chinese. Specifically, it seeks to answer the following two research questions:

1. Do synonymous color terms in Mandarin, such as *cheng/*橙 and ju/橘 for "orange," or *zong*/棕 and he/褐 for "brown", have overlapping category boundaries? Do they share the same focal point?
2. Does the boundary of the color term *qing*/青 ("cyan") include both blue and green, and whether or not the focal color of *qing*/青 ("cyan") displays high perceptual distinctiveness?

II. Methodology

A. Participants

"The survey was conducted among the Chinese Han ethnic group and the participants anonymously completed the survey. Ninety Chinese native speakers (mean age 22, age range 18–26, female 45, male 45) participated in the Mandarin Chinese BCTs survey. Participants were recruited from Sichuan University of Arts and Science (SASU) and Southwest University (SWU), and the survey was conducted on both campuses. All participants were native Mandarin speakers with normal color vision, as assessed by the Ishihara Test. Participants could decline to sign the consent form without facing any consequences. This study collected both the hard copies and soft copies of the participants' consent forms. The soft copies were collected from the online website, which is available at https://dai.tanfushishang.xyz/" (Dai & Zainal, 2025, p. 864).

B. Materials

The framework of this color survey website was predominantly derived from the World Color Survey (WCS) Data Archives.[1] However, the stimuli used in this experiment primarily consisted of the WCS Munsell Chart[2], and all stimuli were integrated into a web-based platform at https://dai.tanfushishang.xyz/, enabling participants to complete the mapping task online. The Munsell and WCS coordinates for the stimulus chart are identical to those utilized in the investigation by Paul Kay and Richard S. Cook (Kay & Cook, 2016). The survey report in this article is the third and fourth section of the website, which is called the mapping tasks section.

C. Procedures

The survey used focus mapping (best example) and boundary mapping tasks. The mapping tasks aimed to explore how the disparities of BCTs influence the focus and boundary by comparing them to the findings of Berlin and Kay (1969) and Sturges and Whitfield (1995) regarding English BCTs (Berlin & Kay, 1969; Sturges & Whitfield, 1995). To complete the mapping tasks, participants were given instructions to map the focal point and the outer boundary of basic colors on a standard array of color stimuli known as the WCS Munsell Chart. The list of mapping tasks included fourteen Mandarin Chinese BCTs, chosen for their psychological salience and reference stability across participants. These BCTs were selected based on Berlin and Kay's definition of a BCT, derived from a literature review and color-naming tasks conducted in a pilot study by one of the authors. More specifically, the BCTs listed in the mapping task were *hong*/红 ("red"), *chéng*/橙 ("orange"), *huang*/黄 ("yellow"), *lu*/绿 ("green"), *lan*/蓝 ("blue"), *zi*/紫 ("purple"), *hei*/黑 ("black"), bai/白 ("white"), *hui*/灰 ("gray"), *qīng*/青 ("cyan"), *zōng*/棕 ("brown"), *fěnhóng*/粉红 ("pink"), *hè*/褐 ("hese"), and *jú*/橘 ("juse") (Dai & Zainal, 2025). Among these colors, *qīng*/青 ("cyan"), *hè*/褐 ("hese"), and *jú* /橘 ("Juse") are considered special Chinese BCTs. This survey included these distinctive BCTs in the mapping tasks list to explore how the Chinese language separates out the color spectrum.

The focus mapping required the participants to indicate the best or most typical example of different basic color categories, like, for instance, *hong*/红 ("red"), *huang*/黄 ("yellow"), *lu*/绿 ("green"), *lan*/蓝 ("blue"), and so on. Participants could respond based on their intuitive judgment to freely choose any chip on the chart by clicking it with the mouse on the electronic WCS stimulus chart, which was arranged in precisely the same way as the hard copy of the WCS stimulus array. After participants had made their selection, a notification would appear at the bottom of the chart,

[1] The website for the WCS Data Archives is http://www.icsi.berkeley.edu/wcs/data.html.
[2] The WCS Munsell Chart is a foundational tool for exploring how human languages' structure color categories and how linguistic differences influence perception, which organizes colors according to three perceptual dimensions: hue, value (lightness), and chroma (saturation).

confirming the coordinate values of the selected chip. For instance, in the red focus mapping task, a message such as "*Nǐ xuǎnzé de dá'àn wèi F4*"/"你选择的答案为F4" ("The chip you selected is F4.") would be displayed (see Figure 1).

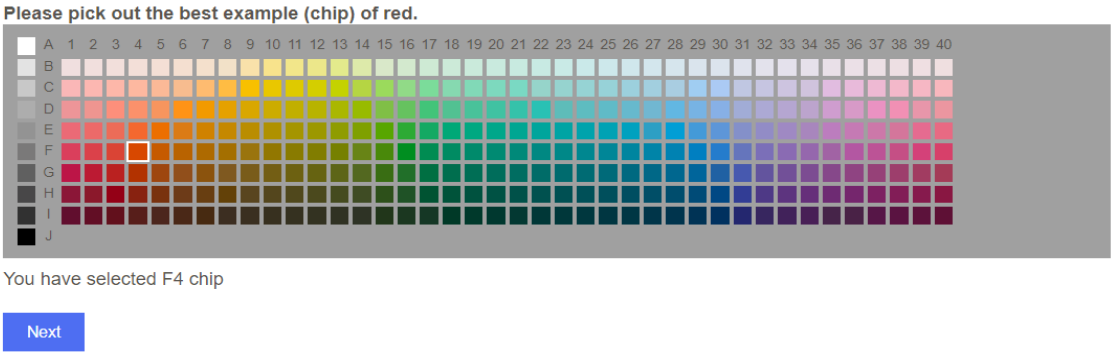

Figure 1. Sample Illustration of Focus Mapping Task

Participants had to select one chip and were not allowed to skip or abstain from selecting. However, they were allowed to modify their selection before clicking the "Next" button. Once the participants had submitted their answers, the system automatically recorded them, and they did not have the option to revise their selection. The researchers' assistants told the participants in advance, "Under no circumstances are participants allowed to refresh the webpage." The 14 color categories were presented in a pseudo-random order (see Appendix A); therefore, the electronic WCS simulation chart was presented 14 times. Participants were required to make their choice as quickly as possible based on intuition in the focus mapping task, which took approximately two minutes to complete. All participants were asked to perform the mapping procedure just once.

The boundary mapping task followed the focus mapping task. The materials and procedures used in this task were consistent with those used in the task for focus mapping, which involved selecting a single color chip, whereas boundary mapping involves selecting multiple color chips. The fourteen color categories were presented in the same pseudo-random sequence as in the focus mapping task. The only difference was in the instructions given to the participants (see Appendix B). For instance, in the "*hong*/红 ("red") boundary mapping task, participants were required to select all the chips that they would call red under any condition as quickly as possible based on their intuition. The Chinese instruction for this task was "*Qǐng xuǎn chū suǒyǒu hóngsè de sè kuài*"/"请选出所有红色的色块," which means "Please pick out all the red chips." After participants had made their selection, a notification appeared at the bottom of the chart confirming the coordinate values of the selected chips. This notification said "*Nǐ xuǎnzé sè kuài wèi F1, F2, F3, F4, G1, G3, G4, H1, H2, H3, H4*"/"你选择色块为F1, F2, F3, F4, G1, G3, G4, H1, H2, H3, H4," which translates to "You have selected F1, F2, F3, F4, G1, G3, G4, H1, H2, H3, H4 chips" in English (see Figure 2). It typically took about three minutes to complete the boundary mapping task. All participants were asked to perform the mapping task only once.

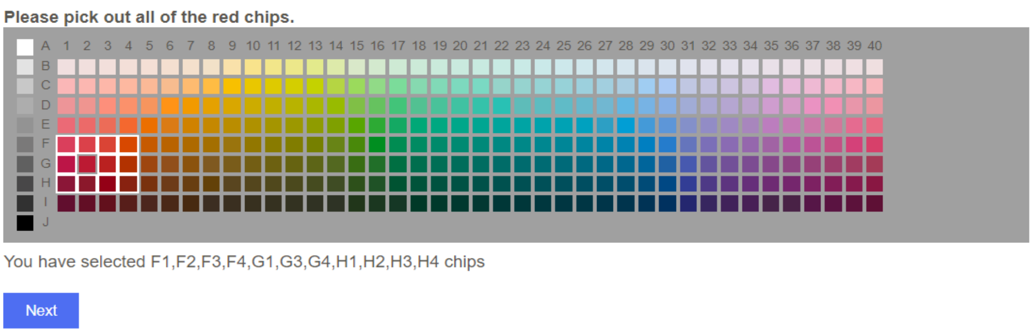

Figure 2. Sample for the Boundary Selection in the Boundary Mapping Task

III. Results

A. Results of the Focus Mapping Tasks

The focus mapping task involves participants selecting chromatic and achromatic color categories. Among them, *hei*/黑 ("black"), *bai*/白 ("white"), and *hui*/灰 ("gray") are achromatic. Specifically, the focus of *hei*/黑 ("black") is primarily on J0; the focus of *bai*/白 ("white") is primarily on A0; and the focus of *hui*/灰 ("gray") is primarily on E0. The chromatic color terms include *hong*/红 ("red"), *chéng*/橙 ("orange"), *huang*/黄 ("yellow"), *lu*/绿 ("green"), *qīng*/

青（“cyan”), *lan*/蓝（“blue”), *zi*/紫（“purple”), *fěnhóng*/粉红（“pink”), and *zōng*/棕（“brown”) (Dai & Zainal, 2025). The focus areas of the chromatic colors are illustrated in Figure 3 below.

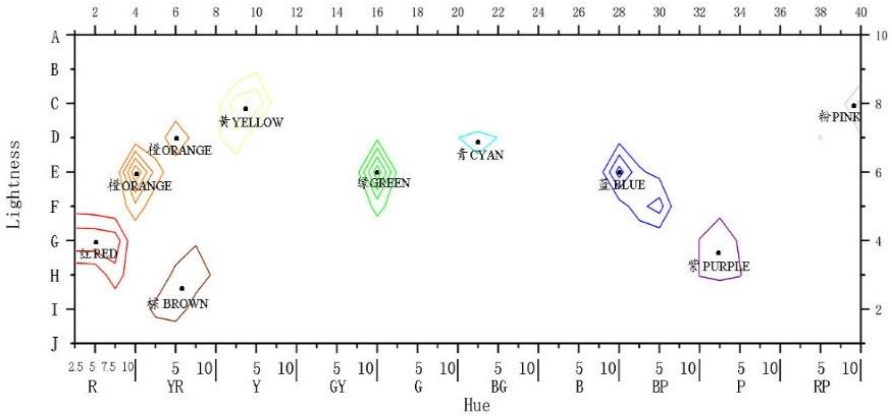

Figure 3. Focus Mapping Results of Chromatic Colors in Mandarin Chinese

An analysis of the participants’ focus selection revealed that the term *chéng*/橙（“orange”) had two distinct focus areas, located next to E4 and D6. Interestingly, the focal points for chéng/橙（“orange”) and *ju*/橘（“orange”) are in line with each other, indicating that these terms are synonymous in the Chinese color naming system and can be used interchangeably. Similarly, the focus areas for *zōng*/棕（“brown”) and *hè/*褐（“brown”) also show a high degree of overlap. For more details, refer to Figure 4 below.

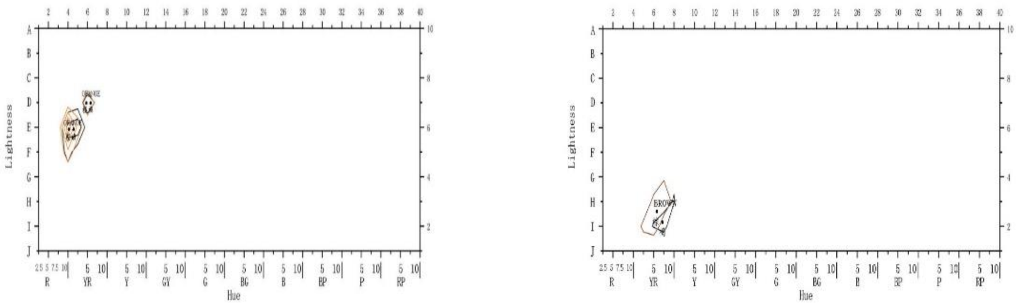

Figure 4. Overlap of *Chéng*/橙（“Orange”) and *Ju*/橘（“Orange”) and *Zōng*/棕（“Brown”) and *Hè*/褐（“Brown”) in Focus Mapping Tasks

Figures 3 and 4 show the focus mapping results, which demonstrate the wide range of Chinese color terms. However, they do not provide information on the dispersion of each color category. Therefore, to better visualize and assess the dispersion of each color category, including *hong*/红（“red”), *chéng*/橙（“orange”), *huang*/黄（“yellow”), *lu*/绿（“green”), *qīng*/青（“cyan”), *lan*/蓝（“blue”), *zi*/紫（“purple”), *fěnhóng*/粉红（“pink”), *zōng*/棕（“brown”), *hei*/黑（“black”), *bai*/白（“white”), and *hui*/灰（“gray”) (Dai & Zainal, 2025), this study includes a scatter plot of the color terms in Mandarin Chinese (refer to Figure 5).

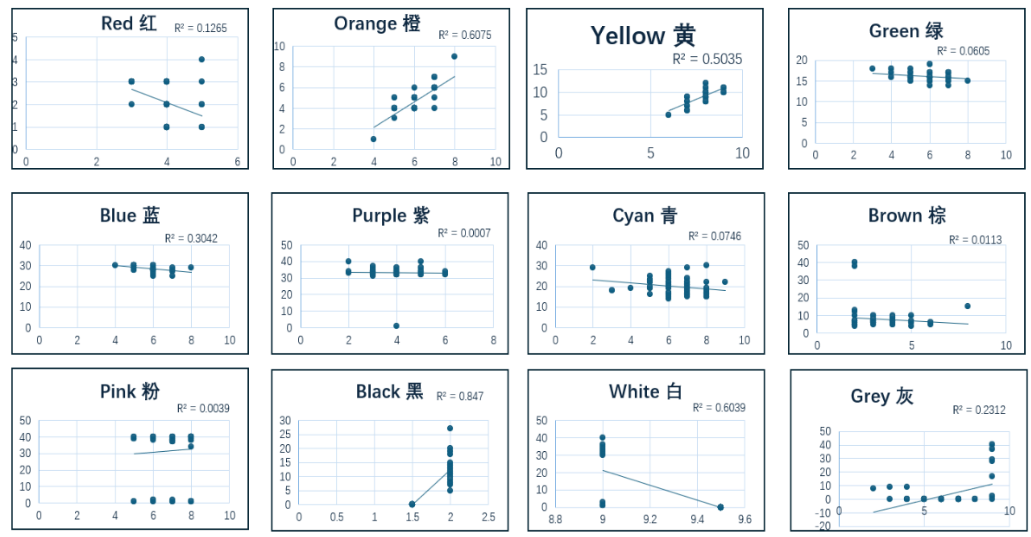

Figure 5. Scatter Plot of the Color Terms in Mandarin Chinese

Furthermore, this study employs dispersion indices[3] to elucidate the degree of variation across color terms. Given the three-dimensional nature of color, the values for lightness and hue of each basic color term were first recorded in the Chinese BCTs survey. Subsequently, the coefficient of variation (CV) for both lightness and hue was calculated separately. Specifically, statistical analysis techniques were utilized, with the CV applied to calculate the lightness (ranging from 1.5 to 9.5) and hue (ranging from 1 to 40) values for each color term. Additionally, the coefficient of determination (R^2) was used to assess the overall dispersion, considering both lightness and hue, within different color categories. Details are provided in Table 1 below.

TABLE 1

R^2 AND CV VALUES IN FOCUS MAPPING TASKS

Color Terms	R^2(Coefficient of Determination) *	CV (Coefficient of Variation) **	
	(Lightness, Hue)	Lightness	Hue
hong/红 (“red”)	0.13	0.13	0.40
chéng/橙 (“orange”)	0.61	0.12	0.24
huang/黄 (“yellow”)	0.50	0.07	0.14
lu/绿 (“green”)	0.06	0.14	0.05
lan/蓝 (“blue”)	0.30	0.12	0.04
zi/紫 (“purple”)	0.00	0.24	0.11
qīng/青 (“cyan”)	0.07	0.19	0.17
zōng/棕 (“brown”)	0.01	0.38	0.77
fěnhóng/粉红 (“pink”)	0.00	0.15	0.48
hei/黑 (“black”)	0.85	0.14	1.67
bai/白 (“white”)	0.60	0.02	2.78
hui/灰 (“gray”)	0.23	0.24	2.98
hè/褐 (“brown”)	0.01	0.34	0.65
ju/橘 (“orange”)	0.46	0.12	0.26

* The R^2 (Coefficient of Determination) is a statistical metric used in prediction models and hypothesis testing. It helps in quantifying the percentage of the overall variance in outcomes observed that can be accounted for by the model. A higher R^2 value suggests a decrease in variability and dispersion, whereas a lower R^2 value denotes an increase in variability and dispersion. The formula for R^2 is as follows:

R^2 = 1 - RSS (Residual Sum of Squares) / TSS (Total Sum of Squares).

** The CV (coefficient of variation) measures the extent of variability relative to the mean of the data. A higher CV denotes greater dispersion of data points, while a lower CV indicates less variation and more stable data. The formula for calculating the CV is as follows:

CV = Standard Deviation (SD) / Average Value (AV)) x 100%.

Based on the statistical results, Figure 6 displays the R^2 (Coefficient of Determination) and CV (Coefficient of Variation) values for color terms in Mandarin Chinese. The x-axis represents color terms in Mandarin Chinese, including *hong*/红 (“red”), *chéng*/橙 (“orange”), *huang*/黄 (“yellow”), *lu*/绿 (“green”), *qīng*/青 (“cyan”), *lan*/蓝 (“blue”), *zi*/紫 (“purple”), *fěnhóng*/粉红 (“pink”), *zōng*/棕 (“brown”), *hei*/黑 (“black”), *bai*/白 (“white”), *hui*/灰 (“gray”), and *ju*/橘

[3] “Measures of dispersion in statistics help to understand the variability of data, indicating its homogeneity or heterogeneity. In simpler terms, it shows how squeezed or scattered the variable is. The two primary approaches to measuring statistical dispersion are absolute measures and relative measures. Absolute measures of dispersion retain the same unit as the original data set, while relative measures are used to compare the distributions of two or more data sets.” (From https://byjus.com/maths/dispersion/)

("orange") again (Dai & Zainal, 2025). The y-axis represents the values for R^2 and CV. The R^2 (hue, lightness) remains relatively low across all colors, indicating weak predictive power. The CV (lightness) remains consistently low and steady around 0.5, showing no significant fluctuations. In contrast, the CV (hue) exhibits significant variation, with pronounced peaks between achromatic and chromatic colors. Overall, the data suggest that hue variability is much more pronounced compared to lightness in Mandarin Chinese.

Specifically, *hei*/黑 ("black") exhibits the highest R^2 value, indicating the lowest dispersion among all color terms. Conversely, the *zi*/紫 ("purple") has the lowest R^2 value, signifying the highest level of dispersion. Additionally, the R^2 values for *fěnhóng*/粉红 ("pink"), *zōng*/棕 ("brown"), and *qīng*/青 ("cyan") are also relatively low. In terms of lightness CV, *zōng*/棕 ("brown") has the highest CV value, indicating the greatest lightness dispersion. On the other hand, the term for *bai*/白 ("white") has the lowest CV value, suggesting the lowest lightness dispersion. Regarding hue CV, *hui*/灰 ("gray") exhibits the highest CV value, indicating the greatest hue dispersion. Conversely, the term for *lan*/蓝 ("blue") has the lowest CV value, suggesting the lowest hue dispersion. The CV values for *fěnhóng*/粉红 ("pink") and *zōng*/棕 ("brown") rank just after the achromatic colors *hei*/黑 ("black"), *bai*/白 ("white"), and *hui*/灰 ("gray").

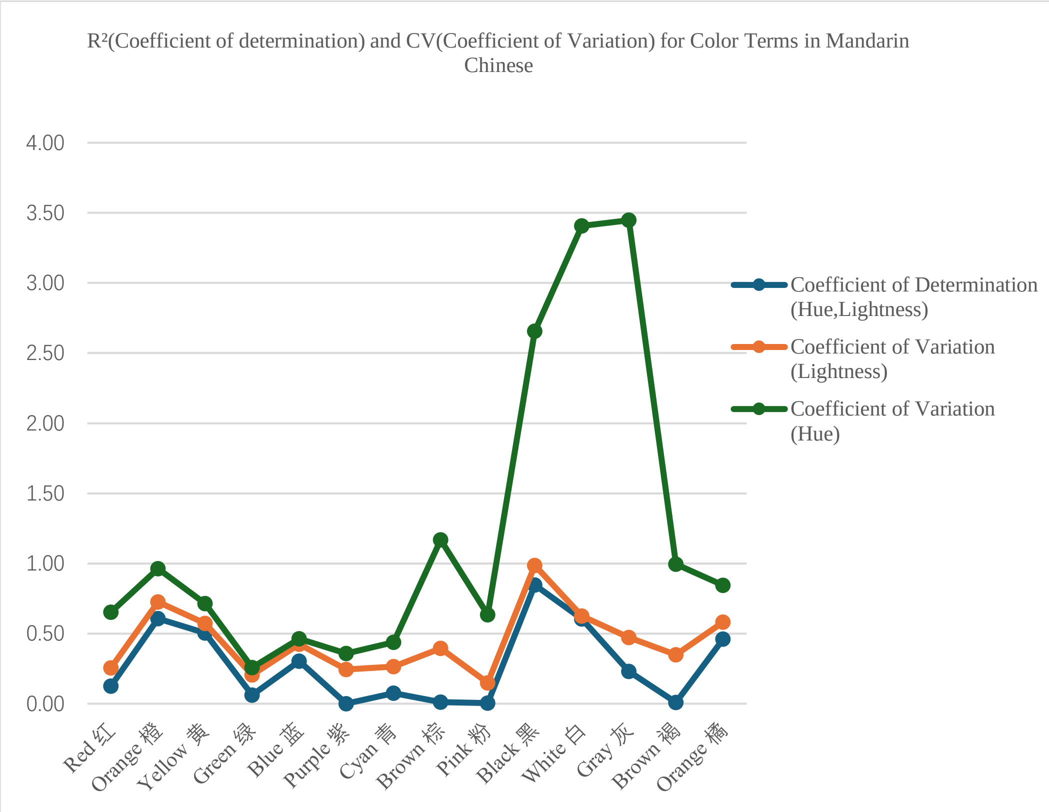

Figure 6. R^2 and CV Values for Color Terms in Mandarin Chinese

B. Results of the Boundary Mapping Tasks

The boundary mapping tasks include fourteen Chinese color terms: *hong*/红 ("red"), *chéng*/橙 ("orange"), *huang*/黄 ("yellow"), *lu*/绿 ("green"), *qīng*/青 ("cyan"), *lan*/蓝 ("blue"), *zi*/紫 ("purple"), *fěnhóng*/粉红 ("pink"), *zōng*/棕 ("brown"), *hei*/黑 ("black"), *bai*/白 ("white"), *hui*/灰 ("gray"), *ju*/橘 ("orange"), and *hè*/褐 ("brown") (Dai & Zainal, 2025). The results of these boundary mapping tasks were consistent with those obtained from focus mapping. Specifically, the achromatic boundary for *hei*/黑 ("black") is predominantly located in the J0 region and in the darker areas, whereas the boundary for *bai*/白 ("white") is primarily found in the A0 region and in lighter areas. The *hui*/灰 ("gray") range is situated predominantly between the A0 and J0 regions. The distribution of the nine chromatic color terms (*hong*/红 ("red"), *chéng*/橙 ("*orange*"), *huang*/黄 ("yellow"), *lu*/绿 ("green"), *qīng*/青 ("cyan"), *lan*/蓝 ("blue"), *zi*/紫 ("purple"), *fěnhóng*/粉红 ("pink"), and *zōng*/棕 ("brown") (Dai & Zainal, 2025) reveals overlaps between adjacent categories. Further details can be found in Figure 7 below.

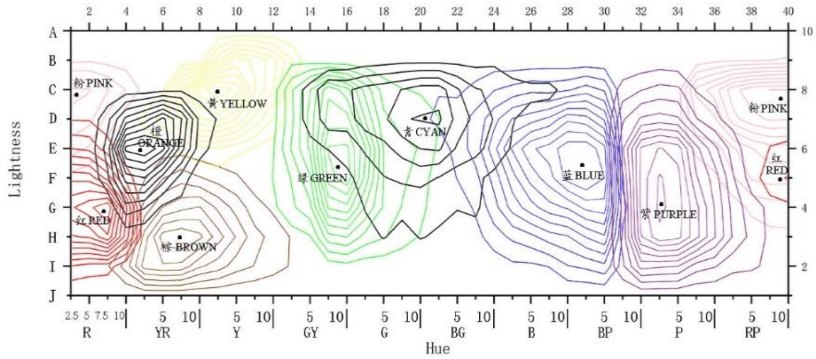

Figure 7. Results of the Boundary Mapping in Mandarin Chinese

The contour plot in Figure 7 shows Mandarin Chinese color terms' lightness and hue distributions. The x-axis shows hue, divided into color zones from red (R) to red-purple (RP). The y-axis shows lightness, labelled A to J, with values from 1 to 10 denoting brightness. Each contour line on the plot signifies areas of equal density or frequency of color term usage within the given lightness and hue parameters. The contours are grouped and color-coded for specific colors, including *hong*/红 ("red"), *chéng*/橙 ("orange"), *huang*/黄 ("yellow"), *lu*/绿 ("green"), *qīng*/青 ("cyan"), *lan*/蓝 ("blue"), *zi*/紫 ("purple"), *fěnhóng*/粉红 ("pink"), and *zōng*/棕 ("brown") (Dai & Zainal, 2025), allowing for visual differentiation of each color cluster. Notably, the contour lines for each color term show the concentration and spread of lightness and hue, with denser areas indicating higher frequency or consistency in the perception of that color term.

More specifically, there is a clustering of pink and red on the left side, with pink having higher lightness values compared to *hong*/红 ("red"). *Huang*/黄 ("yellow") and *lu*/绿 ("green") occupy central positions with broader distributions in lightness, while *lan*/蓝 ("blue") shows narrower distributions towards the higher hue values. *Zi*/紫 ("purple") is distinctly clustered on the right, indicating a unique hue range with moderate lightness. The contours for *zōng*/棕 ("brown") show a broader spread across lightness levels, indicating more variability in the perception of this color term. It is noteworthy that *qīng*/青 ("cyan") occupies a position between *lu*/绿 ("green") and *lan*/蓝 ("blue") in the color spectrum, comprising a majority of *lu*/绿 ("green") and incorporating certain portions of *lan*/蓝 ("blue"). See Figure 8.

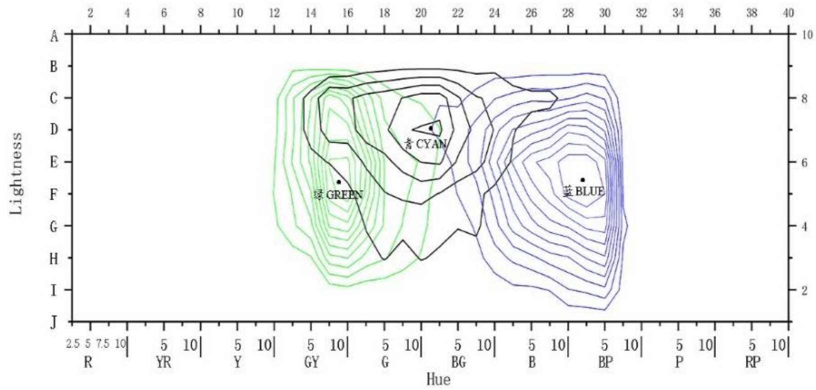

Figure 8. *Lu*/绿 ("green"), *Qīng*/青 ("Cyan") and *Lan*/蓝 ("Blue") Boundaries Overlap in Boundary Mapping Tasks

Furthermore, the results from boundary mapping closely correspond to those of the focus mapping tasks. The contour plot provides a visual representation of color terms in Mandarin Chinese, highlighting the variation and concentration of lightness and hue for each color. It not only illustrates the relative positions of different color terms but also demonstrates where they overlap within the perceptual color space. Specifically, the boundaries of the color terms for *chéng*/橙 ("orange") and *ju*/橘 ("orange") coincide, as do the terms *zōng*/棕 ("brown") and *hè*/褐 ("brown"), as depicted in Figures 9 and 10.

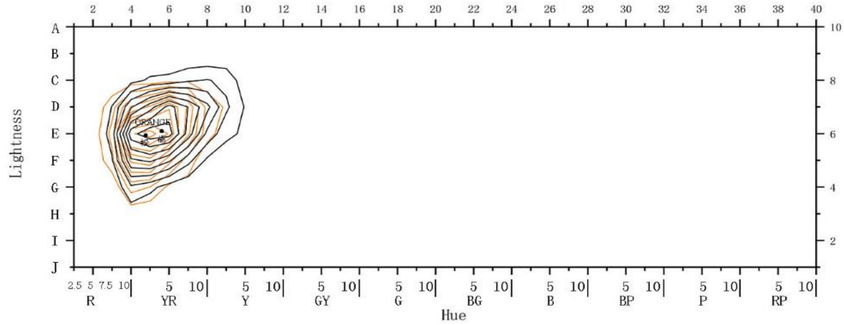

Figure 9. Overlap of *Chéng*/橙 (“Orange”) and *Ju*/橘 (“Orange”) in Mandarin Chinese Boundary Mapping Tasks

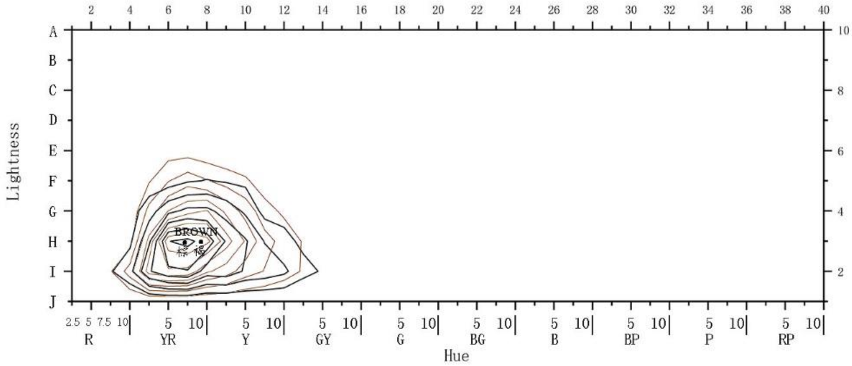

Figure 10. Overlap and *Zōng*/棕 (“Brown”) and *Hè*/褐 (“Brown”) in Chinese Boundary Mapping Tasks

Overall, Mandarin Chinese has 11 basic color categories. *Qīng*/青 (“cyan”) in Chinese does not have corresponding color terms in English. The focus points and ranges of Chinese BCTs closely correspond to those of English BCTs. However, the focal points and ranges of synonymous Chinese terms, such as *chéng*/橙 (“orange”) and ju/橘 (“orange”), as well as *zōng*/棕 (“brown”) and *hè*/褐 (“brown”), exhibit substantial overlap, suggesting that semantically similar color terms in Chinese share similar referential boundaries. Furthermore, the Chinese term *qīng*/青 (“cyan”) often functions as a hypernym, encompassing green, blue, and blue-green, making it a particularly distinctive category within the Mandarin Chinese color nomenclature. Regarding the semantic saliency and dispersion of Chinese color terms, the findings indicate that color terms with greater semantic saliency tend to have lower dispersion rates. However, the color term *qīng*/青 (“cyan”), despite its higher semantic saliency, exhibits a high dispersion rate, differing significantly from other Chinese BCTs in both semantic saliency and dispersion.

IV. Discussion

The study examines the focus and boundary of 14 Mandarin Chinese color terms. The findings suggest a reciprocal relationship between the focal points and boundaries. The observed characteristics in the results can be analyzed and discussed from the following perspectives.

A. Comparison of Focal Points Between Chinese and English

The comparison of focal points between Chinese and English color terms shows that the focal points for the eleven basic color terms are mostly consistent across both languages. The focal point refers to the most frequently selected color chips that participants consider the most representative. When comparing the focus selection in this study (see Figure 3) with the “consensus samples and focal colors on a two-dimensional representation of the Munsell space” identified by Sturges and Whitfield (1995, p. 367), it is evident that, with the exception of color terms related to *qīng*/青 (“cyan”), the focal point selections are generally consistent. This suggests that the focal points and ranges of various color terms in modern Chinese and English are largely similar. Furthermore, the behavioral procedures used in this survey to investigate Chinese BCTs support the universal existence of basic perceptual color categories proposed by Paul and Kay (1969), which posits that all human languages contain a set of BCTs that correspond to a universal set of perceptual color categories. Obviously, there is a commonly accepted belief that all mentally healthy humans see reality in a similar manner, and languages act as itemized inventories of this reality. When it comes to expressing color, the inventory across languages is essentially the same, with differences arising only in pronunciation. However, the theory of linguistic relativity counters this by asserting that the world is experienced and conceptualized differently across different communities, with language shaping specific cognitive structures. The ongoing debate between linguistic universality and linguistic relativity, which touches on the relationship between language and cognition, will be further explored in the future.

B. Comparing the Results of Focus and Boundary Mapping Tasks

By comparing the results of the focus and boundary mapping tasks, the contour plot reveals that most Chinese color terms' focus and boundary regions are predominantly clustered around the prototypical exemplars. As the distance from the prototype increases, there is a notable decline in the frequency with which color chips are identified as focal points. This phenomenon can be interpreted through the lens of the prototype theory, as proposed by Rosch and Mervis in 1975. This theory posits that categories are cognitively structured around prototypes, which serve as mental representations of the most typical or central examples within a category. The prototype theory suggests a gradient of typicality, wherein items closest to the prototype are perceived as more representative of the category, while those with fewer distinctive features or those sharing characteristics with other categories are less central (Rosch & Mervis, 1975). However, it is important to note that the prototype does not accurately represent all cases. For instance, the special macro-category color term *qīng*/青 ("cyan") in Mandarin Chinese has widespread usage in both ancient and contemporary Chinese, but an extensive online survey with a substantial sample size verifies that the term *qīng*/青 ("cyan") displays inconsistent references and meanings among various sources and situations. The *qīng*/青 ("cyan") category, similar to the "grue" (green-blue) category in English, lacks an explicit boundary on the color spectrum. "Focal grue selections have often proved to be bimodal, chosen from both the focal blue and focal green regions, but grue has never been found to be focused in the intermediate blue-green region" (Kay & McDaniel, 1978, p. 630).

C. Unique Characteristic of Color Term Qīng/青 ("Cyan")

Following a comprehensive analysis of the results from the focus mapping tasks, it was observed that the *qīng*/青 ("cyan") category does not exhibit a concentrated focus on the color spectrum as distinctly as other BCTs. However, the results of the boundary mapping tasks in this study unequivocally demonstrate that the scope of *qīng*/青 ("cyan") is concentrated predominantly within the intermediate blue-green spectrum. The distinct range phenomena associated with the Chinese color term *qīng*/青 ("cyan") can be effectively interpreted through the framework of Vantage Theory, proposed by Robert E. MacLaury (1997). Vantage Theory is a dynamic model of color categorization that posits that individuals construct color categories by anchoring their cognitive processes to specific dimensions of color, such as hue, brightness, or saturation. Color stimuli are then evaluated in relation to this fixed coordinate, based on their degree of similarity or difference. Furthermore, Vantage Theory suggests that the language an individual speaks significantly influences their color perception and categorization (Głaz & Allan, 2010). In ancient Chinese, the term *qīng*/青 ("cyan") encompassed a range of colors, including green, blue-green, blue, and even black. However, in modern Chinese, the semantic range of *qīng*/青 ("cyan") has been gradually divided into distinct terms for *lu*/绿 ("green") and *lan*/蓝 ("blue"). In contrast, English operates with a dichotomous system, distinguishing between green and blue as separate categories. Traditionally, Chinese utilized a tripartite system in which qīng/青 ("cyan") represented the overlap between blue and green, often translated as *qīng*/青 ("cyan").

D. Focus and Boundary for Synonymous Color Terms in Mandarin

The classification of basic color terms in Chinese subject to debate among scholars. Some studies have categorized *hè*/褐 ("brown") as a basic color term (Sun & Chen, 2018; Yao, 1988), while others categorized ju/橘 ("orange") as a basic color term (Tusei-Ju Hsieh, 2010). In contemporary Chinese, *zōng*/棕 and *hè*/褐 are used interchangeably to denote brown, as are *chéng*/橙 and *ju*/橘 for orange. Consequently, this study incorporated both sets of terms in its mapping tasks. The results demonstrate that synonymous color terms in Chinese generally exhibit overlapping foci and boundaries (see Figures 9 and 10). This finding aligns with previous research indicating that basic color categories in Chinese largely correspond to those identified in the WCS, despite variations in terminology among participants. Mandarin Chinese allows for multiple synonymous color terms to be associated with a single-color category (Sun & Chen, 2018). It is crucial to distinguish between basic color terms and basic color categories (Biggam, 2012). While color categories encompass basic color words, the reverse is not necessarily true. Color categories are situated within the cognitive domain, whereas color terms belong to the linguistic realm. Although the physical properties of color terms remain constant, human cognition is flexible and susceptible to change. The domain of color perception is an ideal platform for analyzing the complex relationship between language and cognition.

E. Reason for Variability of Coefficient of Variation (CV)

The analysis of the focus mapping results indicates that, with regard to hue, the coefficient of variation (CV) for the achromatic terms *hei*/黑 ("black"), *bai*/白 ("white"), and *hui*/灰 ("gray") is significantly higher than that of the other color terms. This demonstrates a greater variability of achromatic terms relative to chromatic terms in the color focus mapping tasks. In other words, the dispersion of the achromatic terms is greater than that of the chromatic terms, suggesting that the chromatic terms exhibit greater stability than the achromatic ones. Upon further analysis, it was found that the elevated coefficient of variation for hue is attributable to the higher standard deviation (SD) and lower average value (AV) for the achromatic terms *hei*/黑 ("black"), *bai*/白 ("white"), and *hui*/灰 ("gray"). The coefficient of variation is calculated as (SD/AV) × 100%. According to the World Color Survey (WCS), the Munsell stimulus palette from rows A to J contains stimuli with only lightness values and lacks hue value, which means the hue value from A0 to J0 is 0. In the Mandarin Chinese color survey, the majority of participants selected focus points between A0 and J0. However, some participants overlooked the stimulus cards in the far-left column and instead chose stimuli from the right column, leading to a larger standard deviation for the achromatic terms but a relatively low average value. This, in turn, explains the higher coefficient of variation for the achromatic terms *hei*/黑 ("black"), *bai*/白 ("white"), and *hui*/灰 ("gray"). In contrast, the analysis of the coefficient of variation for lightness among the achromatic terms shows that *bai*/白 ("white") exhibits the highest stability, with *hei*/黑 ("black") and *hui*/灰 ("gray") also demonstrating moderate stability compared to the other surveyed color terms.

V. Conclusion

This study empirically investigated the focus and boundaries of BCTs in Mandarin Chinese. The results of the survey revealed that the foci and boundaries of Chinese BCTs are generally similar to those of English BCTs, as revealed by Sturges & Whitfield (Sturges & Whitfield, 1995), although with minor variations. We found that the Mandarin Chinese separation of the color spectrum has its own unique characteristic. The synonymous color terms in Mandarin, such as *chéng*/橙 and *ju*/橘 for "orange" or *zōng*/棕 and *hè*/褐 for "brown", have overlapping category boundaries but do not share identical focal points. Moreover, the unique color term *qīng*/青 ("cyan") in Chinese encompasses a broad spectrum of hues, including a large boundary of blue and green. However, its focal consistency is relatively low, resulting in greater variability and dispersion in focus mapping tasks. Due to the limited sample size, this study provides only a preliminary investigation of the focal points and boundaries of Chinese BCTs. Future research should incorporate both online and offline field studies to further investigate the characteristics of Chinese BCTs and to examine the relationship between language and perception. Such efforts will contribute to a more profound understanding of the complex interplay between language and cognition.

Appendix A. The Presented Pseudo-Random Order in Focus Mapping Task

No.	Task	Selected Color Chip
1	Please pick out the best example of red.	
2	Please pick out the best example of orange.	
3	Please pick out the best example of yellow.	
4	Please pick out the best example of green.	
5	Please pick out the best example of blue.	
6	Please pick out the best example of purple.	
7	Please pick out the best example of cyan (Qingse).	
8	Please pick out the best example of brown.	
9	Please pick out the best example of pink.	
10	Please pick out the best example of black.	
11	Please pick out the best example of white.	
12	Please pick out the best example of gray.	
13	Please pick out the best example of Hese (褐色).	
14	Please pick out the best example of Juse (橘色).	

Appendix B. The Presented Pseudo-Random Order in Boundary Mapping Task

No.	Task	Selected Color Chips
1	Please pick out all of the red chips.	
2	Please pick out all of the orange chips.	
3	Please pick out all of the yellow chips.	
4	Please pick out all of the green chips.	
5	Please pick out all of the blue chips.	
6	Please pick out all of the purple chips.	
7	Please pick out all of the cyan (Qingse) chips.	
8	Please pick out all of the brown chips.	
9	Please pick out all of the pink chips.	
10	Please pick out all of the black chips.	
11	Please pick out all of the white chips.	
12	Please pick out all of the gray chips.	
13	Please pick out all of the Hese (褐色) chips.	
14	Please pick out all of the Juse (橘色) chips.	

Acknowledgements

The authors acknowledge the participants who contributed their talent and time to this study.

REFERENCES

[1] Andrews, D. R. (1994). The Russian Color Categories Sinij and Goluboj: An Experimental Analysis of Their Interpretation in the Standard and Emigré Languages. *Journal of Slavic Linguistics*, *2*(1), 9–28.
[2] Athanasopoulos, P. (2009). Cognitive representation of colour in bilinguals: The case of Greek blues. *Bilingualism*, *12*(1), 83–95. https://doi.org/10.1017/S136672890800388X
[3] Athanasopoulos, P., Damjanovic, L., Krajciova, A., & Sasaki, M. (2011). Representation of colour concepts in bilingual cognition: The case of Japanese blues. *Bilingualism*, *14*(1), 9–17. https://doi.org/10.1017/S1366728909990046
[4] Berlin, B., & Kay, P. (1969). *Basic color terms: Their universality and evolution.* University of California Press.
[5] Biggam, C. P. (2012). *The semantics of colour: A historical approach*. Cambridge University Press.
[6] Bogushevskaya, V. (2015). Chinese GRUE: on the original meaning and evolution of qīng 青. *L'Analisi Linguistica e Letteraria*, *23*(1), 61–76.
[7] Cook, R. S., Kay, P., & Regier, T. (2005). The world color survey database. In H. Cohen & C. Lefebvre (Eds.), *Handbook of categorization in cognitive science* (pp. 223–241). Elsevier.
[8] Dai, S., & Zainal, A. Z. (2025). *An empirical study of basic color terms in Chinese*. *Forum for Linguistic Studies*, *7*(5), 861–872. https://doi.org/10.30564/fls.v7i5.8797.
[9] Davies, I., & Corbett, G. (1994). The basic color terms of Russian. *Linguistics*, *32*(1), 65–90. https://doi.org/10.1515/ling.1994.32.1.65
[10] *Dispersion and Measures of Dispersion*. Retrieved February 9, 2024, from https://byjus.com/maths/dispersion/
[11] Gao, J., & Sutrop, U. (2014). The basic color terms of Mandarin Chinese. *Studies in Language*, *38*(2), 335–359. https://doi.org/10.1075/sl.38.2.03gao
[12] Gibson, E., Futrell, R., Jara-Ettinger, J., Mahowald, K., Bergen, L., Ratnasingam, S., Gibson, M., Piantadosi, S. T., & Conway, B. R. (2017). Color naming across languages reflects color use. *Proceedings of the National Academy of Sciences of the United States of America*, *114*(40), 10785–10790. https://doi.org/10.1073/pnas.1619666114
[13] Głaz, A., & Allan, K. (2010). Vantage Theory: developments and extensions. Introduction. *Language Sciences*, *32*(2), 151–157. https://doi.org/10.1016/j.langsci.2009.10.001
[14] Hardin, C. L. (2011). Basic color terms and basic color categories. In W. G. K. Backhaus, R. Kliegl, & J. S. Werner (Eds.), *Color vision: Perspectives from different disciplines* (pp. 207–218). https://doi.org/10.1515/9783110806984.207
[15] Ji, L.-J., Zhang, Z., & Nisbett, R. E. (2004). Is it culture or is it language? Examination of language effects in cross-cultural research on categorization. *Journal of Personality and Social Psychology*, *87*(1), 57–65. https://doi.org/10.1037/0022-3514.87.1.57
[16] Kay, P., Berlin, B., Maffi, L., Merrifield, W. R., & Cook, R. (2009). *The world color survey*. CSLI Publications.
[17] Kay, P., & Cook, R. S. (2016). World color survey. In M. R. Luo (Ed.), *Encyclopedia of color science and technology* (pp. 1265–1271). Springer. https://doi.org/10.1007/978-1-4419-8071-7_113
[18] Kay, P., & McDaniel, C. K. (1978). The linguistic significance of the meanings of basic color terms. *Language*, *54*(3), 610–646. https://doi.org/10.1353/lan.1978.0035
[19] Lai, H. (2019). Colour terms in Chinese. In B. Meisterernst, C.-R. Huang, & Z. Jing-Schmidt (Eds.), *The Routledge handbook of Chinese applied linguistics* (pp. 105–117). Routledge.
[20] Panitanang, N., Phuangsuwan, C., & Ikeda, M. (2022). Basic color terms in Thai. *Color Research & Application*, *47*(6), 1402–1425. https://doi.org/10.1002/col.22800
[21] Paramei, G. V. (2005). Singing the Russian blues: An argument for culturally basic color terms. *Cross-Cultural Research*, *39*(1), 10–38. https://doi.org/10.1177/1069397104267888
[22] Regier, T., Kay, P., & Cook, R. S. (2005). Focal colors are universal after all. *Proceedings of the National Academy of Sciences of the United States of America*, *102*(24), 8386–8391. https://doi.org/10.1073/pnas.0503281102
[23] Roberson, D., Davies, I., Corbett, G., & Vandervyver, M. (2005). Free-sorting of colors across cultures: Are there universal grounds for grouping? *Journal of Cognition and Culture*, *5*(3–4), 349–386.
[24] Rosch, E., & Mervis, C. B. (1975). Family resemblances: Studies in the internal structure of categories. *Cognitive Psychology*, *7*(4), 573–605. https://doi.org/10.1016/0010-0285(75)90024-9
[25] Rosch Heider, E. (1972). Universals in color naming and memory. *Journal of Experimental Psychology*, *93*(1), 10–20. https://doi.org/10.1037/h0032606
[26] Sturges, J., & Whitfield, T. W. A. (1995). Locating basic colours in the Munsell space. *Color Research & Application*, *20*(6), 364–376. https://doi.org/10.1002/col.5080200605
[27] Sun, V. C., & Chen, C. C. (2018). Basic color categories and Mandarin Chinese color terms. *PLoS ONE*, *13*(11). https://doi.org/10.1371/journal.pone.0206699
[28] Tao, J., & Wong, J. (2019). The confounding Mandarin colour term 'Qīng': Green, blue, black or All of the Above and More? In *Studies in Ethnopragmatics, Cultural Semantics, and Intercultural Communication: Minimal English (and Beyond)* (pp. 95–116). Singapore: Springer Singapore.
[29] Tusei-Ju Hsieh. (2010). *Color terms and lexical color category space in Mandarin* (Doctoral dissertation). National Chiao Tung University.
[30] Valdegamberi, V., Paggetti, G., & Menegaz, G. (2015). On the perceptual/linguistic origin of the twelfth basic color term in the Italian color lexicon. *Cultura e Scienza del Colore – Color Culture and Science*, *4*, 8–13.
[31] Xie, H. (2008). Hànyǔ jīběn yánsè cí pǔ fāng gǔ bǐjiào yánjiū [A contrastive study of basic color terms in Chinese across Modern Standard Chinese, dialects, and Classical Chinese]. *Yǔyán Yánjiū* [Studies in Language and Linguistics], *28*, 91–96.
[32] Xie, S., Zhang, J., & Zhu, J. (2019). Yánsè fànchóu zhījué xiàoyìng fāshēng zài dà nǎo liǎng bànqiú: Láizì Nàxī zú hé Hànzú de zhèngjù [Categorical perception of color is significant both in the right visual field and the left: Evidence from Naxi speakers and Mandarin speakers]. *Xīnlǐxué Bào* [Acta Psychologica Sinica], *51*(11), 1229–1243. https://doi.org/10.3724/SP.J.1041.2019.01229
[33] Xu, M., Zhu, J., & Benítez-Burraco, A. (2023). A comparison of basic color terms in Mandarin and Spanish. *Color Research and*

Application, *48*(6), 709–720. https://doi.org/10.1002/col.22863
[34] Xue, Y., & Yang, Z. (2014). *Renzhi yuyi shijiao de Ying-Han fei jiben yanse ci duibi yanjiu* [A contrastive study of English and Chinese non-basic color terms from the perspective of cognitive semantics]. *Waiguoyu (Shanghai Waiyu Daxue Xuebao)* [Foreign Languages (Journal of Shanghai International Studies University)], *37*(1), 36–42.
[35] Yao, X. (1988). Jīběn yánsè cí lǐlùn shùpíng — Jiān lùn Hànyǔ jīběn yánsè cí de yǎnbiàn shǐ [A survey of studies of basic color terms — With a note on the evolution of those in Chinese]. *Wàiyǔ Jiàoxué yǔ Yánjiū* [Foreign Language Teaching and Research], *1*, 19–28.
[36] Zadeh, L. A. (1996). *Fuzzy sets, fuzzy logic, and fuzzy systems: Selected papers* (Vol. 6). G. J. Klir & B. Yuan (Eds.). World Scientific.
[37] Zhao, X. (2012). Kuàyǔyán shìjiǎo xià de Hànyǔ “qīng” lèi cí [The color category *qīng*/青of Chinese language in cross-linguistic perspective]. *Gǔ Hànyǔ Yánjiū* [Research in Ancient Chinese Language], *3*, 73–79.

Dai Shunbo is a Ph.D. candidate in the English Language Department at the Faculty of Languages and Linguistics, Universiti Malaya in Kuala Lumpur, Malaysia. His primary research interests are in applied linguistics, psycholinguistics, and bilingual/multilingual cognition.

Azlin Zaiti Zainal is a senior lecturer in the Department of English Language, Faculty of Languages and Linguistics, Universiti Malaya, Kuala Lumpur, Malaysia. Her research interests include teacher education, technology in language education, second language writing, oral communication, and discourse studies.