A Quantitative Analysis of the Chromatic Representation of Lotus Imagery in Chinese Animated Films

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Abstract

Lotus imagery is a prominent cultural symbol in Chinese visual traditions, yet its chromatic representation in animation remains underexplored. This study examines the colour characteristics of lotus imagery in Chinese animated films produced between 1926 and 2025, aiming to reveal how colour contributes to cultural expression and visual meaning-making. A mixed-methods approach was employed, combining quantitative colour analysis of selected animation frames with visual-cultural and semiotic interpretation. The findings identify a recurring chromatic structure centred on red, pink, green, and gold hues, while revealing significant variations across historical periods. These variations reflect shifts in aesthetic conventions, production practices, and cultural narratives within Chinese animation. The results suggest that colour functions not only as an aesthetic component but also as a symbolic system that communicates cultural values and identity. This study contributes to animation studies and digital humanities by providing a framework for integrating quantitative visual analysis with cultural interpretation.

Keywords:animated films; colour; lotus; visual; China

INTRODUCTION

In the context of accelerating global audiovisual digitalization, Chinese cinema has witnessed a steady expansion of its international influence. Within this landscape, Chinese animated film has emerged as a significant vehicle for the dissemination of national culture and an important embodiment of China's cultural soft power(Macdonald, 2015) .(Macdonald, 2015) Soft power, as (Nye, 2009) argues, fundamentally derives from attract veness—the capacity to shape the preferences of others through cultural appeal rather than coercion.Chinese animation is deeply rooted in the country's rich traditional heritage. Drawing upon historical narratives, myths, aesthetic philosophies, and long-standing cultural practices, these works function not merely as entertainment products but as repositories of collective memory and civilizational continuity. They record and reinterpret China's historical experiences and cultural transformations, thereby reflecting a profound cultural depth.Tra-

ditional cultural elements, in this regard, constitute the fundamental units of Chinese cultural expression. As the “cells” of traditional culture, they contribute to the structural richness and diversity of the broader cultural system and play an essential role in shaping its symbolic meaning and identity.

Audiovisual language constitutes a foundational component of cinematic expression, directly shaping narrative construction and emotional representation. Among its constitutive elements, color occupies a uniquely central position. As one of the most defining yet linguistically elusive aspects of film style, color operates as a powerful semiotic resource that exceeds precise verbal articulation. The perception of color, as (Hill, 1974)observes, represents one of the most emotionally charged dimensions of visual experience, endowing it with exceptional expressive potential in the articulation of affect.In the course of cinematic narration, filmmakers strategically deploy variations in color, form, plot structure, and storytelling devices to intensify dramatic tension and sustain audience engagement.(Feldman, 1988) Within this framework, color functions not merely as aesthetic ornamentation but as an active narrative agent that modulates atmosphere, guides perception, and shapes interpretive meaning. The aesthetic construction of a scene frequently emerges from its underlying emotional tone, enabling viewers to experience affective resonance and immersive identification (Zumbach & Koglin, 2015).Beyond individual affective responses, color also operates at a broader socio-cultural level. While it influences personal emotional states, it simultaneously participates in the construction of collective memory and cultural identity. Through historically embedded chromatic conventions and symbolic associations, color contributes to the articulation of shared historical consciousness and communal belonging.

As a foundational element of China’s rich traditional cultural heritage, the lotus occupies a significant position within narrative and visual traditions. In classical cultural texts and narrative practices, the lotus is not merely incorporated as decorative imagery but embedded within scene construction and thematic development, where it functions as a symbolically charged visual sign. Through variations in form, color, and compositional context, the lotus acquires layered semiotic meanings that extend beyond its botanical identity and assume cultural and aesthetic value.Within the broader tradition of Chinese visual culture, the lotus has long been associated with notions of purity, transcendence, moral integrity, and spiritual refinement. Its symbolic resonance is neither static nor monolithic; different chromatic renderings of the lotus convey distinct connotations, ranging from sacredness and detachment to vitality and rebirth. In animated cinema, the visual representation of the lotus becomes a narrative device through which thematic depth and character interiority are articulated. By mobilizing culturally embedded associations, such imagery facilitates affective identification and emotional resonance among audiences. In this process, color plays a particularly decisive role, as its perceptual immediacy enables it to communicate symbolic and emotional information with remarkable efficiency.Moreover, the aesthetic configuration of the lotus is historically contingent. As narrative paradigms evolve and socio-cultural contexts shift, the visual and symbolic meanings attributed to the lotus undergo corresponding transformations. Its aesthetic form, therefore, reflects not only continuity within tradition but also adaptation to changing historical and discursive conditions.

International scholarship on the lotus motif has predominantly focused on its religious symbolism and philosophical connotations, as well as its application in material culture and design-related domains, including textile patterns, sculpture, decorative arts, ceramics, and painting. In contrast,

within the digital era, algorithmic approaches to the study of color in animated cinema have largely concentrated on computational methodologies rather than symbolic or affective interpretation. These approaches primarily include deep learning–based neural network models, visual space simulations, color appearance models, and traditional image quality assessment (IQA) frameworks addressing color degradation.

For instance, (Zhang et al., 2018)together with Phillip Isola and colleagues, proposed perceptual similarity metrics based on deep neural network features to model visual perception in image analysis. Earlier studies by (Wyszecki & Stiles, n.d.) employed color space–based computational methods to examine perceptual differences across images. (Sharma et al., 2005) developed new color appearance models to refine perceptual color measurement under varying viewing conditions. (Temel & AlRegib, 2014)explored color degradation compensation techniques to enhance image quality evaluation in alignment with human visual perception. (Fiorucci et al., 2020) utilized CNS instrumentation to extract chromatic and decorative features from folk ceramic collections for pattern and color analysis.

While these studies significantly advance quantitative and perceptual modeling of color, they tend to detach color from its expressive function in conveying emotion and cultural meaning. In other words, color is often treated as a measurable visual variable rather than as a semiotic and affective medium embedded within narrative and historical contexts.

The present study shifts the focus toward the chromatic representation of the lotus in Chinese animated cinema, situating it within the broader historical and cultural trajectory of Chinese animation. Here, color is approached as an imagistic and emotional vehicle that mediates cultural symbolism. Audience responses to cinematic color are inherently subjective, shaped by individual cognition, aesthetic preference, and cultural experience. At the same time, color operates as a symbolic system that facilitates communication between culture and emotion(Ge, n.d.2025). Consequently, examining the chromatic construction of the lotus in film offers insight into how viewers perceive and internalize cultural meaning through visual cues.

This research contributes to both theoretical and practical dimensions of Chinese animated film production. By foregrounding the emotional and symbolic functions of color in visual design, it provides conceptual grounding for creative decision-making in animation aesthetics. Furthermore, it offers a structured framework for integrating cultural symbolism into color design, potentially enhancing creative efficiency and expanding imaginative possibilities within animated visual storytelling.

METHODOLOGY

Research Sample

This study takes the “lotus imagery” in Chinese animated films as its core analytical focus and conducts a quantitative investigation. Through a combination of image sampling and Region of Interest (ROI) selection, lotus-themed shots were manually extracted from four representative films: *Princess Iron Fan* (1941), *Nezha Conquers the Dragon King* (1979), *Lotus Lantern* (1999), and *White Snake: Afloat* (2024). The film sources were obtained from publicly available digital platforms. The materials were provided in 4K resolution, and for earlier animated works, restored 4K versions were employed to ensure clarity and chromatic consistency.

Table 1. Lotus Characteristics Table

Each film was first decomposed at the shot level, followed by targeted manual extraction of the principal visual areas in which the lotus appeared as a dominant narrative element. All selected

Film Title	Stable K Values (1–5 Trials, Elbow Method)	Stable K Values (1–5 Trials, Silhouette Coefficient)	Final Stable K (Elbow Method)	Final Stable K (Silhouette Coefficient)
Princess Iron Fan (1941)	4,	3	4	2
Nezha Conquers the Dragon King (1979)	3-5,	2,3	4	2
Lotus Lantern (1999)	4-5,	2,4,	4	2
White Snake: Afloat (2024)	4-5,	2	4	2

frames were uniformly cropped to 512 × 512 pixels while maintaining the original aspect ratio. The number of extracted frames constitutes an essential component of the primary dataset. Using Adobe Photoshop, a total of 43 single-frame images featuring the lotus as the central narrative subject were manually captured. To preserve chromatic integrity, all images were exported in lossless PNG format. In terms of color processing, a unified color space conversion procedure was applied, and RGB values were maintained in a standardized format to minimize potential interference from display devices and ensure consistency in computational analysis.

The four selected films differ significantly in terms of production system, aesthetic paradigm, and narrative type, representing key developmental stages in Chinese animation—from early industrial experimentation to the formation of a national style, from market-oriented transformation to digital-industrial maturity. This diachronic framework provides a contextual foundation for comparative analysis across historical phases.

In this study, the “lotus” is not treated as a purely naturalistic botanical object. Rather, it is understood as a cross-media symbolic construct whose visual forms derive from decorative, ritual, and pictorial traditions, including ceramic ornamentation and mural imagery. These inherited symbolic and aesthetic associations collectively shape the narrative function of the lotus motif in animated visual storytelling.

Additionally, morphological characteristics were extracted from each film to determine stylistic parameters. Line-based abstractions were produced to analyze formal features, including symmetry, number of petals, hierarchical layering, material rendering, viewing perspective, and compositional structure. The narrative function of the lotus imagery was further examined in relation to these visual configurations. The resulting data were systematically organized into a structured analytical table.To ensure perceptual consistency in chromatic analysis, all pixel values were converted from the sRGB color space (D65) to the CIELAB color space. Compared with RGB, CIELAB provides an approximately perceptually uniform representation, allowing Euclidean distances to better correspond to human visual differences in color perception.

Each ROI image was reshaped into an $N \times 3$feature matrix

$$\mathrm{X} \in \mathbb{R}^{N\times 3}$$

where each row represents a pixel vector (L^*, a^*, b^*). This matrix served as the input for K-means clustering. The clustering procedure was applied to the dominant chromatic information extracted

from the four selected films, and the centroid of each cluster $\mu_i$was interpreted as a representative palette color.

The proportional weight of each color cluster was calculated as:

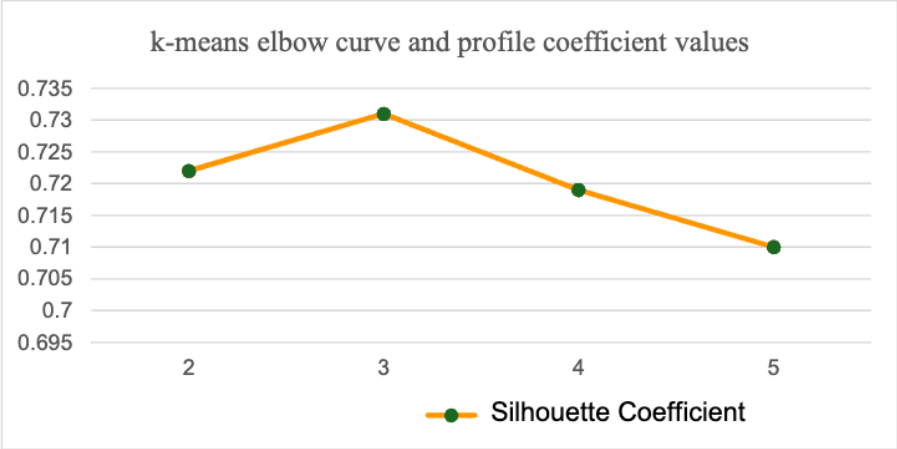
$$p_i = \frac{n_i}{\sum_{j=1}^{K} n_j}, i = 1, \ldots, K$$

where $p_i$denotes the relative proportion of the i-th color cluster, $n_i$represents the number of pixels assigned to cluster i, Kindicates the total number of clusters, and $\sum_{j=1}^{K} n_j$corresponds to the total number of pixels involved in the clustering process.

This proportion reflects the visual weight of each color cluster within the image. A larger pixel count within a cluster indicates greater chromatic dominance in the overall composition. By examining cluster proportions and centroids, dominant, secondary, and accent colors can be quantitatively identified, providing a structured basis for subsequent color structure analysis and cross-film comparison.

In the clustering process, each pixel was assigned to its nearest centroid according to Euclidean distance in CIELAB space. After assignment, pixel counts within each cluster were computed, and their relative proportions were derived using the above formula. This procedure was repeated for all ROI images to ensure stable and comparable chromatic distribution profiles across films.The number of clusters $K$was determined using the elbow method based on the within-cluster sum of squared errors (SSE). Clustering was performed across candidate values $K = 4$, and the SSE curve was examined to identify the inflection point where the rate of error reduction shifted from steep to gradual.For example, in the case of Princess Iron Fan, a substantial reduction in SSE was observed between $K = 2$ and $K = 4$, whereas further increases in Kresulted in only marginal improvements. This inflection point suggests an appropriate balance between model complexity and representational adequacy. Accordingly, $K = 4$， was selected.To assess clustering stability, the algorithm was repeated five times under different initialization conditions, yielding consistent convergence patterns. In addition, silhouette coefficients were computed for each candidate K. The silhouette score achieved its highest stable value at $K = 4$, further supporting the robustness of the selected cluster number.By comparing the proportional structures of color clusters across films, it becomes possible to examine differences in chromatic organization, emotional tone, and representational strategies across historical stages of Chinese animated cinema. The quantitative extraction of palette structures thus provides a measurable foundation for analyzing color as both an aesthetic and symbolic component of animated visual storytelling.

Table 2. k-means elbow curve and profile coefficient values



The Survey Process

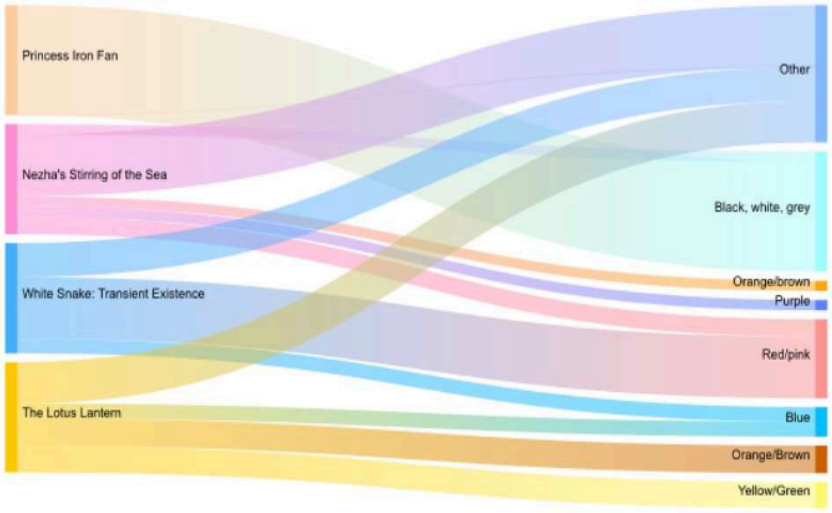
To compare the chromatic configurations of the four film samples, an audience-based evaluation was conducted with 44 undergraduate participants, all born after 2000 and familiar with the lotus imagery presented in the selected films. Prior to the assessment, participants were briefly informed of the procedural steps but were not told the specific purpose of the study. They completed the questionnaire independently, responding according to their immediate perceptual and emotional impressions. No explanatory framework was provided for the 16 evaluative descriptors. In particular, the distinction between affective and aesthetic dimensions was not disclosed, and no definitions were offered for individual labels. Participants therefore interpreted each descriptor according to their own experiential and cultural understanding. This approach was intended to preserve spontaneous evaluative judgments and to reduce the likelihood that conceptual framing might influence their responses, Colour, as a form of visual symbolism, reflects national culture and a sense of unity(Ai, 2026).

Table 3. The Lotus Flower as a Symbolic Colour

Film Title	Colour swatch (1-20)
The Iron Fan Princess	
zThe Legend of the Lotus Lantern	
Nezha Conquers the	

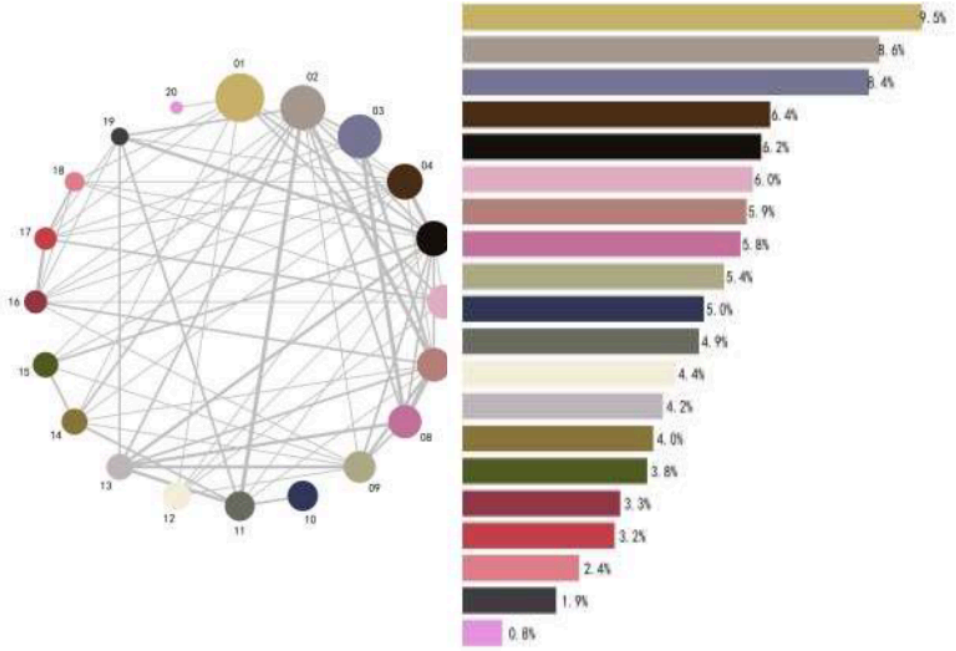
Sea	
White Snake: The Floating Life	

Table 4. Colour trends in four representative films



A Likert-type scale was employed to measure the intensity and direction of participants' evaluations across two conceptual domains: affective response and aesthetic judgment. Likert scales are commonly used to quantify attitudinal strength across ordered response categories(Aybek & Toraman, 2022). In this study, a 10-point scale was adopted to allow fine-grained differentiation of perceptual intensity. For each descriptor, participants assigned a score ranging from 0 to 10 to indicate the degree of correspondence between the stimulus and the evaluative term. Scores from 0 to 6 reflected relatively low endorsement, 7 to 8 indicated moderate endorsement, and 9 to 10 represented a high degree of endorsement. The two ends of the scale corresponded conceptually to weak versus strong perceptual alignment, with lower scores reflecting a more negative or less salient impression and higher scores reflecting stronger perceptual agreement. This scaling structure enabled the analysis to capture both directional orientation and intensity variation across the four samples.

Table 5 Results of colour K-value measurement and calculation



The evaluation instrument was constructed through a staged procedure involving preliminary surveys, corpus-based extraction of candidate adjectives from viewing materials, and expert review. Eight affective descriptors were selected to represent distinct experiential dimensions: warmth, coldness, calmness, exaltation, healing, tension, sacredness, and mystery(Schütte, 2005). These terms encompass variation in emotional valence, arousal level, and culturally embedded affective resonance. In parallel, eight aesthetic descriptors were established using the same screening process: elegance, purity, dignity, ethereality, Zen-like serenity, auspiciousness, splendor, and poetic quality. These items were intended to assess formal refinement, symbolic atmosphere, and culturally informed aesthetic judgment. All responses were coded numerically and analyzed using IBM SPSS Statistics 27. Mean scores and distributional characteristics were calculated for each descriptor within each film condition, providing the empirical basis for subsequent comparative and inferential analyses(Huang et al., 2012).

Table 6. Total variance of Lotus colour values : Colour and Aesthetics

	NO 1	NO2	NO3	NO4
Warm	6.57	3.64	7.23	1.98
cool	4.21	5.06	2.95	6.59
calm	4.08	5.22	4.28	4.97
passionate	6.22	3.55	4.19	3.16
healing	5.41	5.07	6.6	2.33
stressful	4.73	4.86	2.98	7.74
sacred	4.39	4.03	4.12	4.41
mysterious	4.75	5.73	4.1	7.77
（a）Total variance of colour				
	NO 1	NO2	NO3	NO4

Elegant	4.44	5.67	4.94	3.73
Holy	4.29	4.34	4.47	3.36
dignified	5.34	5.35	5.06	4.57
Ethereal	3.94	4.89	4.24	4.53
Zen	4.54	5.85	3.87	3.22
Auspicious	6.1	4.22	5.5	2.6
Wealth	6.08	4.09	5.45	2.65
Poetic	4.89	6.14	5.12	3.92

（b）Total variance in aesthetics

RESULTS

Lotus Color Image Analysis

To examine the aesthetic and emotional structure of film color usage, factor analysis was conducted using IBM SPSS Statistics 26. Prior to factor extraction, the suitability of the dataset for factor analysis was assessed through Bartlett's test of sphericity and the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy. Bartlett's test yielded a significance level of $p = 0.000$, indicating that the correlation matrix significantly differed from an identity matrix and that sufficient correlations existed among the variables. The KMO values of the four datasets were 0.681, 0.588, 0.583, and 0.561, respectively, exceeding the commonly accepted threshold of 0.50 (Hsu et al., 2016) These results suggest that the dataset contains adequate shared variance and is therefore appropriate for factor analysis.

Principal component analysis with varimax rotation was subsequently applied to identify the underlying structure of the aesthetic and emotional descriptors associated with film color usage. The results indicate that the first two principal components explain the majority of the variance across the variables, with cumulative contribution rates exceeding 80%. This suggests that a two-factor solution provides an effective representation of the relationships among the color perception variables. The rotated component matrix presented in Table 2 reports the factor loadings of each descriptor, while Figure 2 illustrates the factor scores of the representative color samples extracted from the four films.

The rotated factor structure suggests that the perceptual interpretation of film color can be broadly understood along two primary dimensions. The first principal component is primarily associated with descriptors reflecting the visual and perceptual characteristics of color expression. In the context of the four films analyzed in this study, this component is strongly associated with emotional color keywords such as *warmth*, *calmness*, *intensity*, and *stimulus*. These descriptors capture the perceptual and affective impact of color on viewers and therefore represent the perceptual-emotional dimension of cinematic color.

The second principal component, by contrast, is more closely associated with aesthetic and cultural imagery descriptors, including *elegance*, *purity*, *solemnity*, *ethereality*, *Zen-like atmosphere*, *auspiciousness*, *luxury*, and *poetic quality*. These descriptors reflect the cultural and symbolic meanings that viewers attribute to color compositions within the films. Accordingly, this component may be interpreted as representing the aesthetic–cultural dimension of film color imagery.

The factor scores further reveal that the four films exhibit distinct color-aesthetic characteristics across these two dimensions. Some color samples achieve relatively high scores on the first component, indicating stronger perceptual intensity and emotional expressiveness. These colors contribute primarily to the immediate visual impact and emotional atmosphere of the films. Other color samples exhibit higher scores on the second component, suggesting a stronger association with aesthetic symbolism and cultural imagery. Such colors tend to evoke more refined aesthetic impressions and contribute to the cultural narrative embedded in the visual language of the films.

Taken together, these findings suggest that film color operates through a two-layer perceptual structure, in which colors first influence viewers through emotional perception and subsequently generate aesthetic imagery associations. The four films analyzed in this study demonstrate distinct configurations within this perceptual framework, reflecting different visual strategies in the use of cinematic color. While some films emphasize emotional intensity and visual dynamism, others rely more heavily on symbolic and aesthetic color associations to construct a culturally resonant visual atmosphere.

The results therefore indicate that cinematic color functions not only as a visual design element but also as a perceptual mechanism linking emotional response and aesthetic interpretation.

Correlation Analysis Between Lotus Colours and NCS Colours

To investigate the hue, lightness, and chroma characteristics of colors associated with specific semantic perceptions, a correlation analysis was conducted between the perceptual color image level (Z) and the quantitative color attributes defined in the Natural Color System (NCS), including hue variables (Y, R, B, and G), the blackness variable (S), and the chroma variable (C).

Prior to the correlation analysis, the distribution characteristics of the data were examined. Data normalization and normality testing were performed using IBM SPSS Statistics 26. Two commonly used normality tests, namely the Kolmogorov–Smirnov test and the Shapiro–Wilk test, were considered(Araveeporn, 2022) . The Kolmogorov–Smirnov test is typically applied to large datasets with more than 50 observations, whereas the Shapiro–Wilk test is more suitable for smaller datasets with fewer than 50 observations (Mudholkar et al., 1995) Based on the characteristics of the dataset, the Shapiro–Wilk test was adopted to evaluate the normality of the color perception variables and the NCS color elements.

The results of the normality tests indicate that most of the significance values (P) for the perceptual color image variables and the NCS color elements are lower than 0.05, suggesting that the variables do not follow a normal distribution. Consequently, a non-parametric correlation method was considered more appropriate. Spearman's rank correlation coefficient was therefore employed to examine the relationships among the variables.

Spearman's correlation analysis is based on ranked data rather than the original values. Assuming that the original observations $x_i$and $y_i$are arranged in descending order, the ranked variables $x_i'$and y_i'represent the positions of the observations after ranking. These ranked values are referred to as the ranks of variables $x_i$and y_i, respectively. The difference between the two ranks is defined as $d_i = x_i' - y_i'$. When no tied ranks occur, Spearman's correlation coefficient $r_s$can be calculated using Equation (2):

$$r_s = 1 - \frac{6\sum d_i^2}{n(n^2-1)}$$

When tied ranks are present, the Pearson correlation coefficient between the ranked variables is calculated, as expressed in Equation (3)(Hanxiao et al., 2022) .

Spearman's correlation coefficient is particularly suitable for analyzing non-linear relationships and non-normally distributed data. Correlation coefficients approaching 1 or −1 indicate strong positive or negative associations between variables, respectively(Li et al., 2022).

The correlation results reveal several statistically significant relationships among the NCS color elements. A strong negative correlation was observed between blackness and chroma ($r_s = -0.662$, $p < 0.01$), indicating that colors with higher chromatic intensity generally exhibit lower levels of blackness. Blackness also shows a significant negative correlation with R Hue ($r_s = -0.485,\ p < 0.01$) and a weaker negative relationship with B Hue ($r_s = -0.221,\ p < 0.05$), suggesting that darker colors tend to be less associated with red- and blue-dominant hue components.

Chroma demonstrates a strong positive correlation with R Hue ($r_s = 0.687,\ p < 0.01$), as well as moderate positive correlations with B Hue ($r_s = 0.309,\ p < 0.01$) and Y Hue ($r_s = 0.220,\ p < 0.05$). These results indicate that colors with higher saturation levels tendto be associated with stronger red- and blue-oriented hue compositions. Meanwhile, Y Hue exhibits a significant negative relationship with B Hue ($r_s = -0.400,\ p < 0.01$) but a strong positive correlation with G Hue ($r_s = 0.480,\ p < 0.01$), reflecting the structural balance among hue components within the NCS color framework.

Additionally, R Hue shows a positive correlation with B Hue ($r_s = 0.296,\ p < 0.01$) and a negative correlation with G Hue ($r_s = -0.316,\ p < 0.01$). These findings indicate that the hue components within the NCS system exhibit systematic interrelationships, which together influence the perceptual characteristics of color images. Overall, the results demonstrate that measurable NCS color attributes are significantly associated with perceptual color imagery, providing a quantitative basis for understanding how hue composition, chromatic intensity, and brightness contribute to semantic color perception.

The results of the Spearman correlation analysis indicate that the perceptual color imagery of the four films exhibits distinct relationships with the NCS color elements. For Film A, both the extrinsic and intrinsic perceptual dimensions show a strong positive correlation with chroma and a negative correlation with blackness. This pattern suggests that higher levels of color saturation are closely associated with both the visual appearance and the aesthetic perception of the film's color imagery. In Film B, moderate correlations are also observed between chroma and the perceptual imagery factors, implying that chromatic intensity plays a meaningful role in shaping the overall visual impression of the film.

By contrast, Film C demonstrates stronger correlations with the red hue component, indicating that the color composition of the film is characterized by a pronounced red-oriented hue structure. This tendency suggests that hue distribution, rather than solely chromatic intensity, contributes significantly to the perceptual interpretation of the film's color scheme. Film D, however, presents a different pattern: the perceptual imagery factors show a relatively strong negative association with blackness but comparatively weak correlations with the remaining NCS color elements. This finding implies that the visual characteristics of Film D are primarily influenced by variations in brightness levels rather than by hue composition or chromatic saturation.

Overall, these results suggest that the perceptual color imagery in cinematic visuals can be systematically associated with specific NCS color attributes, while the dominant influencing factors vary across different films.

Table 7. Analysis of NCS colour results

Film	Color Characteristics	Blackness	Chroma	Y Hue	R Hue	B Hue	G Hue
Film A	Extrinsic characteristics	-0.5	-0.26	0.16	-0.52	0.45	0.32
	Intrinsic characteristic	-0.49	0.36	-0.18	-0.55	0.13	0.59
Film B	Extrinsic characteristics	0.03	-0.21	-0.34	-0.02	0.4	-0.03
	Intrinsic characteristic	-0.17	0.18	0.64	0.11	-0.74	0.1
Film C	Extrinsic characteristics	-0.7	0.64	-0.08	0.36	0.33	-0.21
	Intrinsic characteristic	0.02	0.54	-0.01	0.38	0	-0.28
Film D	Extrinsic characteristics	-0.42	0.83	0.28	-0.35	-0.57	0.61

1.Correlation between film color images and NCS color elements：Spearman correlation analysis was conducted to examine the relationships between the image variable $Z$and the NCS color elements, including hue components (Y, R, B, and G), blackness (S), and chromaticness (C). The results are presented in Table 3.

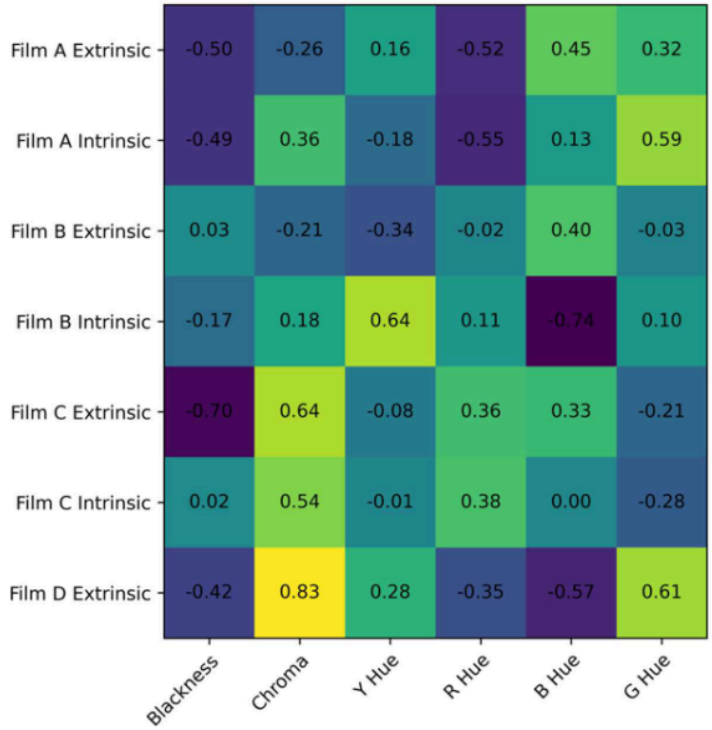
2. External color characteristics：The external perceptual characteristics of the films show different correlation patterns with the NCS color elements. For Film A, blackness shows a moderate negative correlation with red hue ($r_s = -0.52$). Blue and green hues show p_$r_s = 0.45$ and 0.32). This indicates that darker tones are associatedFor Film B, correlations between blackness and$r_s = -0.74$), suggesting that the appearance of this film is mainly influenced by variations in hue rather than brightness or saturation.For Film C, blackness shows a strong negative correlation with chroma ($r_s = -0.70$). Chroma is positively correlated with red hue ($r_s = 0.36$) and blue hue ($r_s = 0.33$). This suggests that color saturation is an important factor shaping the visual appearance of this film.For Film D, chroma shows a strong positive correlation ($r_s = 0.83$), while blue hue shows a negative correlation ($r_s = -0.57$). These results indicate that the external visual perception of this film is strongly associated with chromatic intensity.

3. Internal color characteristics：Different correlation patterns are also observed for the internal perceptual characteristics.In Film A, chroma is positively correlated with the intrinsic variable ($r_s = 0.36$), while blackness and red hue show negative correlations ($r_s = -0.49$ and $r_s = -0.55$). This indicates that higher saturation tends to strengthen the internal perceptual response, whereas darker tones and strong red components reduce it.In Film B, the intrinsic variable shows a strong positive correlation with yellow hue ($r_s = 0.64$) and a strong negative correlation with blue hue ($r_s =$

-0.74). This suggests that warm color components contribute more strongly to the internal perceptual characteristics.In Film C, chroma and red hue show moderate positive correlations ($r_s = 0.54$ and $r_s = 0.38$), while blackness shows almost no correlation. This indicates that brightness variation has limited influence on the internal perceptual characteristics of this film.In Film D, chroma and green hue show positive correlations ($r_s = 0.83$ and $r_s = 0.61$), while blackness remains negatively correlated ($r_s = -0.42$). This suggests that saturated colors are associated with stronger internal perceptual responses.

4.Patterns of color perception：Several consistent patterns can be identified from the correlation results.First, blackness generally shows negative correlations with perceptual variables, indicating that darker tones tend to weaken both external and internal perceptual responses.Second, chroma tends to show positive correlations, particularly in Films C and D. This suggests that higher saturation contributes to stronger perceptual impressions.Third, hue components influence perception differently across films.Warm hues (such as red and yellow) tend to be associated with positive correlations in some films, whereas blue hues often show negative correlations with perceptual variables.Overall, the results indicate that chroma and hue composition play a more important role than brightness in shaping film color perception. Differences in these color elements lead to distinct perceptual characteristics among the four films.

Table 8 . Spearman Correlation Heatmap of Film Colour Characteristics (Intrinsic vs. Extrinsic)



5. Conclusions

This study examined the chromatic representation of lotus imagery in Chinese animated films through a quantitative framework that combined dominant colour extraction, perceptual evaluation, factor analysis, and correlation analysis. By selecting four films from different historical periods of Chinese animation, the research placed lotus imagery within a diachronic visual context and investigated how its colour configuration relates to audience perception and aesthetic judgment. Rather

than treating colour as a purely decorative surface attribute, this study approached colour as a structured visual language through which symbolic meaning, emotional atmosphere, and cultural imagination are conveyed.

Several conclusions may be drawn from the results.

First, the chromatic representation of lotus imagery in Chinese animated films is not random or merely stylistic; it displays measurable internal structure. The K-means clustering results show that lotus-related colour palettes in the selected films can be reduced to relatively stable dominant configurations, suggesting that lotus imagery is consistently shaped through a limited but meaningful range of chromatic choices. These choices do not simply organize the visual surface of the image; they also participate in the construction of atmosphere, symbolic tone, and narrative emphasis. In this sense, colour is not supplementary to lotus imagery but constitutive of its cinematic expression.

Second, audience responses to lotus colour imagery reveal a two-dimensional perceptual structure. The factor analysis indicates that viewers' evaluations are organized around two interrelated but distinguishable dimensions: a perceptual-emotional dimension and an aesthetic-cultural dimension. The first dimension reflects immediate sensory and affective responses, such as warmth, tension, calmness, and stimulation. The second dimension reflects more culturally mediated judgments, including elegance, purity, solemnity, poetic quality, and Zen-like serenity. This finding suggests that colour in animated film works simultaneously on two levels: it is first felt, and then it is interpreted. Put differently, colour reaches the viewer as sensation before it settles into meaning. This layered mechanism helps explain why lotus imagery can carry both immediate emotional force and enduring symbolic resonance in Chinese animated cinema.

Third, the correlation analysis demonstrates that perceptual colour imagery can be meaningfully associated with NCS colour elements. Across the full dataset, blackness shows a significant negative relationship with chromaticness, while chroma exhibits positive associations with several hue components. These results indicate that brightness suppression and saturation enhancement do not contribute equally to perception. In the case of lotus imagery, perceptual meaning is more strongly shaped by chromatic richness and hue composition than by darkness alone. This is an important finding, because it shows that the expressive power of lotus colour in animation does not depend simply on whether colours are bright or dark, but on how saturation and hue are organized within the image.

Fourth, the four films display different chromatic strategies in their treatment of lotus imagery. The comparison suggests that each film constructs lotus colour through a distinct balance of blackness, chroma, and hue preference, and that these differences correspond to different perceptual outcomes. In some films, lotus imagery is associated more strongly with saturation and visual intensity; in others, it is defined more by hue structure or by restraint in brightness. These differences should not be understood merely as technical variation. They reflect broader shifts in animation aesthetics, representational conventions, production systems, and cultural sensibilities across historical periods. The lotus, therefore, is not a fixed visual symbol repeated unchanged from one film to another; it is a culturally continuous motif whose colour meaning is repeatedly rearticulated through changing cinematic forms.

Fifth, this study confirms that the lotus in Chinese animated film is more than a recognizable traditional motif. Its chromatic construction functions as a carrier of cultural memory and aesthetic value. Within Chinese visual culture, the lotus has long been associated with purity, transcendence, dignity, renewal, and spiritual refinement. The present findings suggest that these associations are

not conveyed by iconography alone. They are materially supported by colour organization. Hue, saturation, and brightness do not merely accompany symbolic meaning; they help produce it. When colour changes, the symbolic temperature of the image changes with it. The lotus remains the lotus, but its emotional and cultural inflection is transformed through chromatic design.

Taken together, these findings contribute to current research in three ways. At the methodological level, the study provides an empirical framework for connecting computational colour extraction with audience-based perceptual analysis. At the theoretical level, it extends colour research beyond technical measurement by demonstrating that colour can be studied as an interface between perception, aesthetics, and cultural symbolism. At the practical level, the study offers a reference for animation design involving traditional Chinese visual motifs, especially when creators seek to balance historical resonance with contemporary visual expression.

More broadly, this study suggests that the chromatic study of traditional motifs should not be confined to descriptive art history or isolated image analysis. In animated cinema, colour is not only what the viewer sees; it is also how the image thinks and how culture remembers. To analyse the colour of the lotus is therefore not simply to identify a palette, but to trace the visual logic through which a traditional symbol acquires affective force, aesthetic depth, and renewed cinematic life.

This study also has limitations. The sample size remains restricted to four films and a finite number of lotus-centred frames, which means that the conclusions should be understood as analytically grounded rather than universally exhaustive. In addition, while the present study focuses on static frame-based colour extraction and audience evaluation, lotus imagery in film is also shaped by movement, editing rhythm, sound, and narrative context. Future research may therefore expand the corpus, include additional traditional motifs, and examine how colour interacts with temporality, character development, and cross-cultural reception. Such work would further clarify how traditional visual symbols continue to evolve within contemporary moving-image media.

In conclusion, the chromatic representation of lotus imagery in Chinese animated films reveals a stable yet historically variable relationship between colour structure and perceptual meaning. The lotus is not only drawn; it is chromatically articulated. Its colours do not merely decorate the screen; they organize feeling, activate memory, and sustain cultural imagination. For this reason, the study of lotus colour is also a study of how Chinese animation transforms tradition into perception, and perception into form.

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