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A Study on Color Emotion Mapping and Character Matching in Animated Films Based on Fuzzy Logic

Jingfeng Fang[1,✉]

[1] *Shanghai Institute of Visual Arts, School of New Media Arts, Shanghai, 201600, China*

ABSTRACT

As the most intuitive visual phenomenon of animated films, color has emotional characteristics that are closely related to the viewers' emotional experience. From the perspective of chromaticity and psychology, we explain the method of color emotion quantification, calculate the fuzzy affiliation degree and grey correlation degree for the uncertainty and fuzziness between color and emotion mapping, put forward the method of fuzzy grey correlation for emotion mapping in animated movies, and carry out the experiment of color emotion mapping in animated movies. Through the experiment, it is found that the character color schemes of warm, cold and neutral colors are suitable for the design of character color emotion experience in animated movies. Taking the animated film “Ne Zha: The Descent of the Magic Boy” as the research object, the correlation between color emotion mapping and character matching is further explored. Most of the H-value color blocks in Ne Zha are distributed between 0-60, which indicates warm and neutral tones, and the distribution of S-value and V-value color blocks shows a clear trend of decreasing color saturation, while the overall luminance remains basically stable. The whole film takes the proportion of red, blue, color purity changes and other aspects of color design to achieve the position of the characters, the character of the transformation of the transformation of the matching and implied.

Keywords: fuzzy affiliation, gray correlation, color emotion, animation film

1. Introduction

In the world's 3D industry in full swing today, more and more cartoon and animation characters with their three-dimensional, exquisite shape, bright and diverse colors, jumping in more and more animated films. Throughout the history of the development of the film, the metamorphosis from silent to sound, from black and white to color across, all make us see the development of the film more clearly [1-3]. As an important part of the film as an animated film, but also experienced by the development of silent to black and white, and then to the current three-dimensional color film such a relatively

✉ Corresponding author.
E-mail address: Fang197754@163.com (J. Fang).
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perfect and continuous development process, but also experienced by the black and white two-dimensional silent film to three-dimensional three-dimensional color animation of the transformation [4-6]. Animation is not only a kind of visual art, belongs to the category of film and television art, its animation scene colorful changes triggered by the different visual effects, the composition of different color elements touch the audience's emotions, affecting the audience's mood, the purpose is to let the audience to feel the author carefully designed and arranged the storyline, to experience the atmosphere of the scene with the composition of color [7-9]. Color to the viewer to bring the emotional response and association is very important, a good film to have a clever color design to set off the theme, increase the expressive power of the scene, if the animation scene does not have a reasonable color composition collocation will result in the scene performance of the void, empty [10-12]. The emotional effect triggered by the color in the animated film scene has the effect of influencing the audience's viewing mood, while the use of digital technology also enriches the color expression style, highlighting the display of individuality color, triggering visual shock. The use of color in the animation scene also has the function of influencing the plot narrative and other functions, which brings emotional triggers to the viewer, and also greatly promotes the artistic creation activities of animation scene design, and completes the beautiful and rich animation scene design works [13-16]. In addition, in animated films, character, plot and structure are three important elements, no matter how complex the plot designed by the playwright, how profound the social issues involved, first of all, there must be a standing crop of people, only the character has a unique and stable character traits, so that the character's behavior can be matched to support the logic of the entire narrative [17-19]. If the character's own character is illogical, then the character's subsequent actions and changes will not allow the audience to identify with the complete and rich plot and structure can not be unfolded, even if the forced involvement, it will give the audience a raw feeling, can not make the audience resonate also can not be through the development [20-22]. In summary, it is necessary to use fuzzy logic to study the animation film color emotion mapping and character role matching, in order to better portray the animation of rich characters and emotions, to create a scene atmosphere for the film's expression, effectively enhance the realism and richness of the picture, but also effectively increase the appreciation value of animated films [23-25].

This paper firstly starts from the perspective of chromatics and psychology, proposes the basic related theories of chromatics, and determines the research method of color emotion quantification, so as to make theoretical support for the subsequent research. The innovative scheme of using fuzzy mathematical theory and gray theory in the analysis of the influence factors of animated film competitions is proposed, and the fuzzy affiliation degree as well as the gray correlation model of animated films are established. The data related to animated movies are processed without dimension, the Spearman correlation method is chosen to establish the mathematical model of fuzzy similarity matrix, and the monotonic equation is used to evaluate the similarity degree of statistical variables, and the original gray correlation formula is simplified. The fuzzy gray correlation analysis is used to analyze the importance of the features of the animated movie, extract the set of features with strong correlation, and finally bring them into the decision-making algorithm for the prediction of the viewing experience of the actual animated movie. After clarifying the utility of color for characterization and personality expression in animated films, the color emotion mapping experiments are conducted by combining the color emotion quantification method and fuzzy gray correlation analysis method. Finally, we take the animated film “Nezha: The Descent of the Magic Boy” as the research object, and discuss and analyze the matching performance of emotion mapping and characterization in its color design.

2. Methods for Quantifying Color Emotion

2.1. Basic Theory of Chromaticity

Color perception is produced by external stimulation of human sense organs, involving optics, physiology, psychology and other aspects. From the external light stimulation to the final color perception is a complex process, chromaticity preliminary solution to the problem of quantitative description and measurement of color, to find the external light stimulation and color perception of the correspondence between.

1) Chromaticity principle. The principle of chromatics is the basis for the study of color, an important element in the field of color science, which initially solves the problem of quantitative description and measurement of color by means of psychophysical quantities, and is one of the basic theories of this study.

The system of chromaticity is based on the color matching experiment as a starting point, based on the basic fact that each color can be made using three selected primary colors mixed in the appropriate proportion. The color matching experiment is a method of using different colors of light to be added together, by adjusting the intensity of the three primary colors of light, so that the light to be measured is essentially the same as the matching light visually.

According to the color matching experiment, each light color can be mixed with a certain proportion of the three primary colors mixed color light to achieve color matching, the three primary colors most commonly used are red, green and blue. Two mutually matching colors, regardless of how the surrounding environment changes, the two colors will always remain matched. In the experiment, the number of primary colors needed to achieve a match with the color to be measured is called the triple stimulus value.

2) CIE standard colorimetric system. In order to measure the consistency of chromaticity index, CE (International Commission on Illumination) has stipulated a set of standard chromaticity system, which is based on color matching experiments and used to quantitatively describe the color, and this study involves the CIE1931-RGB system, the CIE1931-XYZ system, and the CIE1976 $L^*a^*b^*$ homogeneous color space.

(1) CIE1931-RGB system. The CIE1931-RGB system converts the experimental three primary colors to 700 nm red light R, 546.1 nm green light G, 435.8 nm blue light B, matches the various colors of the isoenergetic spectrum with an equal number of triple stimulus values within a 2° circular field of view and obtains the relative luminance units $1_R:1_G:1_R$, and measures a set of spectral triple stimulus value data $\bar{r}$, $\bar{g}$, $\bar{b}$, which is a function called the CIE1931-RGB system standard chromaticity observer spectral three stimulus values, the system is called CIE1931-RGB chromaticity system.

(2) CIE1931-XYZ system. There are negative values in the calculation of the CIE1931-RGB system, which is not conducive to the calculation and understanding, and thus a new chromaticity system has been established on the basis of the CIE1931-RGB system using the hypothetical three primary colors X, Y, Z, and the three stimulus values it matches are referred to as the CIE1931 Standard Chromaticity Observer Spectral Triple Stimulus Values, which is called the CIE1931 Standard Chromaticity System, or the CIE1931-XYZ system.

The CIE1931-XYZ system and its theory are the basis for the subsequent drawing of color analysis charts and color conversion in this study.

(3) CIE1976 $L^*a^*b^*$ uniform color space. Chromaticity system can solve the problem of quantitative color description, but in the CIE1931-XYZ color chart, the spatial distance of the color difference expressed with the visual difference is not consistent, in order to solve the problem of quantitative

judgment of color difference, so that it is in line with the visual laws of the human eye, the new color space and the related color difference formula (1), that is, the CIE1976 $L^*a^*b^*$ * uniform color space:

$$\Delta E_{ab}^{*} = \left[\left(\Delta L^* \right)^2 + \left(\Delta a^* \right)^2 + \left(\Delta b^* \right)^2 \right]^{1/2} \tag{1}$$

The biggest advantage of CIE1976 $L^*a^*b^*$ uniform color space is that it is close to the human observation perspective, and can judge the color difference very intuitively. In the uniform color space, L^* indicates brightness, ranging from 0 to 100, indicating that the color from dark to light, that is, from black to white; a^* indicates red and green, the value changes from positive to negative, indicating that the color from red to green; b^* indicates yellow and blue, the value changes from positive to negative, indicating that the color from yellow to blue.

3) Computer RGB color system. The basic law of color mixing shows that any one of the colors in nature, can be matched with a certain proportion of red, green and blue light, geometrically able to R, G, B of the three mutually perpendicular axes of the spatial coordinate system, so it is called the RGB three stimulus space or RGB color space.

2.2. Research on Quantitative Methods of Color Emotion

Color psychology is the subjective psychological reaction caused by the external objective color world, and this psychological reaction can be quantitatively described by objective psychophysical quantities. Combining psychophysical quantities with the attributes of the color itself, so as to establish a functional relationship between psychophysical quantities and color attribute parameters, i.e., the quantification of color emotion can be realized.

1) Color presentation. The presentation of color refers to whether the color is flat, three-dimensional, spatial; whether there is a sense of distance and depth; whether it is luminous, continuous, flickering or diffuse light.

2) Color properties. Hue refers to the basic appearance of color, indicating that different wavelengths of light stimulation caused by different color sensations, is used to distinguish between different colors of the most basic features; chromaticity refers to the purity of color, that is, describing the degree of saturation of color; brightness refers to the color brightness in the visual reflection of the brightness of the luminous object, the higher the luminance, the brighter the human eye feels, the higher the brightness. There is a certain correspondence between the psychological attributes of color and the physical attributes of color in the main wavelength, brightness, purity.

3) Color psychological space. In order to summarize the colors in order in the same space, the three indicators of color and three-dimensional coordinate system linked to the color and spatial location of one-to-one correspondence, each point in the space represents a specific color, the space is called the color space, representative of the color psychological space are mainly:

Mental scale of the Menzel color space, the spatial scale for hue, brightness, color; psychophysical scale of the CIE XYZ color space, the spatial scale for the three stimulus values;

The $L^*C^*H^*$-color space of the psychometric scale is derived from the homogeneous color space CIE LAB or CIE LUV.

4) Color Emotion [26]. Color emotion is another characteristic of color psychology, which refers to the fact that when a person's accumulated visual experience of color once a certain resonance with external color stimuli occurs, emotional associations will be generated, swaying people's emotions, and emotional associations are abstract associations of color.

(1) Psychophysics. Psychophysics is the science of using human responses to measure the physical properties perceived by a person on an object, the purpose is to establish a functional relationship between physical parameters and subjective responses, the laws of the relationship between psychological and physical quantities are: Weber's law, logarithmic law, power law.

(2) Semantic Analysis. Semantic analysis method (SD method for short) is to use the semantic semantics "language" as the scale of psychological experiments, through the analysis of the established scale, quantitatively describe the concepts and structures of the research object, has become one of the basic methods of psychological assessment of the amount of spatial environmental relevance.

3. Fuzzy gray correlation analysis method for animated films

In this paper, the use of fuzzy mathematical theory and gray theory in the analysis of influencing factors of animated films is an innovative solution. At present, in the field of correlation analysis and evaluation, the fuzzy comprehensive judgment method and gray correlation method are widely mentioned, which have certain limitations due to their specific problems [27-28]. The main reason for the fuzzy nature between factors is that there is an intermediate transition of judgment between various factors in the process of distinguishing the different ones, containing the connection of containing each other. However, in the process of containing each other still exists this objective difference, further comparison can be clearly derived in the previous stage of the relationship between each other contain information, in the next stage may not contain a very strong connection.

The affiliation function as a fuzzy theory in the evaluation of the fuzziness of the affairs of the important evaluation, at the same time is the correlation analysis method of the main components [29]. In this paper, based on Spearman's correlation coefficient model and Deng's gray correlation analysis model based on the principle of proximity, we use the displacement difference to separate the degree of importance between different columns, and analyze the correlation sequences according to the calculated correlation, so as to judge the degree of correlation between different factors based on the correlation sequences, and to construct fuzzy degree of subordination as well as the gray scale correlation model.

3.1. Raw data processing

Data standardization can significantly reduce the data error generated by the model prediction due to the different scale of variables. For the traditional grey correlation analysis method often use the initial value or a single homogenization for data processing, this paper cites the data interval dimensionless transformation and the traditional fuzzy clustering in the polar deviation transformation is similar to that of the comparison of the data in the sequence $X_i(i=1,2,\cdots,n)$ dimensionless processing.

3.2. Fuzzy affiliation and gray scale correlation calculation

In order to ensure that the model is inclusive of all information and can reduce the impact of linear proportionality of data, this paper chooses the Spearman correlation method, which is commonly used in statistics, to build a mathematical model of fuzzy similarity matrix, which is also used as a non-parametric indicator of the dependence of the two variables, and the use of monotonic equations to evaluate the degree of similarity of the two statistical variables, and is insensitive to the response to the data errors and extremes of the values. It is expressed in the form of:

$$\rho = \frac{\sum_{i=1}^{N}(x_i-\bar{x})(y_i-\bar{y})}{\left[\sum_{i=1}^{N}(x_i-\bar{x})^2\sum_{i=1}^{N}(y_i-\bar{y})^2\right]^{\frac{1}{2}}} \tag{2}$$

where x_i, y_i are the ranks of the values taken by the influencing factors i, $\overline{x}$, $\overline{y}$ are the evaluation ranks of the variables x, y, and N is the total number of influencing factors.

The correlation coefficient $\xi_{ij}(k)$ for the comparison sequence X_i against the reference sequence Y_i at $i=k$ can be determined by the following formula:

$$\xi_{ij}(k)=\frac{\Delta_{\min}+\rho\Delta_{\max}}{\Delta_{ij}(k)+\rho\Delta_{\max}} \tag{3}$$

where $\Delta_{\min}$ and $\Delta_{\max}$ are the absolute magnitude of the maximum and minimum values of the influences in Y_i and X_i, respectively. $\Delta_{ij}(k)$ for Y_i and X_i in the K th point of the absolute value of the difference. ρ is the discriminant coefficient, that is, the weight of the maximum and minimum values, need to meet the consistency of interference and correlation. The mean value of the difference between the absolute value of the great value and the very small value is calculated, followed by determining the value interval of ρ based on the ratio of Δ to $\Delta_{\max}$. The formula of the calculation method is as follows:

$$\overline{\Delta}=\frac{1}{n\cdot m}\sum_{j=1}^{m}\sum_{k}^{n}\left|y_t(k)-x_{ij}(k)\right| \tag{4}$$

Due to the calculation of correlation coefficient will lead to numerous calculation results, in order to be able to facilitate the comparison and analysis of this time the correlation coefficient will be concentrated to show the effect of a value, that is, the gray correlation degree. Due to the many factors affecting animated films, this paper is based on the simplification of the original gray correlation formula can be obtained:

$$\zeta_{ij}(k)=\frac{1}{n}\sum_{k=1}^{n}w(k)\gamma_{ij}(k)w(k)=1 \tag{5}$$

3.3. Fuzzy gray correlation analysis of animated films

According to the fuzzy affiliation degree ρ and gray correlation degree ξ_{ij} is calculated a kind of animation film influencing factors of a judgment comprehensive evaluation index, that is, this paper refers to the fuzzy gray correlation degree R_{ij} its formula is as follows:

$$R_{ij}=\frac{\rho+\xi_{ij}}{2}=\frac{\dfrac{\sum_{i=1}^{N}(x_i-\overline{x})(y_i-\overline{y})}{\left[\sum_{i=1}^{N}(x_i-\overline{x})^2\sum_{i=1}^{N}(y_i-\overline{y})^2\right]^{\frac{1}{2}}}+\dfrac{1}{n}\sum_{k=1}^{n}w(k)y_{ij}(k)}{2} \tag{6}$$

Initial data processing for feature construction and reasonable supplementation of missing data. The extracted seven types of feature data features are analyzed for importance using fuzzy gray correlation analysis to extract the set of features with strong correlation. Finally, it is brought into the decision-making algorithm to predict the actual animated movie viewing experience.

4. Color on the characterization and personality expression of animation film characters

Characters in animated films are expressed in the designer's mind and hands, they all have their personalities, especially the main characters in animated films have their outstanding character and qualities, so how can the designer express the character image and unique temperament in his mind to the screen and on the screen, in addition to the need for a very clear image outline and action characteristics, but also can't be detached from the good use of color color, color is very intuitive and

exciting, it brings the first visual experience is very important, it can trigger a kind of emotional experience in the viewer's ordinary life into the work more emotional experience. Visual effect is very intuitive and very stimulating, it brings the first visual feeling is very important, it can trigger a kind of viewers in the life of the relative emotional experience, the emotional experience of life into the work more image to enrich the character personality and temperament of the animated cartoon positioning and the color has a very strong symbolic and allegorical function is inseparable.

Lovely characters we can generally use high purity, color saturation of bright colors to show the lovely temperament for the evil characters, the general use of brightness and purity are relatively low turbid color to show plus brown, gray, dark green and other relatively dark colors to reflect the character's dark psychology. Noble, elegant temperament type of role we generally have to use purple and blue these high-profile bright colors to accentuate the role of the inner temperament of the character image through the psychological implication to the viewer of the spirit and full of the character of the inner character traits.

The effect of the final animated film how, for the viewer to bring how the visual experience and memory, can not be separated from the color of the animated film character role modeling and personality performance. Through the emotional mapping of color, the abstract concept is transformed into a visual image of character temperament, so that the inner spiritual world of the character is externalized.

Next, this paper will be based on the color emotion quantification method proposed in the previous paper, combined with the fuzzy grey correlation analysis method of animation film, to explore the connection between the color matching design of animation film characters and emotional experience, so as to provide a reference basis for the color matching design of animation film characters.

5. Experiments on Color Emotion Mapping in Animated Films

In this chapter, we will take animated movie characters as the research object, and collect cases of animated movie characters' color according to three basic color systems: warm color system, cold color system and neutral color system, and obtain a total of 15 cases as the experimental samples of this product color multidimensional emotional experience test, and the corresponding color schemes of different samples are shown in Table 1. Among them, C1~C5 are warm color cases, C6~C10 are cold color cases, and C11~C15 are neutral color cases. The number of color combinations of each case is 3-color matching ratio.

Table 1. Test sample of character color case

Number	Specific color	Color system
C1	Red, black, light grey	Warm color system
C2	Orange-red, light grey, dark grey	
C3	Light pink, light grey, dark grey,	
C4	Deep pink, black, dark grey	
C5	Yellow, light grey, black	
C6	Light green, light grey, dark grey	Cold color system
C7	Dark green, black, shallow brown	
C8	Light blue, dark gray, light grey	
C9	Dark blue, dark brown, black	
C10	Purple, light grey, dark grey	
C11	White, brown, dark grey	Neutral color system
C12	Dark gray, dark brown, light grey	
C13	White, light gray, dark grey	
C14	Dark gray, light brown, dark grey	
C15	Light gray, white, dark grey	

5.1. Color scheme design and emotional experience analysis

Twenty target users with some knowledge or viewing experience of animated movies were recruited as subjects for the multidimensional emotion measurement of character color in animated movies. The closeness between the PAD measurements of each case and the 8 basic emotion PAD reference values is specifically shown in Table 2. As can be seen from the table, there are cases of positive and negative polarity color matching in the three basic color families of warm, cool and neutral colors. Among them, the color matching cases that can lead users to produce negative emotions are warm color cases C1, C2, C4, cold color cases C7, C10, neutral color cases C12, C14, which indicates that the basic color system should be used to configure and moderately reduce the warm color system such as crimson, orange-red and other warm color as the main hue of the color matching design, to avoid the user to produce hyperactivity, agitation and other emotional reactions. Secondly, the color matching cases corresponding to the three basic color systems all have color matching cases that are easy to cause users to produce negative emotional characteristics of aversion. As can be seen from the visual expression of the color matching cases, the warm color case C4 and the cold color case C7 both use colorful or retro product color scheme as the main tone, and the auxiliary colors are all black, the overall color scheme design style and the animation movie character character fit is low. The neutral color system case C14 color module, although the chromaticity close to the neighboring colors, but the main body color of cooked brown, easy to lead to the overall product color tone gray, and then cause the user to produce unclean, fuzzy psychological feelings. Finally, C10 and C12 are prone to triggering negative emotional traits of contempt and boredom in users. Although the overall color scheme of C10 is relatively harmonious, some subjects said that the color scheme of the characters, which is mainly purple-gray, is too exotic and individualistic, which is easy to trigger the audience to produce the psychological association of cheap and frivolous colors. C12 due to the black accounted for a large area, and auxiliary colors and accent colors are saturated gray system, easy to cause color matching single, bulky color visual perception.

Table 2. Statistical results of PAD emotional experience tendency

Number	Actual PAD measurement			PAD emotional experience tendency							
				Positive emotion				Negative emotion			
	Pleasure (P)	Activation (A)	Dominance (D)	Joy	Ease	Wonder	Dependence	Boredom	Anxiety	Flouting	Revulsion
C1	-0.9874	0.5248	-0.513	4.2803	3.734	3.0459	2.1493	1.8616	0.2391*	1.6549	1.4395
C2	-0.6746	0.3623	0.9494	3.579	3.0428	2.8439	2.9015	2.413	1.6042	0.9078*	1.1594
C3	2.0243	1.124	1.074	0.8245*	1.7936	1.0789	3.5983	3.9786	3.5216	3.6937	3.9135
C4	-1.8883	0.4616	0.6757	4.775	4.2464	3.8432	3.3837	2.659	1.6122	0.4827	0.1078*
C5	1.7373	0.9383	0.2372	1.5929	1.8485	0.7728*	2.7964	3.329	2.8898	3.4644	3.6046
C6	2.1126	0.9385	1.1507	0.7621*	1.6032	1.272	3.5963	3.9651	3.595	3.7458	3.9785
C7	-1.7757	0.4381	0.8634	4.6443	4.1184	3.7742	3.4242	2.7019	1.7096	0.2765	0.1988*
C8	1.9632	-0.688	0.938	2.1182	0.2556*	2.5152	2.8871	3.1119	3.4572	3.6843	3.9251
C9	0.4252	-0.763	-1.3369	4.1217	2.9707	3.1973	0.1546*	1.183	1.8872	3.2787	3.215
C10	-1.363	0.338	0.9122	4.2549	3.6914	3.4455	3.1789	2.5079	1.5968	0.2423*	0.5042
C11	2.7255	1.1124	1.3617	0.1216*	1.8775	1.6356	4.1498	4.5862	4.2541	4.3904	4.6321
C12	-0.4877	-0.975	-0.7882	4.5014	3.2629	3.6195	1.129	0.2835*	1.3831	2.4779	2.3958
C13	2.1249	-0.612	0.776	2.0371	0.2861*	2.4218	2.8526	3.1729	3.5069	3.8284	4.0543
C14	-1.7876	0.3122	0.6132	4.7141	4.119	3.7964	3.2223	2.4762	1.4993	0.4573	0.1056*
C15	0.3507	-0.775	-1.3259	4.164	3.0073	3.2314	#VALUE!	1.1108	1.8369	3.2285	3.16
The data of the target * show the user emotional experience tendency of 15 groups of product color cases.											

5.2. Color scheme design evaluation and fuzzy gray correlation analysis

The color matching form of the cases that tends to trigger negative and negative emotional tendencies in the audience is not the main color matching content in animated movies. In this section, we will focus on discussing the color matching of cases with positive and positive emotional tendencies, and delete the above seven groups of color matching cases that are prone to triggering negative emotions in users and renumber them with D1~8. The 20 users who had participated in the pre-PAD emotional experience measurement were invited as the subject group of the color emotional experience evaluation. Pleasure, activation, dominance and satisfaction were used as the assessment indexes, and the assessment thresholds ranged from -4 to 4, i.e., -4 for strong disagreement and 4 for strong agreement.The mean value of the assessment results of the emotional experience of the 20 subjects for the 8 groups of color schemes was solved to obtain the raw data of the assessment of each color scheme, and fuzzy grey correlation analysis was performed on the raw data to calculate the fuzzy affiliation and gray correlation, obtain the fuzzy gray correlation degree of each color scheme, and complete the priority ranking of the color emotional experience design scheme for home humidifier. The evaluation results of fuzzy gray correlation analysis are shown in Table 3. As can be seen from the table, the priority ranking of the emotional experience assessment of this color scheme is D6, D4, D1, D7, D3, D2, D5, D8. Among them, the top-ranked schemes are D6, D4, D1, and D7, which are the preferred schemes, with fuzzy gray correlations of 0.9455, 0.87525, 0.82355, and 0.74525, respectively. The results show that warm, cool and neutral colors are suitable for the design of color emotional experience of animated film characters.

Table 3. Analysis of fuzzy grey correlation analysis

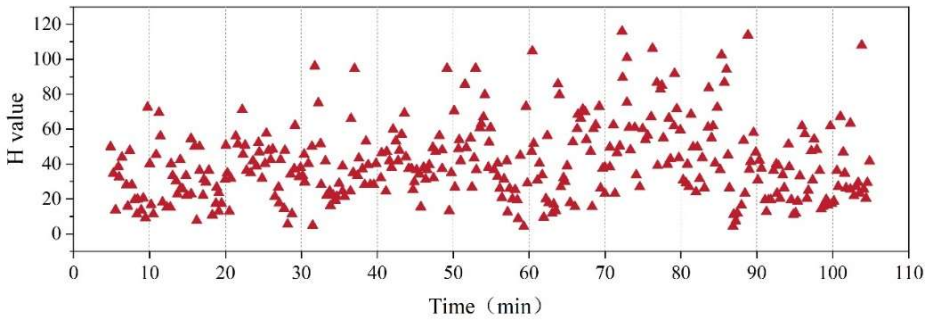
Number	Fuzzy membership	Gray correlation	Fuzzy grey correlation	Priority sort
D1	0.9713	0.6758	0.82355	3
D2	0.8325	0.4786	0.65555	6
D3	0.9559	0.4838	0.71985	5
D4	0.9865	0.764	0.87525	2
D5	0.7525	0.3842	0.56835	7
D6	0.9971	0.8939	0.9455	1
D7	0.961	0.5295	0.74525	4
D8	0.6582	0.3452	0.5017	8

6. Analysis of Color Emotion Design and Character Matching in Animated Films

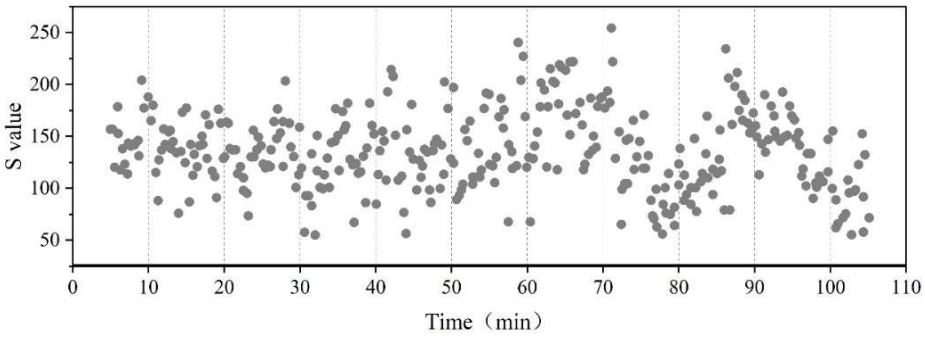
In this chapter, we will take the Chinese animated film “Nezha: The Descent of the Magic Boy” (hereinafter referred to as “Nezha”), which will be released in the summer of 2019, as the object of study and explore its performance in terms of color emotion design and character role matching.

6.1. Color presentation analysis

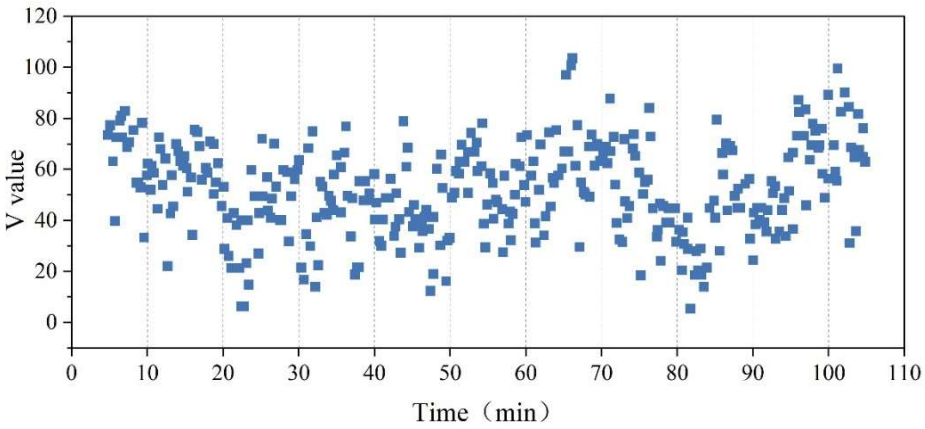
A total of 360 images of the animated film “Ne Zha” were intercepted by using the cut shot as the standard, and the HSV of all the images were analyzed after numbering, and the HSV values of the main body color of the film are specifically shown in Fig. 1. Figures (a), (b) and (c) show the distribution of H, S and V values of the images, respectively. From the distribution of the color blocks of H value in the figure, it can be seen that the film in the middle and late cold tones gradually increase, but the distribution of the color blocks between 0-20 is still relatively more, which means that the film's use of warm colors is more prevalent, and the other color blocks are concentrated in the distribution of the warm tones and neutral tones between 0-60. In the distribution of S-value color blocks, the final color saturation of the film shows a clear trend of decreasing, through the use of low saturation to express the depressing, dull and melancholic atmosphere. The overall brightness of the film is basically stable in the distribution of V-value color blocks.



(a)H value



(b)S value



(c)V value

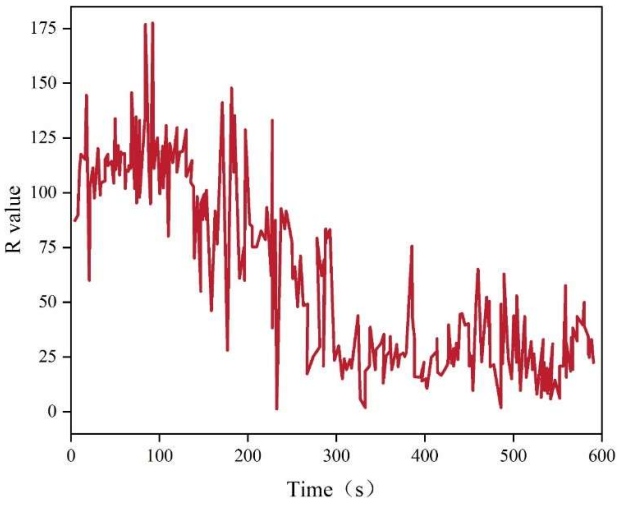
Fig. 1. HSV value

6.2. Color change analysis

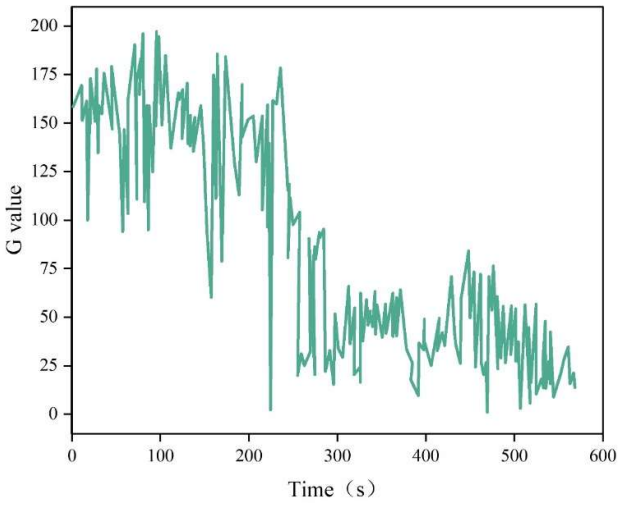
The design of this paper employs 1/24th frame extraction to generate several pictures arranged according to the same amount of time axis as the movie. In order to specifically reveal the rhythm of color change inherent in the animated movie, the red, green and blue (RGB) in each picture is taken as the basic variable, and through the code writing, so as to realize that, within a short period of time, with the time axis as the coordinates, the color change value of the pictures under the specific number of frames of the whole movie is calculated and the visualization curve is generated, compared with the subjective viewing experience, the quantified red, green, blue degree of red, green and blue degree of change, which is also the time axis as the coordinate, more clearly expresses the characteristics of the animated movie. Compared with the subjective viewing experience, the quantized red, green and blue color changes in the same time-axis coordinates more clearly represent the characteristics of animated movies. On this basis, a comparative sample analysis is further made for the Ne Zha movie.

The movie clip sample analyzed in this section is the drama clip from 1:43 to 11:16 in “Ne Zha”, which is the prelude to the appearance of Tai Yi Zhen with the Spirit Pill and Demon Pill, and the birth of the demonic child Ne Zha. Under the premise of common time axis, combining the color implied effect and change trend of R, G and B values in the color of the pictures, the change curves of the three respectively from the opening of 1:43 to 11:16 are further generated, as shown in Fig. 2. Figures (a), (b), and (c) show the trends of the R, G, and B values of the images, respectively. As can be seen from the figure, in line with the unfolding of the plot and the emergence of contradictions, the red pixel scene hue ratio maintains a small difference fluctuation before and after the scene, while the green color that affects the brightness of the screen and the blue color that affects the color temperature of the screen develops along with the unfolding of the plot, and the alternation of the screen from light

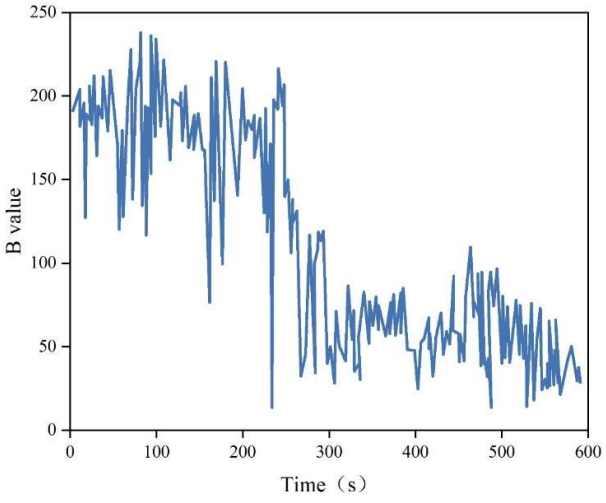
to dark implies the development of the story as well as the “uneasiness” and “negativity” that Nezha himself was born with, Based on the audience's strong positive color correlation, the first contradiction in the narrative structure of Nezha's birth scene unfolds in front of the audience as the screen changes from the bright color of the opening scene to the dark red color. The change in the main color of the scene strengthens the audience's visual and psychological feelings of the film's immersion, which is conducive to the realization of good “interactive sympathy”. The change of the main color of the scene strengthens the audience's visual and psychological feelings on the film immersion, laying a good foundation for the realization of good “interactive sympathy”, and playing a significant positive impact.



(a)R value



(b)G value



(c)B value

Fig. 2. RGB value

6.3. Color Emotion Design to Match the Expression Needs of Character Roles

The color analysis of the data in the movie “Ne Zha” to generate a three-dimensional map, as shown in Figure 3. Establishing the same 1/24 frame sample, the red and blue proportion in the development of the time axis of the comparative graphic (Y axis is the time axis, XZ axis is the proportion of R value and B value), the film “Ne Zha” contrast color is strong, the color aesthetics of the film in the high frequency conveyed to the majority of the audience, the hue is rich and harmonious, the essence of the film is also to cater to the needs of the contemporary people's preferences in the pursuit of strong

visual stimulation, the color contrast is rich in order to meet the needs of The color contrast is rich to satisfy the people's experience of watching movie scenes, combined with the national tradition of using colors. For example, during Nezha's third birthday, when the thunderbolt is about to strike, Shen Gongbao deliberately sabotages and distorts the truth, implying that Ao Beng will destroy Chen Tang Pass to protect the dragon family. At this point, Ao Beng's sky-blue clothing begins to fade with the scene and is replaced by a pillar of water that fills the sky in the next shot, and the decrease in the purity of the blue color implies a transformation of Ao Beng's character from goodness to a murderous aura at this moment. When Nezha returns to the scene after realizing the truth, the contrast between the grey background and the dark grey-blue color of Nezha's coloring tends to change from the initial dark red to a brighter red, which shows the transformation of Nezha's character from goodness to kindness in the same way that the brightness is increased. The contrast between light and dark colors also puts the audience into the narrative space of the animated film, where emotions are rapidly transformed, pushing the audience to “sympathize” with the plot, with the power to touch people's hearts and suggest their feelings.

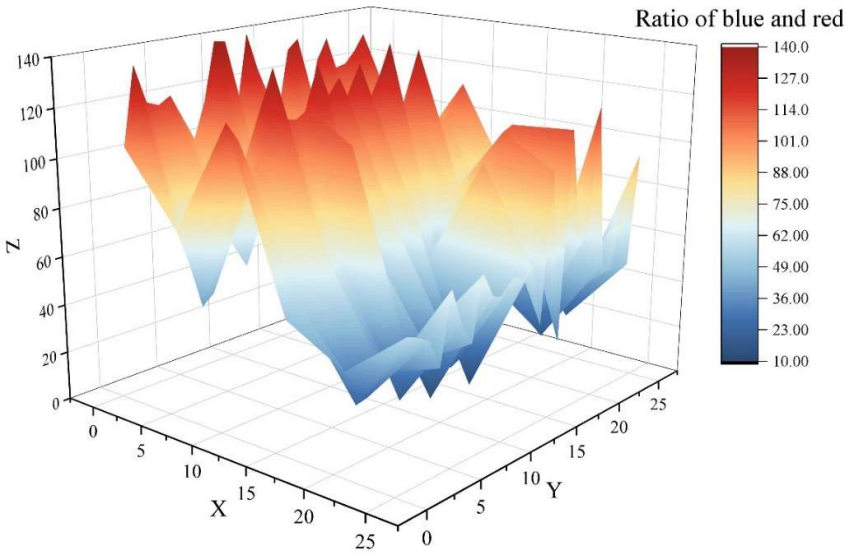


Fig. 3. Three-dimensional graph of color data

7. Conclusion

This paper proposes the color emotion quantification method, fuzzy affiliation and grey scale correlation related theories as the research method of color emotion mapping and character matching in animation movies, and proposes the fuzzy grey scale correlation mapping method of color emotion in animation movies. To make clear the importance of color for character image building and personality expression in animated films, we conduct color emotion mapping experiments based on color emotion quantification and fuzzy gray scale correlation analysis method. In the fifteen color matching cases from C1 to C15, there are positive and negative color matching cases in the three basic color systems of warm color, cold color and neutral color, and the color matching cases in the color design of the characters' corners should be moderately reduced to reduce the color matching of the warm color system such as crimson, orange-red and other warm colors as the main color tones, so as to reduce the audience's exuberance, agitation and other emotions. Remove the negative, negative emotional tendency of the audience to produce the case of color matching form and case renumbering, through the fuzzy gray correlation analysis of D6, D4, D1, D7 for the optimal color design scheme, fuzzy gray correlation were 0.9455, 0.87525, 0.82355, 0.74525, verified that both the warm color system, the cold color system and the neutral color system are applicable to the design of color emotional

experience of animated film characters. In the subsequent case study, Ne Zha: The Descent of the Magic Boy was chosen as the research object to discuss the color emotion design and character matching. In terms of color presentation, Ne Zha's H-value color distribution is concentrated in the 0-60 range, which represents warm and neutral tones. The S-value color distribution shows a trend of decreasing color saturation in the later stages of the film, while the V-value color distribution shows that the film basically maintains a stable brightness throughout the entire film. In the episode of "Ne Zha" from 1:43 to 11:16, the trend of R, G and B values brings a strong positive color correlation to the viewers, which strengthens the visual and psychological feelings of the viewers. Based on the three-dimensional chart of Ne Zha's data and color data, the entire film is designed to realize the implied transformation of the positions and personalities of the characters Ao Bi and Ne Zha with the help of the ratio of R value and B value and the changes in the purity of blue and red, so as to bring about a rapid transformation of the animated film's own emotions and touch the audience's emotions.

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