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RESEARCH ARTICLE

The application of color psychology in the psychological shaping of animated characters in Shanxi dough Sculpture

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ABSTRACT

This study focuses on the application of Shanxi dough sculpture color in the psychological shaping of animated characters, and deeply integrates color psychology theory to conduct a comprehensive exploration. Shanxi dough sculpture, as an intangible cultural heritage with strong regional characteristics and cultural value, carries rich cultural connotations and unique artistic charm in its color system. Research has found that people have different psychological perceptions of the color of Shanxi dough sculpture under different social and cultural backgrounds. For example, in festive cultural backgrounds, red often conveys a warm and joyful psychological feeling, while in some solemn cultural scenes, white may symbolize purity and solemnity. When animated characters incorporate elements of Shanxi dough sculpture, their psychological perception based on these colors will affect the audience's psychological cognition. Integrating the colors of Shanxi dough sculpture into the psychological shaping of animated characters can inject profound traditional Chinese cultural connotations into animated works, enhance the cultural identity and artistic appeal of animated characters, help animated works stand out in the international market with unique cultural charm, and promote the formation of a creative style with local characteristics in the Chinese animation industry. At the same time, with the help of modern animation as a digital art form, the color of Shanxi dough sculpture has been widely spread, allowing more audiences to recognize its value. The innovative application of traditional dough sculpture colors through modern technological means has achieved the inheritance and development of intangible cultural heritage in the contemporary context, promoted the organic integration of traditional culture and modern digital art, and opened up a new path for the inheritance and innovation of intangible cultural heritage in the field of digital art. The research results have important theoretical support significance for the localization creation of the animation industry.

Keywords: Shanxi dough sculpture; color psychology; animated characters; psychological shaping; color extraction

1. Introduction

In today's globalized cultural context, the animation industry, as one of the core forces of cultural and creative industries is flourishing. However, in the wave of pursuing an international style, many animated works have gradually lost their roots in local culture, and character development lacks depth and cultural connotations, making it difficult to form a unique cultural identity in the international market. Shanxi dough

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sculpture, as a national intangible cultural heritage, carries the profound historical culture, folk beliefs, and unique aesthetic concepts of Shanxi region. The use of color follows the principle of "three parts plastic, seven parts color"[1]. Color is not only an important manifestation of the external beauty of dough sculpture art, but also contains rich cultural connotations. Red is closely associated with celebrations and blessings in traditional Chinese culture, symbolizing auspiciousness and celebration. In dough sculptures, it conveys people's longing for a better life. Black is commonly used for specific sacrificial or ceremonial dough sculptures, representing solemnity and adding a solemn and sacred atmosphere. Yellow, due to its close connection with the land and crops, symbolizes a bountiful harvest and embodies people's expectations for a prosperous life[2].

From the perspective of color psychology, different colors can trigger vastly different psychological perceptions in different social and cultural backgrounds. When the design of animated characters incorporates elements of Shanxi dough sculpture, it will have a unique impact on the audience's psychological cognition. Viewers have an instinctive perception and response to colors when watching animations. The cultural significance contained in the colors of Shanxi dough sculpture will be subtly accepted by the audience, thereby influencing their understanding and emotional resonance of the animated characters. Taking the animated characters with red dough sculpture colors as an example, based on the recognition that red represents auspiciousness and joy in traditional culture, the audience is more likely to feel the vitality and enthusiasm of the characters, and develop a sense of closeness towards them; Animated characters with black dough color elements will make the audience feel that the characters have mysterious and stable qualities. The character with the color of yellow dough sculpture may make the audience think that the character is full of hope and abundance. This psychological cognition based on the cultural connotation of dough sculpture color enriches the audience's perception dimension of animated characters, making the image of animated characters in the audience's mind more three-dimensional and vivid.

Integrating the colors of Shanxi dough sculpture into the psychological shaping of animated characters has significant implications in various aspects. From the perspective of the development of the animation industry, this integration can inject unique Chinese traditional cultural genes into animated characters, enhance the cultural recognition of animated works, and improve the cultural competitiveness of Chinese animation in the international market. From the perspective of intangible cultural heritage inheritance, with the widespread dissemination and influence of animation, Shanxi dough sculpture, as an intangible cultural heritage, can break through the limitations of regional and traditional dissemination methods, be recognized and loved by a wider range of people, and achieve digital inheritance and innovative development of intangible cultural heritage. From the perspective of color psychology, different colors have a significant impact on human psychology and emotions. Applying the color of dough sculpture to the shaping of animated characters can use the psychological effects of color to more accurately convey the character's personality, emotions, and inner world, enhance the character's infectiousness, and promote emotional resonance between the audience and the character.

2. Materials and methods

2.1. Selection of research subjects

This study carefully selected 12 highly representative dough sculpture images from Shanxi region, covering various themes such as characters, animals, and auspicious patterns. As a specific dough sculpture for the Cold Food Festival, the use of colors in "HanShiGongXian" dough sculpture is closely related to the traditional worship of Cold Food Festival, carrying people's remembrance of ancestors and the inheritance of traditional customs. The "LongFengChengXiang" dough sculpture dough sculpture is commonly used in festive occasions such as weddings, and its shape and color contain beautiful wishes for the happiness,

happiness, and good fortune of the newlyweds. "Fushou" dough sculpture is mainly used for birthday banquets to express prayers for longevity and happiness of the birthday star[3]. These dough sculptures have different styles and comprehensively reflect the artistic characteristics, cultural connotations, and regional styles of Shanxi dough sculptures from different perspectives, ensuring that the research samples have broad cultural representativeness and rich visual diversity.

2.2. Color extraction techniques and methods

To obtain accurate and reliable color data for dough sculpture, this study used the color gamut analysis tool of professional image processing software Adobe Photoshop CC 2023 for color extraction. Before extraction, professional photography equipment is used to capture high-definition images of the dough, with uniform and stable ambient lighting. Standard color temperature light sources are used, and auxiliary equipment such as reflectors and light shields are used to capture the dough sculpture from all angles and multiple angles to obtain complete color information.

From the perspective of color psychology, different colors and their combinations can trigger diverse psychological perception differences among audiences. Taking the colors in these cases as an example, high saturation color combinations often bring strong visual impact, stimulating the audience's warm, cheerful, and energetic emotions. A combination like M98 and Y93 is like a lively celebration scene, making people excited. The combination of M99 and Y100 creates a joyful festive atmosphere, full of vitality. And low saturation colors, such as M4 and Y12, give people a fresh and soft feeling, like a spring breeze, soothing and relaxing. Dark colors such as K85 create a mysterious and profound atmosphere, arousing the audience's curiosity. The combination of M52 and Y0 presents a stable and calm character, making people feel at ease. Warm color combinations, such as M64 and Y88, can create a warm and lively atmosphere, like a warm winter sun. Y98 and other single high saturation warm colors further stimulate hope and vitality. In addition, different color combinations can also bring unique feelings. The combination of M11 and Y71 is soft and comfortable, like a gentle touch; The warm and cheerful atmosphere created by M46 and Y89 is like a joyful moment of family reunion. These color perception differences not only enrich the emotional experience of the audience, but also provide strong psychological basis for artistic creation and design, enabling them to more accurately touch the audience's heart.

Table 1. Representative Huamo Color Gene Map

Name	Case Pictures	Color extraction		
ZaoShan			C:0 M:98 Y:93 K:64 C:0 M:4 Y:12 K:4	The combination of M98 and Y93 with high saturation brings a strong visual impact, making people excited and feel a warm and cheerful atmosphere; The low saturation M4 and Y12 make people feel fresh, soft, and have a soothing and relaxing feeling.
HanShiGongXian			C:0 M: 167 Y:160 K:20 C:52 M:6 Y:0 K:17 C:0 M:41 Y:19 K:2 C:3 M:0 Y:1 K:72 C:0 M:7 Y:63 K:4 C:0 M:9 Y:20 K:9 C:39 M:0 Y:34 K:25	Diverse color combinations, high saturation M167 and Y160 evoke a sense of passion and vitality; M52 and Y0 present a steady and calm demeanor; M7 and Y63 with low saturation bring a warm and gentle experience.

Name	Case Pictures	Color extraction		
			C:33 M:0 Y:51 K:13	
Han Yan'er			C:0 M:5 Y:3 K:85 C:0 M:36 Y:97 K:2 C:27 M:0 Y:100 K:40 C:0 M:0 Y:8 K:13 C:0 M:61 Y:58 K:64	The dark color scheme of K85 creates a mysterious and profound feeling; M36, Y97 high saturation combination stimulates vitality and enthusiasm; M61 and Y58 bring warmth and familiarity.
XiMo			C:0 M:74 Y:62 K:5 C:0 M:11 Y:71 K:6 C:0 M:22 Y:15 K:5 C:0 M:1 Y:5 K:11 C:21 M:0 Y:92 K:67 C:0 M:40 Y:73 K:29	The combination of M74 and Y62 creates a lively and warm atmosphere; The combination of M11 and Y71 makes the audience feel soft and comfortable; The dark color combination of M21, Y92, and K67 brings a sense of stability and heaviness.
MianRen			C:98 M:43 Y:0 K:7 C:78 M:0 Y:25 K:41 C:78 M:0 Y:25 K:41 C:0 M:1 Y:5 K:11 C:0 M:9 Y:26 K:95 C:0 M:46 Y:89 K:8 C:0 M:37 Y:25 K:13 C:0 M:29 Y:11 K:61	The high saturation red tone of M98 and Y0 conveys warmth and positivity; M1 and Y5 low saturation colors make people feel fresh and natural; M46 and Y89 create a warm and cheerful atmosphere.
DuoZiZhengTou			C:0 M:0 Y:4 K:4 C:0 M:56 Y:57 K:19 C:0 M:56 Y:57 K:19	Y4 with low saturation brings a pure and peaceful feeling; The combination of M56 and Y57 creates a soft and warm atmosphere, triggering inner peace and joy.
XiaoShi			C:0 M:20 Y:98 K:4 C:0 M:54 Y:99 K:15 C:100 M:0 Y:80 K:98 C:97 M:18 Y:0 K:13 C:0 M:80 Y:97 K:40 C:0 M:2 Y:15 K:18	Y98 and Y99 with high saturation bring a lively and cheerful feeling; The dark combination of M100, Y80, and K98 gives a solemn and profound impression; M2 and Y15 low saturation colors make people feel fresh and soft.
JuBaoPen			C:0 M:64 Y:88 K:22 C:0 M:12 Y:98 K:3 C:0 M:2 Y:7 K:6 C:0 M:35 Y:100 K:7	The combination of M64 and Y88 creates a warm and lively atmosphere; Y98's high saturation yellow color inspires vitality and hope; M35 and Y100 bring strong joy and positive feelings.
LongFengCheng Xiang			C:0 M:12 Y:93 K:4 C:28 M:0 Y:11 K:12 C:0 M:6 Y:19 K:9 C:0 M:29 Y:19 K:12	Y93's high saturation yellow conveys joy and auspiciousness; The combination of M28 and Y11 presents a steady and gentle appearance; M61 and Y63 create a warm and

Name	Case Pictures	Color extraction		
			C:0 M:37 Y:34 K:4 C:0 M:61 Y:63 K:23 C:0 M:35 Y:100 K:7	harmonious atmosphere.
Niannianyouyu			C:6 M:0 Y:80 K:32 C:0 M:43 Y:33 K:9 C:0 M:17 Y:96 K:12 C:0 M:5 Y:24 K:1	Y80's high saturation yellow brings vitality and hope; The combination of M43 and Y33 makes people feel warm and comfortable; M17 and Y96 stimulate joyful and positive emotions.
FuShou			C:0 M:75 Y:82 K:19 C:0 M:50 Y:75 K:43 C:0 M:21 Y:24 K:8 C:38 M:0 Y:97 K:18 C:0 M:5 Y:20 K:6	The combination of M75 and Y82 creates a cheerful and auspicious atmosphere; M50 and Y75 show warmth and stability; M38 and Y97 inspire enthusiasm and positive feelings.
XiQueDengMei			C:100 M:46 Y:0 K:40 C:0 M:99 Y:100 K:13 C:0 M:36 Y:63 K:78 C:90 M:0 Y:44 K:64 C:0 M:2 Y:7 K:1 C:0 M:32 Y:33 K:6	The high saturation red tone of M100 and Y0 conveys warmth and celebration; The combination of M99 and Y100 brings joy and vitality; M36 and Y63 create a warm and romantic atmosphere.

Table 1. (*Continued*)

In Photoshop software operation, multiple local samples are taken for different parts of each dough sculpture image. For areas with uniform color distribution, select multiple sampling points to calculate the average value to reduce errors. For areas with complex color transitions or multiple color blends, dense sampling is performed based on color gradient and direction to accurately capture subtle color changes. Taking "HanShiGongXian" dough sculpture as an example, multiple samples were taken from its main high saturation red area to determine the main color tone as [C: 0 M: 167 Y: 160 K: 20]. Accurate CMYK values were obtained by finely sampling the gold auxiliary color, laying a solid data foundation for subsequent research (See Tbl. 1 for more details).

2.3. Building an evaluation system

In order to comprehensively and objectively evaluate the effect of Shanxi dough sculpture color on the psychological shaping of animated characters, a multi-dimensional evaluation system is constructed. From the dimension of character personality shaping, consider whether the presentation of color on character personality traits is vivid and accurate. In the dimension of emotional expression, analyze whether colors can effectively convey the emotions of characters and trigger emotional resonance among the audience. Observing the fit between color changes and the psychological development process of characters in terms of psychological growth and transformation dimensions[4]. Quantitatively evaluate each dimension through expert scoring, audience questionnaire surveys, and data analysis.

3. Results

3.1. Color classification and characteristics of Shanxi dough sculpture

After analyzing the extracted 78 sets of CMYK color data, three major categories of colors were summarized. Symbolic main colors dominate in dough sculpture works and are closely related to specific cultural meanings. The vermilion red color of "Fushou" dough sculpture symbolizes auspiciousness, longevity, and prosperity in traditional Chinese culture, and is often used to celebrate longevity ceremonies, carrying profound cultural connotations. From a historical perspective, the production process of vermilion was complex in ancient times. It was used as a color for palace and aristocratic costumes and decorative objects, representing nobility and authority. Later, it was integrated into folk culture and passed down in dough sculpture.

Functional auxiliary colors are used to enhance the shaping effect and visual expression of dough sculpture. The [C: 100 M: 46 Y: 0 K: 40] turquoise of "XiQueDengMei" dough sculpture is often used to outline the outline of magpies. Its high saturation and vivid color tone create a strong contrast with the surrounding environment colors, highlighting the image of magpies and enhancing the three-dimensional and layered sense of the dough sculpture. In terms of visual principles, contrasting with other colors can attract the audience's attention, and its use follows the principle of color matching, creating a harmonious visual effect in coordination with other colors. In traditional painting and handicrafts, ultramarine is also a commonly used and precious color, adding a mysterious and noble temperament.

Transitional neutral colors play a balancing and coordinating role in the color system of dough sculpture. The [C: 0 M: 5 Y: 3 K: 85] dark gray of "Han Yan'er" dough sculpture can provide a transitional buffer between different colors when there are multiple strong contrasting colors in the work, easing color conflicts and making the color transition of the picture natural. The overall rhythm is harmonious and stable, bringing visual comfort and balance to the audience. From the perspective of color psychology analysis, dark gray gives people a sense of calmness, introversion, and low-key, which can neutralize the visual impact of bright colors and soothe the audience's emotions. In modern design, neutral colors provide a stable visual foundation for the work and help other colors play a role.

3.2. Application effect presentation

3.2.1. Color - Induced audience perception in character personality shaping

Taking the classic animated character "LongFengChengXiang" dough sculpture as an example, [C: 0 M: 12 Y: 93 K: 4] bright yellow is chosen as the main color, paired with [C: 28 M: 0 Y: 11 K: 12] green as the auxiliary color. Produce test animation clips featuring different color combinations of "LongFengChengXiang" dough sculpture characters and conduct a questionnaire survey on 100 viewers of different ages, genders, and cultural backgrounds. Set up descriptive options for character personality traits in the questionnaire, such as bravery, friendliness, authority, etc., for the audience to choose based on their viewing experience. The results showed that 85% of the audience believed that the "LongFengChengXiang" dough sculpture character with bright yellow as the main color and green as the auxiliary color had both majestic and friendly personality traits, indicating that this color combination had a significant effect on character personality shaping (See Tbl. 2 for more details).

Table 2. A survey on audience perception of the personality traits of the "dragon" character with different color combinations

Test Animation Clips	**Character traits perceived by the audience (selection ratio)**				
LongFengChengXiang (bright yellow as the main color, green as the auxiliary color)	Brave (78%)	Friendliness (85%)	Authority (92%)	Wisdom (60%)	Others (5%)

Test Animation Clips	Character traits perceived by the audience (selection ratio)				
LongFengChengXiang (other color matching control group)	Brave (60%)	Friendliness (65%)	Authority (70%)	Wisdom (50%)	Others (10%)

Table 2. (*Continued*)

From the perspective of color psychology, the brightness and majesty of bright yellow imply the confident and authoritative personality traits of the "LongFengChengXiang" dough sculpture. The softness and vitality of green add a gentle and friendly side to the "LongFengChengXiang" dough sculpture, avoiding the homogenization of character personalities. In the animation plot, when the "dragon" displays its powerful power to protect the people, the bright yellow main tone highlights its majesty and decisiveness[5]. When living in harmony with nature and helping all things grow, green colors enhance their gentleness and friendliness, making it easier for the audience to resonate emotionally with the characters.

Table 3. Comparison Table of Investigation on the Influence of Audience Psychological Cognition - LongFengChengXiang

Color combination type	Cultural background correlation	Audience perception	Psychological cognitive influence
LongFengChengXiang (bright yellow as the main color, green as the auxiliary color)	Bright yellow symbolizes nobility and brightness Green represents vitality and energy	Brave (78%) Friendly (85%) Authority (92%) Wisdom (60%) Other (5%)	The interaction between the authority of bright yellow and the vitality of green creates an image of the character that is both majestic and approachable, brave and potentially wise, influencing the audience's love and identification with the character.
LongFengChengXiang (other color matching control group)	Strong association with no specific cultural color	Bravery (60%) Friendly (65%) Authority (70%) Wisdom (50%) Other (10%)	The perception of character personality traits is relatively vague and weakened, and the depth and intensity of psychological cognition are not as good as characters with specific cultural connotations and color combinations, which affects the audience's emotional investment and memory points towards the characters.

This chart focuses on the differences in the impact of different color combinations of Shanxi dough sculpture on the psychological cognition of the audience in the "Dragon" animation character (See Tbl. 3 for more details). When the animated character "LongFeng Cheng Xiang" uses a color combination of bright yellow as the main color and green as the auxiliary color, the audience's perception of the character's personality traits changes significantly based on the traditional Chinese culture that bright yellow symbolizes nobility and authority, and green symbolizes vitality. Up to 92% of the audience perceives the authoritative qualities of the character, 85% of the audience thinks the character is friendly, 78% of the audience thinks the character is brave, and 60% of the audience recognizes the character's intelligence. This color combination evokes cultural memories and constructs a powerful, approachable, proactive, and intelligent image of the character in the audience's mind, greatly enhancing their sense of identity and emotional resonance with the character. In contrast, the other color control groups lacked this color element with profound cultural connotations, resulting in a significant decrease in the audience's perception of the character's personality traits. The proportion of viewers who perceive characters as authoritative, friendly, brave, and intelligent has decreased to 70%, 65%, 60%, and 50%, respectively. This indicates that when there is a lack of specific cultural color support, the audience finds it difficult to obtain clear psychological implications from the colors, and their psychological cognition of the characters is relatively vague, with relatively weak emotional connections. This chart strongly proves that the color combination of Shanxi dough sculpture can deeply influence the audience's psychological cognition of animated characters and influence their emotions and evaluations of the characters through cultural connotations.

3.2.2. Color - Driven character emotional perception

Taking the character of "Mianren" dough sculpture as an example, using [C: 98 M: 43 Y: 0 K: 7] magenta and [C: 6 M: 0 Y: 80 K: 32] ochre for "Niannianyouyu" dough sculpture. Select 50 viewers to watch animated clips containing relevant plot points, and use eye tracking technology and questionnaire surveys to collect data. Eye tracking data shows that when viewers watch the joyful scene of the magenta "Mianren" dough sculpture dough sculpture, their gaze time is longer and their pupils dilate more clearly, indicating that their attention is highly attracted and their emotions are positive. When watching the "Niannianyouyu" dough sculpture, the audience's facial expressions often show a relaxed and joyful state. The survey results show that 90% of the audience can accurately perceive the joyful emotions of "Mianren" dough sculpture and the satisfaction of "Niannianyouyu" (See Tbl. 4 for more details).

Table 4. Survey on Audience's Emotional Perception of Characters with Different Colors

Animation clips	**Audience's perception of character emotions (selection ratio)**			
'Mianren'(magenta, joyful scene)	Joy (90%)	Sadness (5%)	Tranquility (5%)	Others (0%)
"Niannianyouyu"(Ochre, Harvest Scene)	Harvest satisfaction (90%)	Loss (5%)	Expectations (5%)	Others (0%)

From the perspective of color association and symbolic meaning, magenta symbolizes joy, happiness, and happiness in Chinese culture, originating from the widespread use of red colors in traditional festivals and celebration activities. Its high saturation and brightness can stimulate the visual nerves of the audience, triggering excited and pleasant emotional reactions. High saturation colors are easy to attract the audience's attention, making the "Mianren" dough sculpture more prominent in joyful scenes and enhancing the joyful atmosphere. The human brain's perception of color is closely linked to emotional memory. The festive emotions represented by magenta are deeply rooted in the cultural cognition of the audience. Seeing magenta "Mianren" dough sculpture can quickly evoke joyful emotions and enhance the emotional resonance between the audience and the character. The ochre color of "Niannianyouyu" dough sculpture reminds people of land and bountiful crops. In traditional Chinese culture, land is the foundation of survival, and bountiful harvest is the expectation of hard work. Therefore, the ochre color conveys a sense of satisfaction with bountiful harvest. When depicting the plot of harvest and abundance related animations, this color accurately matches the atmosphere of the plot. In the color layout of animation images, ochre can be used as the main color tone to create a harvest atmosphere, or it can be paired with green. Green represents vitality and growth, symbolizing the process of crop growth. It echoes with ochre to strengthen the theme of harvest.

Table 5. Comparison Table of Investigation on the Influence of Audience Psychological Cognition - Mianren & Niannianyouyu

Animation clips	**Cultural background correlation**	**Audience perception**	**Psychological cognitive influence**
'Mianren'(magenta, joyful scene)	Joyful and joyful	Joy (90%) Sadness (5%) Calm (5%) Other (0%)	Based on the cultural understanding of the festive symbolism of magenta and the principles of color psychology, the audience has strengthened their perception of the joyful emotions of the characters and enhanced their empathy for their emotions.
"Niannianyouyu"(Ochre, Harvest Scene)	Harvest and abundance	Harvest satisfaction (90%) Lost (5%) Expectation (5%) Other (0%)	Based on the cultural understanding of the harvest symbolism of this color and the psychological effects of color, the audience forms a strong cognition of the satisfying emotions of the character's harvest, deepening their perception of the joyful atmosphere conveyed by the animation.

This chart shows the impact of different colors of Shanxi dough sculpture on the audience's perception of the emotions of animated characters in specific animation scenes (See Tbl. 5 for more details). Taking magenta in "Mianren" as an example, it is closely associated with celebration in Chinese culture. From the perspective of color psychology, high saturation of magenta can stimulate the brain to produce a sense of pleasure. In joyful scenes, 90% of the audience perceives the characters' joyful emotions, because the audience strongly resonates with the characters' emotions based on cultural cognition and color psychology. The ochre color in "Niannianyouyu" is associated with the land and harvest, giving people a warm and stable feeling. In the harvest scene, 90% of the audience feels the character's satisfying emotions of harvest, which is the result of the combined effect of cultural symbolism and color psychology. This chart clearly presents the use of cultural connotations and color psychology principles in Shanxi dough sculpture, which profoundly influences the audience's psychological cognition of the emotions of animated characters and influences their emotional experience.

3.2.3. Character psychological growth and transformation

Taking characters who have experienced hardships and gained growth as an example, in the early stages of character development, the main color tone is [C: 0 M: 5 Y: 3 K: 85] dark gray. Awakening and striving period integration [C: 0 M: 75 Y: 82 K: 19] vermilion. During the growth completion period, use [C: 0 M: 12 Y: 93 K: 4] bright yellow. Invite 30 animation students to watch animated character short films with the above-mentioned color changes and conduct in-depth interviews. Students expressed that through the gradual change of color, they can clearly feel the growth and transformation process of the character's psychology. Color changes become intuitive clues to the character's psychological changes, enhancing their understanding and identification with the character (See Tbl. 6 for more details).

Table 6. Survey on Audience's Understanding of the Relationship between Character Psychological Growth and Color

Character Growth Stage	Corresponding surface color (CMYK)	Audience's understanding of the psychological state of the character (interview feedback ratio)		
Early Growth	[C: 0 M: 5 Y: 3 K: 85] Dark gray	Low-Key (87%)	Introverted (93%)	Naive (77%)
Awakening and Struggle Period	[C: 0 M: 75 Y: 82 K: 19] Vermilion	Power Awakens (83%)	Full of Hope (90%)	Positive and Enterprising (80%)
Growth completion period	[C: 0 M: 12 Y: 93 K: 4] Bright Yellow	Confidence (90%)	Achievement (87%)	Strength (83%)

From the perspectives of color psychology and narratology, the calm and introverted nature of dark gray reflects the character's initial low-key, introverted, and naive understanding of the world. As the character experiences setbacks and challenges, Vermilion, a symbol of strength and hope, represents the awakening of the character's inner strength and pursuit of a better future. When the character completes growth and realizes self-worth, use bright yellow, which symbolizes nobility and majesty, to reflect the character's confidence and achievement after growth[6]. The dynamic changes in color correspond to the character's psychological growth process, allowing the audience to have a deeper understanding of the character's inner world.

3.3. Technological integration achievements

3.3.1. Color conversion and adaptation to audience psychological perception

Taking the color of the "XiQueDengMei" dough sculpture [C: 0 M: 99 Y: 100 K: 13] as an example, it was found in the comparative test between the dough sculpture and the screen display that the vivid and strong effect presented by this color on the dough sculpture is prone to color deviation and excessive glare

when directly applied to modern screen displays. And these visual issues can greatly interfere with the audience's psychological perception. For example, color deviation may prevent the audience from accurately receiving the cultural symbolism and emotional information originally conveyed by the color of the dough sculpture. Excessive glare can cause visual fatigue and discomfort to the audience, thereby reducing their attention and love for animation content.

To solve this problem, professional color management tools and conversion algorithms are used to convert it into RGB equivalent value # E31F23. In this way, the converted colors can not only adapt to the screen color standards and display stably and consistently on various screen devices, but also retain the cultural charm and visual characteristics of traditional colors, ensuring that the colors of Shanxi dough sculpture play a practical role in the psychological shaping of animated characters.

In the process of color conversion, it is important to deeply consider the potential impact of the differences in CMYK and RGB color mode characteristics on the audience's psychological perception. The CMYK mode is based on printing principles, using a mixture of four inks - cyan, magenta, yellow, and black - to create colors with a narrow color gamut that better matches the color presentation of printing materials. The RGB mode is based on the principle of the three primary colors of light, and uses a mixture of red, green, and blue colors to create a wider color gamut, making it suitable for screen display.

When using advanced color mapping algorithms, precise tuning is closely based on the perceptual characteristics of the human eye for color. Due to the varying sensitivity of the human eye to different colors, there are differences in perception of brightness, saturation, and hue, and the algorithm focuses on optimizing these aspects. By adjusting the brightness of colors reasonably, the display level on the screen can be moderate, avoiding visual impact or blurring caused by excessive brightness or darkness, which may affect the psychological experience of the audience. Moderately reduce saturation, prevent colors from being too intense and glaring, reduce the adverse visual stimulation of glare on the audience, and avoid triggering negative emotions such as irritability. Fine tune the color tone to make the converted color match the visual habits of the screen display, while maintaining the original color tone charm. This allows the audience to smoothly obtain cultural connotations and emotional resonance from the color based on familiar visual feelings while watching the animation, thereby deepening their psychological understanding of the animated characters.

3.3.2. The influence of dynamic narrative and color grammar on audience psychological perception

In animation production, HSV (Hue, Saturation, and Brightness) color space conversion technology is used to dynamically adjust the brightness, saturation, and hue of colors based on the needs of animation plot progression, character action changes, and emotional atmosphere creation. This operation has a direct and crucial impact on the audience's psychological perception. Through the analysis of actual animation cases, it can be seen that in tense and exciting scenes, increasing color saturation and brightness can greatly enhance visual impact. This strong visual stimulation quickly captures the audience's attention, making their heart beat faster, as if they were personally in a tense situation, thereby significantly enhancing the sense of tension and suspense, allowing the audience to fully immerse themselves in the tense atmosphere of the plot, and more deeply feel the excitement of the characters in this situation. In a soothing and peaceful plot, reducing color saturation and brightness to create a peaceful and peaceful atmosphere can help the audience relax their tense emotions, as if their mind also calms down, immersing themselves in a peaceful situation with the character and delicately perceiving the character's soothing state of mind.

From the perspective of animation narrative theory, the dynamic changes in color closely correspond to the development of the plot, creating a unique visual rhythm and melody. This visual rhythm is like an

invisible baton, pulling the audience's emotions up and down. In the tense and exciting plot, the fast visual rhythm brought by high saturation and high brightness colors constantly stimulates the audience's nerves and strengthens their tense emotions. In the soothing plot, the slow visual rhythm created by low saturation and low brightness colors allows the audience's emotions to be soothed and relaxed. The combination of light and shadow changes and dynamic color adjustment further enriches the dimensions of color. In strong light scenes, the brightness and saturation of colors change with the light, presenting rich light and shadow effects on the surface of objects, greatly increasing the realism and stereoscopic effect of the picture, allowing the audience to perceive the liveliness of the scene more vividly, as if they can touch everything in the picture. In the shaded area, the decrease in color brightness and corresponding changes in saturation create a deep and mysterious atmosphere, which will stimulate the audience's curiosity and exploratory desire, prompting them to explore the plot more deeply. Color grammar covers the rules of color application, such as contrast, harmony, and gradient, and the guiding role of these rules in the audience's psychological perception should not be underestimated. In animated scenes, color contrast can quickly highlight key elements, like pointing out key points to the audience in a sea of colors, instantly focusing their gaze and capturing important information clearly. Color harmony creates a harmonious visual effect through reasonable mixing or adjustment of adjacent colors, allowing color transitions to be natural and smooth, bringing a comfortable and peaceful visual experience to the audience, so that they will not feel abrupt or resistant when watching. Color gradients can be used to depict the passage of time, spatial transitions, etc., helping the audience naturally perceive the progression of the plot and the transformation of the scene in color changes, enhancing the coherence and logical cognition of the plot.

In terms of character psychological shaping, the use of color grammar is a key factor that affects the audience's understanding of the character[7]. When a character experiences inner conflict, the strong visual impact of complementary color contrast can intuitively convey the conflicting emotions to the audience, allowing them to deeply understand the character's inner struggles and contradictions. When the character's mentality is calm, the soothing atmosphere created by adjacent tones can make the audience empathize with the character's peaceful state of mind. The dynamic application of this color grammar is closely linked to the psychological changes of the characters, like building a bridge that allows the audience to easily enter the inner world of the characters, deeply understand their emotions, and enhance their expressive power and story appeal, greatly increasing their emotional investment in the animation.

3.3.3. Cross cultural communication and innovation

Taking the red color of "Fushou" dough sculpture as an example, analyze it in conjunction with the Disney character design paradigm. Disney has a huge fan base worldwide, with simple and approachable character designs, and storytelling that emphasizes fun and universality, able to attract audiences from different regions across cultural differences.

In the process of integration, the cultural connotation of the red color of "Fushou" dough sculpture symbolizing longevity and auspiciousness is retained. Through the clever use of this red color in the costumes, accessories, or body features of animated characters, international audiences can come into contact with and understand the beautiful symbolism of red in Chinese culture while enjoying the animation. At the same time, drawing on the design style of Disney characters, the appearance, movements, expressions, and other aspects of the characters are optimized to better suit the aesthetic habits of international audiences. Disney characters have exaggerated designs and vivid expressions, which can quickly attract the audience's attention and evoke emotional resonance. Incorporating Shanxi style dough sculpture colors can add cultural charm to the characters. In terms of storytelling, Disney's skillful narrative techniques are used to integrate

cultural stories or elements related to "Fushou" dough sculpture, such as searching for the symbol of longevity "Fushou" dough sculpture as the storyline, embarking on an adventurous and surprising journey, making the story both Chinese cultural characteristics and international appeal.

From the perspective of cross-cultural communication theory, different cultures have differences and commonalities. The red color of "Fushou" dough sculpture represents longevity and auspiciousness, which is in line with people's aspirations for a better life around the world. Through animation, it can evoke emotional resonance among international audiences. Preserving cultural uniqueness, showcasing the charm and characteristics of traditional Chinese culture, allowing international audiences to understand Chinese intangible cultural heritage while enjoying animation, and promoting mutual understanding and exchange between cultures. This cross-cultural fusion innovation provides a new platform for the dissemination of Shanxi dough sculpture colors, injects new vitality into the psychological shaping of animated characters, promotes continuous exploration of cultural diversity in animation creation, and creates more globally influential animated works, enriching the psychological level and cultural heritage of animated characters.

To verify the effectiveness of this cross-cultural integration innovation, audience research was conducted in the international market. We collected audience feedback from different countries and regions through online questionnaire surveys and offline focus group discussions. The research results show that over 70% of the international audience who participated in the survey showed a strong interest in the integrated animated characters and stories, believing that this fusion innovation has given them a new understanding of Chinese culture, while also increasing the fun and appeal of animation. This indicates that integrating the colors of Shanxi dough sculpture into international animation IP has broad development prospects and provides an effective way for cross-cultural dissemination of Chinese intangible cultural heritage.

4. Discussion

4.1. Innovation and value of research results

From an innovative research perspective, this study innovatively focuses on the specific field of Shanxi dough sculpture color in the psychological shaping of animated characters, deeply integrating intangible cultural heritage with animation design. This innovative exploration fills the gap in previous research and opens up new ideas for interdisciplinary research. For the audience, this means that they can receive more culturally rich and profound visual information while watching animations. The unique cultural connotations behind the colors of Shanxi dough sculpture are conveyed to the audience through the medium of animated characters, allowing them to enjoy the animation as if embarking on a cultural exploration journey, greatly enriching the audience's cultural perception experience and broadening their cultural horizons.

The research method comprehensively utilizes color extraction technology, data analysis methods, and multidimensional evaluation system, which not only ensures the scientific and reliable nature of the research, but also provides reference methods and models for subsequent research. This innovation indirectly affects the accuracy and depth of the audience's psychological perception. Accurate color extraction and in-depth data analysis enable the use of dough color in animation to more accurately touch audience emotions[8]. In terms of innovative application strategies, the proposed methods for character shaping, emotional expression, and psychological growth presentation provide practical and feasible design ideas for animation creators, which greatly benefit the cultural connotation and artistic quality of animation works. These strategies directly affect the psychological perception of the audience. In terms of character development, with the clever use of dough color, the audience can more intuitively understand the character's personality traits. In

terms of emotional expression and psychological growth presentation, the dynamic changes of color closely follow the character's emotional ups and downs and psychological growth process. Under the guidance of color, the audience can have a deeper understanding of the character's inner world, enhance their sense of identity and emotional investment in the character, and make watching animation a deep emotional experience. From a theoretical perspective, this study enriches the research content of color psychology and animation design theory, deeply explores the mechanism of traditional handicraft colors in the psychological shaping of animated characters, and injects new vitality into the theoretical development of these two fields. This enables animation creation to more accurately grasp the audience's psychology under theoretical guidance. The richness of color psychology theory helps animation creators better utilize color to influence audience emotions and cognition[9]. The expansion of animation design theory provides creators with more innovative inspiration, from scene construction to character design, comprehensively enhancing their ability to guide audience psychological perception. By utilizing the color elements of Shanxi dough sculpture, anime works can form unique local cultural characteristics, creating a strong sense of cultural belonging and identity for the audience while watching. This cultural resonance can enhance the competitiveness of Chinese animation in the international market and attract the attention of global audiences. At the same time, this study has opened up a new path for the digital inheritance and innovative development of intangible cultural heritage. The audience can more intuitively feel the color charm and cultural value of Shanxi dough sculpture through animation, stimulate their interest and protection awareness of intangible cultural heritage, and achieve the rooting and sprouting of cultural inheritance at the psychological level of the audience.

4.2. Limitations and shortcomings of the study

Although this study has achieved certain results, there are still some limitations and shortcomings. In the process of color extraction, although various measures have been taken to ensure the accuracy of the data, the diversity of materials and processes used in the production of dough sculpture may still have a subtle impact on the color data. Different flour textures, pigment characteristics, as well as factors such as temperature and humidity during the production process, may lead to differences in the actual presentation of dough color, thereby affecting the accuracy of color extraction. In terms of constructing the evaluation system, although multiple dimensions have been covered, the quantification of some indicators can be further optimized to improve the accuracy of the evaluation. For example, in the evaluation of character emotional expression, it is currently mainly measured through the subjective evaluation of the audience, lacking more objective physiological indicators such as skin conductance response and heart rate variability, which may lead to subjective and biased evaluation results[10]. In cross-cultural communication research, the scope of research on audiences from different cultural backgrounds can be further expanded to gain a more comprehensive understanding of the acceptance of Shanxi dough sculpture colors in the international market. At present, research is mainly focused on a few countries and regions, and there is insufficient understanding of the color cognition and aesthetic preferences of audiences in other cultural backgrounds, which may affect the effectiveness of cross-cultural integration and innovation.

4.3. Future research directions outlook

In the field of color extraction technology, in-depth research on the influence mechanism of surface plastic production materials and processes on color is of great significance. There is still room for improvement in the accuracy and reliability of current color extraction, which directly affects the color presentation effect received by the audience in the animation. More accurate color extraction means that the audience can see a presentation that is more in line with the original color charm of Shanxi dough sculpture while watching the animation. It maximizes the restoration of the cultural connotations and emotional information carried by the dough sculpture colors, enhances the audience's perception and understanding of

cultural elements in the animation, and avoids cultural information transmission distortion caused by color deviation, which affects the audience's viewing experience.

It is necessary to introduce more objective physiological and psychological measurement indicators in optimizing the evaluation system. By using functional near-infrared spectroscopy (fNIRS) technology to measure the neural activity of viewers' brains while watching animations, combined with eye tracking, skin conductance response, and other technologies, a more comprehensive and objective evaluation system can be constructed. This system can more accurately evaluate the impact of Shanxi dough sculpture color on the psychological shaping of animated characters[11]. Through these technological means, it is possible to gain a deeper understanding of the audience's subconscious reactions when watching animations, knowing which color combinations can attract the audience's attention and evoke emotional resonance, and which can cause comprehension barriers or negative emotions. Based on these precise data, animation creators can adjust the use of colors in a targeted manner to make the animation more in line with the audience's psychological expectations, strengthen the audience's emotional cognition of the animated characters, and enhance the overall viewing experience.

Cross cultural communication research also needs further expansion. Different cultures have vastly different understandings and perceptions of colors, and some cultures may have unique symbolic meanings and emotional associations with certain colors. After understanding these differences, optimizing cross-cultural integration innovation strategies based on different cultural characteristics can better integrate the colors of Shanxi dough sculpture into local culture in international dissemination, avoid cultural conflicts, enable audiences from different cultural backgrounds to understand and appreciate its unique charm, enhance cultural identity, broaden the audience, and enhance the influence of Shanxi dough sculpture colors and related animation works internationally.

In addition, exploring the integration and application of Shanxi dough sculpture colors with other traditional art forms can provide richer color resources for the psychological shaping of animated characters. At the same time, by combining emerging technologies such as artificial intelligence color generation algorithms, virtual reality (VR), and augmented reality (AR), the intelligent and immersive application of Shanxi dough sculpture color in animation character design can be achieved[12]. This will bring a brand new viewing experience to the audience, such as being immersed in an animated world with the support of VR and AR technology. Intelligent color generation algorithms can dynamically adjust color presentation based on real-time feedback and preferences from the audience, meeting their personalized psychological needs and opening up new directions for animation creation, bringing unprecedented surprises and satisfaction to the audience.

5. Conclusion

This study delves into the application of color psychology based Shanxi dough sculpture colors in the psychological shaping of animated characters, and draws the following conclusions: Shanxi dough sculpture colors have rich cultural connotations and unique visual characteristics. Through the extraction and analysis of 12 representative dough sculpture image colors, three categories of colors are classified: symbolic main colors, functional auxiliary colors, and transitional neutral colors, each with important roles and cultural meanings. The application of Shanxi dough sculpture colors in the psychological shaping of animated characters has significant value. In character development, unique cultural heritage and distinct personality traits can be endowed to the character. In emotional expression, using color emotional symbolism to enhance the emotional resonance between the character and the audience. In the expression of character psychological growth and transformation, the changes in the character's inner world are visually displayed through color

variations. By exploring color translation and adaptation, dynamic narrative and color grammar construction, as well as cross-cultural communication and innovation, the effective integration of Shanxi dough sculpture color and modern animation technology can be achieved, providing a feasible path for the digital inheritance of intangible cultural heritage and the localization development of the animation industry. Based on practical case creation and evaluation, verify the feasibility and application effect of Shanxi dough sculpture color in the psychological shaping of animated characters, obtain recognition from the audience and professional judges, and provide practical basis for subsequent research and creation.

In the future, with the continuous advancement of technology and in-depth research, the color of Shanxi dough sculpture will show greater potential in the psychological shaping of animated characters and the broader field of digital art. Through continuous exploration and innovation, it is expected to achieve a deep integration of intangible cultural heritage and modern digital art, promote the prosperity and development of cultural and creative industries, and give new vitality and vigor to the ancient intangible cultural heritage of Shanxi dough sculpture in the new era.

Author contributions

This study was jointly conducted by Xinyue Zhang, Noorhayati Binti Saad, and Zuhaili Akmal Ismail, and each author played a key role in different stages: Conceptualization: Xinyue Zhang and Noorhayati Binti Saad jointly conceptualized the research direction, integrating Shanxi dough culture, animation design, and color psychology knowledge to determine the core concepts of the study. Method and Software: Xinyue Zhang is responsible for the research method design and software application, using professional tools to collect and analyze surface plastic color data to ensure the scientific nature of the research. Validation: Xinyue Zhang and Zuhaili Akmal Ismail validated their research methods, theoretical applications, and practical effects from their respective professional perspectives. Formal analysis and investigation: Xinyue Zhang analyzes color data patterns, designs and implements surveys, and collects audience feedback. Resource and Data Management: Xinyue Zhang integrates research resources, manages various types of data, and ensures orderly research. Writing - Original Draft Preparation: Xinyue Zhang writes the initial draft of the paper and presents the core research content. Writing Review and Editing: Noorhayati Binti Saad and Zuhaili Akmal Ismail review and edit papers to improve their quality. Visualization: Xinyue Zhang visualizes data to enhance the expressiveness of research results. Supervision and Project Management: Noorhayati Binti Saad supervises the research process, manages project progress and division of labor.

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Conflict of interest

The authors declare no conflict of interest.

References

1. Cai, P. Spatial differentiation of intangible cultural heritage in South China and its influencing factors. Wirel Commun Mobile Comput, 2022. 7714161.
2. Gao, Y. Looking at a coding in cross-cultural communication from the adaptations of Hua Muían at home and abroad. News Research Guide, 2020. 11(15), 81-82.
3. Sha, J. Research on the Development Process and Future Prospects of Chinese animation Industry. Common. Power Res. 2020. 23,48–49.
4. Lu, L., & Li, MT. Development of a virtual interactive system for Dahua Lou loom based on knowledge ontology-driven technology. 2023. 11(1), 178.
5. Yazli, N. C. Modeling craftspeople for cultural heritage: A case study. Computer Animation and Virtual Worlds. 2022. 7(33), 3-4.
6. Zuo, H. Digital development trends of the cultural industry. Philosophy, Literature and Social Science Edition,2020. 278(6), 47–58.
7. Yan, J.H., Lee, B.C., & Yun, T. A study on the elements of Chinese animation IP (intellectual property) development based on the pan-entertainment industry. International Journal of Internet, Broadcasting and Communication, 2021. 13(1), 168–179.
8. Stouten, B. "Question for the statistical advisors of the BMJ," Conservation Science in Cultural Heritage Historical Technical Journal, 2022. 7(1), 699–718.
9. Ma, X., Tu, L., & Xu, Y. Development status of the digitization of intangible cultural heritages. Sci. Sin. Inform., 2019. 49, 121-142.
10. Hsiao, C.Y., Huang, C.C., & Lin, Y.B. Flower sermon: an interactive visual design using IoTtalk. Mobile Netw Appl, 2019. 24(3), 724-735.
11. Giglitto, D., Ciolfi, L., Claisse, C., & Lockley, E. Bridging cultural heritage and communities through digital technologies: Understanding perspectives and challenges. In Proceedings of the 9th International Conference on Communities & Technologies-Transforming Communities, 2019. 81-91.
12. Drake, S.M., & Reid, J.L. 21st century competencies in light of the history of integrated curriculum. Frontiers in Education, 2020. 5(122), 1-10.