

Visual Image Design for the Extraction of Cultural Theme Based on the Analytic Hierarchy Process and Image Processing Extraction Method

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Submitted: 06/12/2023 Revised: 17/01/2024 Accepted: 27/01/2024

Abstract: This study seeks to adapt the traditional cultural theme to the contemporary era as a cultural inheritance by redesigning the visual images that are associated with it. First, descriptive words about the traditional Spring Festival were collected through mind mapping, and visual image designs were collected from pictures. Then, the traditional visual symbols of the Spring Festival were analyzed and extracted. The index weights were determined by the analytic hierarchy process. Next, the color theme extraction method and image processing extraction methods were used to establish a color database. The key cultural theme elements of the traditional Spring Festival visual images were extracted through the analytic hierarchy process, color theme extraction and image processing extraction and then combined with modern visual expression forms to design a visual language for symbol design. The results provide relevant design references for research on the traditional cultural Festival visual image inheritance and innovative design, which is helpful to show the world the history and civilization of the Chinese cultural theme and externally promote Chinese culture.

Keywords: Visual image design, Cultural theme, Traditional Spring Festival, Analytic hierarchy process, Image processing extraction

1. Introduction

The traditional Spring Festival, also known as ‘Lunar New Year’ and commonly known as ‘Guo Nian’, is one of the traditional festivals in China with the most extensive participation (Kuang, 2021). The festival manifests many aspects of Chinese culture and living, including the following customs: taking New Year pictures, setting off firecrackers, offering sacrifices to ancestors, paying New Year’s greetings and so on (Gao, 2017). In addition, the Spring Festival has social and cultural functions such as integrating ethnic groups, strengthening national identity, facilitating nostalgia, adjusting to life and stimulating consumption.

However, China has recently undergone reforms and opening up, leading to the rapid development of the social economy, and people’s material lives have been greatly improved. A large number of foreign festivals (e.g., Valentine’s Day and Christmas Day) have entered the Chinese market and been recognized and accepted by young people with increasing influence and popularity. The traditional ‘Nian’ flavor of the Spring Festival is fading, as are the sense of ritual and the festival’s functionality. For culture to develop and be passed on as an inheritance, it needs to adapt to modern technology and information. Therefore, it is important to explore the parts of the Spring Festival that mesh well with modern society and adapt them accordingly. For instance, extracting the traditional Spring Festival visual designs and redesigning

the images to meet the aesthetic taste of young people is one way to keep the New Year ‘flavor’ from fading (Zhou, 2020).

The traditional Chinese Spring Festival is one of the most important traditional festivals in China, with a long history and rich cultural connotations (Xiao & Jia, 2020). The visual image design of the Spring Festival is an important way to combine traditional culture with modern design. Through the conveyance and expression of visual images, it can effectively convey the atmosphere and cultural connotations of the festival, enhance people’s festival experience and emotional resonance (Hang, 2018). However, currently, there is relatively little research on the visual image design of traditional Chinese Spring Festival, and it lacks systematic and scientific approaches. Therefore, this study aims to investigate the application of visual image design for traditional Chinese Spring Festival through the Analytic Hierarchy Process, providing a scientific decision-making basis for designers and decision-makers, and promoting the inheritance and innovation of traditional Chinese culture.

This study will conduct an in-depth exploration and analysis of the cultural connotation of traditional Chinese Spring Festival. Secondly, it will establish an evaluation system for visual image design of traditional Chinese Spring Festival based on the Analytic Hierarchy Process (AHP). Then, starting from the graphics of traditional Chinese Spring Festival, it will construct an indicator system for evaluation and determine the weights of each indicator through expert interviews and questionnaire surveys, thus achieving a scientific evaluation of Spring

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Festival visual image design. Finally, this study will conduct empirical analysis on the application of visual image design of traditional Chinese Spring Festival using the highest-rated design factors for evolutionary creation, designing visual images that meet modern aesthetic needs. By analyzing and extracting design elements from traditional Chinese festival culture, it can not only achieve cultural inheritance but also meet market demands, enhancing the perceived, communicative, and universal attributes of cultural and creative products while promoting the intrinsic cultural attributes of Spring Festival products (Zhang, et al.2019)

2. Related Work

The traditional Chinese Spring Festival is a unique part of Chinese culture and customs, and it has profound cultural connotations in Chinese history. Further, with the development of the times and the progress of society, the festival is ever-changing. Therefore, the festival's visual image designs are an important topic to be addressed in academic research.

In recent years, researchers have studied the content of visual image designs of the traditional Chinese Spring Festival from the viewpoints of history, literature, art and religion. For example, In the article "A Study on the Japanese Traditional Festival of 'Shokyoto (Small-Kyoto)'" , Kim (2010) mentions the traditional festival (matsuri) in Japan, introducing its characteristics, background, and rituals. It is believed that traditional festivals play a very important role in Japanese society during the modernization process. Traditional festivals create a lasting impression through visual forms, events, activities, and so on. In the article "Cultural sustainability and fluidity in Bhutan's traditional festivals," Sontikul, W (Wantanee Sontikul)(2019) explores the impact of modernization on traditional festivals and examines the necessity of sustainable development of traditional culture from the perspective of fluidity and evolution. Deng, et al(2023). discuss the role of national traditional festivals in cultivating a sense of identity in their article "National traditional festival tourism and visitors' national identity: a dual collaborative framework of cultural inheritance and inherited innovation." They employ the method of fuzzy set qualitative comparative analysis to analyze issues related to cultural inheritance and inherited innovation. Han (2018) is committed to studying the cultural inheritance and revitalization of traditional Chinese Spring Festival through the perspective of folk arts. He proposes to rediscover the beauty of classics, emphasize the significance of cultural and artistic expression, and seek "change" on the basis of tradition. In the transformation of Chinese tradition in modern times, its charm and aesthetics have become compatible with contemporary aesthetic tastes, rather than simply being ancient replicas. In the

article, Wang et al (2023). utilized the Analytic Hierarchy Process and Entropy Weight Method to extract design factors of Chinese Spring Festival culture. They also applied these factors to design an interactive, cultural, and technological Spring Festival couplet projector. Ji (2019) and other scholars discussed the evolution of Spring Festival images in traditional Chinese feudal religious culture. Research Group of "Promoting Festival Culture" (2012) analyzed the development process of Spring Festival images and their influence on contemporary society by looking at historical and cultural changes as well as the characteristics of Chinese culture.

At the same time, some scholars have discussed the application of visual images of the Spring Festival in the field of design. For example, in the article "A Study on the Visual Performance of Brand Marketing," Aishen and Pan (2014) pointed out the significant role of visual image design in the development of global brand strategies. Zhang (2017), in the article "Application and Innovation of New Media Technology in Visual Communication Design," explored the influence of new media technology on the future development of visual communication design and discussed its application in traditional visual design from different perspectives. Chen, et al. (2023), in the article "Application of Computer Image Processing Technology in Visual Communication System," proposed a new method that combines computer image processing technology to further construct a computer-based visual image design system. Shi, et al. (2017), in the article "Application of Visual Communication Design under Communication Theory," analyzed the relationship between designers, media, information, and the audience, and established the effectiveness of communication models in visual communication design. Hyatt (2023), in the article "Exploring Visual Communication: The Development of a Conceptual Model," raised questions about the main concepts in visual design and how visual communication is conveyed, emphasizing the interpretive nature of understanding visual communication. In "Research on Application of Visual Communication Design and Digital Printing Technology," Dian (2017) discusses the need for the combination of visual communication and digital printing technology, providing detailed descriptions of the theory and elements of visual communication design through specific case studies. Design techniques such as color, images, and layout are used to better serve the theme. In Ying 's (2012) doctoral thesis, "Research on Graphic Symbols Design Recognition," it is pointed out that the cognitive process of visual graphic symbol recognition is composed of visual perception and perceptual processing, with human factors, graphic symbol factors, and environmental factors constituting the process of graphic symbol recognition. Visual design emphasizes the interaction and integration of

practice and theory, revealing the essence and characteristics of design through insights, conceptualization, and implementation in design practice (Tim Brown, 2009. Zheng et al (2014). found that there are many traditional artistic features in the festival's image designs, including sculptures, murals, embroidery, poetry, bamboo weaving and abstract art. Yang and Liu (2019) put image design ideas into practice and explored a new type of visual typesetting to create Spring Festival images with unique composition characteristics.

In short, with the continuous development of the times, Chinese traditional culture attaches great importance to restoration and inheritance, and accordingly, research on traditional Chinese Spring Festival visual image designs has gradually become active and diversified. It not only provides strong support for the inheritance of culture but also offers a good reference for the design of visual images involving the Chinese language with Chinese characteristics.

3. Math

The research framework refers to the combination of theories, concepts, and methods adopted by researchers in their studies. The research framework for the application study of traditional Chinese Spring Festival visual image design based on the Analytic Hierarchy Process (AHP) can be conducted in the following steps:

Firstly, we need to conduct in-depth research and analysis to gather visual image materials related to the traditional Spring Festival. We obtain these materials from online books, image libraries, and other relevant sources. Using the AHP, we evaluate and determine the weights of design factors for Spring Festival activities based on the collected materials.

Secondly, through the AHP, we score the collected design factors and identify the highest scoring factor (Liu, et al, 2006). This graphic factor will become a key element in our design process. To better manage and organize these elements, we establish an element database for efficient use during the design process.

Next, we use shape analysis to further evolve the highest scoring design factor. By analyzing the shape of these factors, we can explore different design possibilities to find the visual design that best meets current aesthetic needs. This process helps us validate the feasibility of the selected design factors and ensure that the final design meets people's aesthetic demands for the Spring Festival image.

Finally, based on the research and analysis results mentioned above, we have designed a set of Spring Festival visual images that cater to the current aesthetic demands. These designs will incorporate traditional and modern elements to express the joy and blessings of the Spring Festival. They will have a modern and fashionable appeal that can attract more attention and participation. At the same time, these designs will also enhance the internationalization of Spring Festival promotion, enabling more people to understand and participate in the celebration of the Spring Festival.

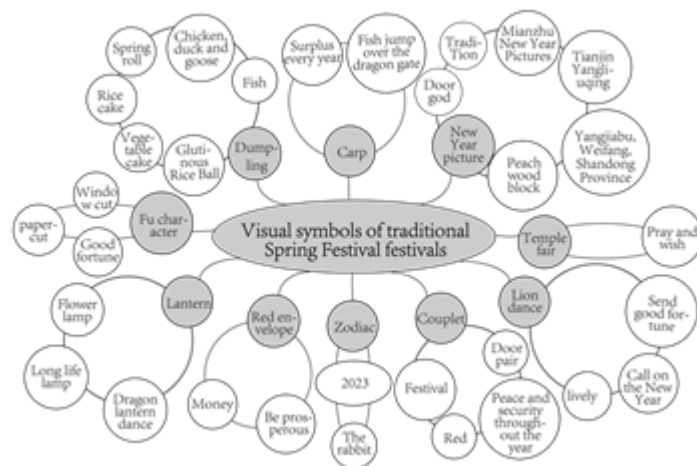


Fig. 1 Research frame diagram

4. Research on the Extraction of Cultural Theme Elements of the Spring Festival

The Spring Festival is a traditional part of Chinese culture and is known as a grand festival with strong folk customs. Full of rich cultural elements, the festival inspires people's spiritual pleasure and visual enjoyment. Therefore, it is particularly important to study the culturally themed elements. The following shows a perceptual analysis of the elements of visual images of the Spring Festival, extracts feature factors related to language about graphics and color and establishes a feature map of the traditional visual language of the Spring Festival.

First, we should have an in-depth understanding of the Spring Festival and sort out the main elements of its cultural significance. Through historical data, document analysis and in-depth research on various cultural contexts, the typical Spring Festival stories, idioms, customs and other visual images are extracted for further analysis.

Second, the background of the festival and its cultural connotations are analyzed. From different cultural perspectives,

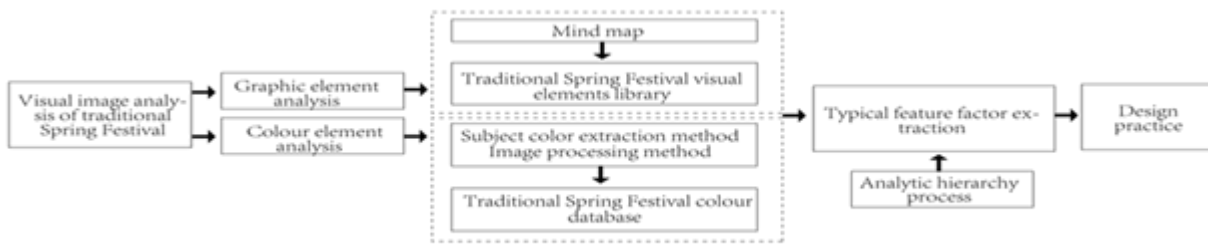


Fig. 2 Mind map of visual symbols of the traditional Spring Festival

this paper explores the cultural values and ideological contents contained in the cultural elements of the Spring Festival, highlighting the unique cultural significance and the festival’s role in social development and traditional culture development.

Finally, as a practical application, we can use the identified important features to create representative cultural products, thereby amplifying the festival’s social effects and enhancing the influence of Chinese culture.

4.1. Graphic element extraction

4.1.1. Figure Axis labels

Many literature reviews begin with brainstorming and drawing the traditional Spring Festival visual symbols in a mind map (Ma, et al 2014). The traditional visual symbols of the Spring Festival are the following: New Year pictures, temple fairs, lion dances, couplets, Chinese zodiac, red envelopes, lanterns, blessing characters, dumplings, carp and so on. Then, divergent thinking is used to expand the image symbols, including the following visual images: door God, Tianjin Yangliuqing, Taohuawu woodblock, Shandong Weifang Yangjiabu, sending good luck, calling on the New Year, peace, rabbits, good luck, lanterns, window cuttings, cut paper, rice cakes, glutinous rice balls and spring rolls. Specific visual symbols of the traditional Spring Festival are shown in Figure 2.

4.1.2. Figure Axis labels Graphic element screening and extraction

The mind maps of traditional visual symbols of the Spring Festival were examined using subject extraction, contrast statistics and image processing. First, popular color themes were collected from historical documents by the theme extraction method, and the Spring Festival elements used in the most popular graphics were screened out. Second, the corresponding graphic elements were extracted and counted by the contrast statistics method. Finally, based on image processing, the graphic language conforming to the characteristics of the Spring Festival was integrated, and the most typical Spring Festival graphic elements were selected step by step (Fig.3).

	Traditional Spring Festival visual elements
Spring Festival story	
Spring Festival Traditional ware	
Custom of Spring Festival	
Spring Festival 'food' vision	
Auspicious Chinese New Year	
Spring Festival activities	

Fig.3 Traditional Spring Festival visual elements library

4.1.3. Weight analysis of traditional Spring Festival graphic elements based on the analytic hierarchy process

The Analytic Hierarchy Process (AHP) expresses subjective judgments in quantitative form, hierarchically organizes the thought process of individuals, and quantifies the decision-making process (The SPSSAU project,2023). It is a commonly used decision analysis method that decomposes complex decision problems into multiple levels and derives the final decision by comparing and evaluating the weights of each level (Han et al, 2004). In the article “A multi-criteria decision-making methodology on the selection of facility location: fuzzy ANP,” Ozdagoglu, A. states that AHP is one of the best ways to make decisions using qualitative variables in complex criteria structures at different levels (Clarivate, 2012). First, the traditional Spring Festival visual elements were divided into six categories: stories, traditional objects, customs, food, auspicious language and activities. Then, relevant experts were invited to compare the importance of the listed factors in pairs and determine the weight of each factor by the mathematical method, as shown in Table 1.

Table 1. AHP data table of traditional Spring Festival visual elements

	Stories	Traditional wares	Customs	Food	Auspicious language	Activities
Stories	1.000	1.000	0.333	0.500	0.200	0.250
Traditional wares	1.000	1.000	0.250	0.500	0.250	0.333
Customs	3.000	4.000	1.000	1.000	0.200	0.333
Food	2.000	2.000	1.000	1.000	0.250	0.500
Auspicious language	5.000	4.000	5.000	4.000	1.000	1.000
Activities	4.000	3.000	3.000	2.000	1.000	1.000

Table 2. AHP hierarchical analysis results of traditional Spring Festival visual elements

Visual Element Item	Feature vector	Weight value	Maximum eigenvalue	CI value
Stories	0.358	5.973%		
Traditional wares	0.392	6.535%		
Customs	0.826	13.772%	6.267	0.053
Food	0.696	11.608%		
Auspicious language	2.134	35.559%		
Activities	1.593	26.553%		

As can be seen from Table 2, a six-order judgement matrix was constructed for the AHP hierarchical method (calculation method: analysis and method of product), characteristic vector for the Spring Festival visual elements (0.358, 0.392, 0.826, 0.696, 2.134, 1.593), and the six corresponding weights as follows: 5.973%, 6.535%, 13.772%, 11.608%, 35.559% and 26.553%, respectively. In addition, the maximum characteristic root (6.267) can be calculated by combining the feature vector, and then the CI value (0.053) can be obtained by using the maximum characteristic root value [CI = (maximum characteristic root - n)/(n-1)]. The CI value was used for the following consistency test (TAN, 2012)

Table 3. Random consistency RI table

n	3	4	5	6	7	8	9	10	11	12	13	14	15	16
RI value	0.5	0.8	1.1	1.2	1.3	1.4	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.5

The random consistency RI value that can be queried corresponding to Table 4 was 1.260, which was used to calculate the consistency test RI value shown in Table 4.

Table 4. Summary of the consistency test results

Maximum characteristic root	CI value	RI value	CR value	Consistency test result
6.267	0.053	1.260	0.042	pass

Generally, the smaller the CR value is, the better the judgement of matrix consistency is. Generally, if the CR value is less than 0.1, the matrix conforms to the consistency test. The CI value obtained by the calculation of the six-order judgement matrix was 0.053, indicating that the judgement matrix of this study conforms to the consistency test and the weight obtained by calculation is consistent (Xu, 2016).

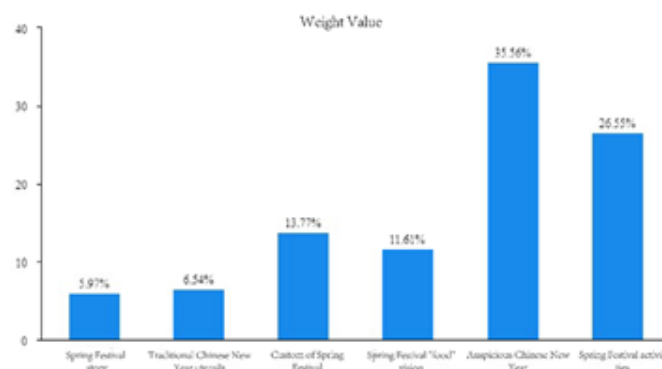


Table 6. Weight values of traditional Spring Festival visual elements

Therefore, traditional auspicious language was applied in new, innovative designs for the Spring Festival. The new designs grasp not only auspicious language but also the

context of Chinese traditional culture and fashion, include a mix of international and Chinese elements and integrate traditional and modern elements to create a richer form, promoting the development of traditional Chinese Spring Festival culture.

4.2. Color element screening and extraction

China is a country with a long history and culture. As a major festival, the Spring Festival brings special pleasure to the Chinese people with its unique color and atmosphere. The festival's color elements have a long tradition which not only symbolizes the rich and colorful Chinese culture but also creates a strong emotion for the festival atmosphere.

In order to accurately capture the Spring Festival color elements, it is necessary to use a specific extraction method. This paper mainly uses two methods to extract the Spring Festival color elements: the color theme extraction method and the image processing extraction method.

The Spring Festival is the most important annual festival. The Spring Festival color elements show the most typical cultural characteristics of the Spring Festival. We used color theme extraction to extract the color elements of the Spring Festival. First, we imported the visual pictures obtained during the traditional Spring Festival into Adobe Photoshop. Then, we used the 'Color' tool to extract the elements of corresponding color categories based on its built-in color palette and integrated and matched the elements with similar colors. This allowed us to identify the most typical Spring Festival color elements (Figure 3).

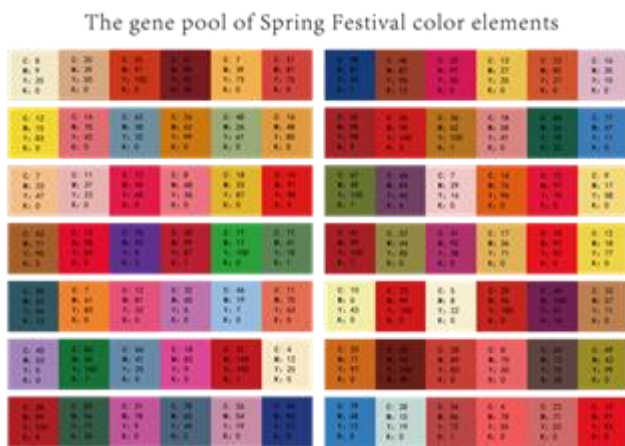


Fig. 3 Traditional Spring Festival color database

5. Application of Typical Traditional Spring Festival Design Factors in Visual Communication

Based on the above analysis, it can be concluded that the weight value of the visual elements of Spring Festival auspicious phrases is the highest. Therefore, in the following text, the design of elements and Spring Festival

cultural and creative products will be based on the health blessings in the Year of the Rabbit. In the design of the Year of the Rabbit gift box packaging, we have chosen to creatively combine the English word "health" with the Chinese character for rabbit. This design not only facilitates the reading of both domestic and international audiences, but also enhances the international dissemination of the Spring Festival. To match the atmosphere of the Spring Festival, we have extracted orange as the main color from the color gene bank of the Spring Festival. Orange not only has a festive characteristic, but also showcases the liveliness and prosperity of the Spring Festival.

In the design of Spring Festival cultural and creative products for the Year of the Rabbit, we have created a series of products, including Spring Festival tote bags and red envelopes. In these designs, we have used the techniques of two-way continuity and four-way continuity to transform and design the Chinese character for rabbit. Through these creative techniques, we can provide people with different visual experiences while also showcasing the characteristics and significance of the Year of the Rabbit.

In the design of the Spring Festival tote bag, we have utilized a scaling technique to enlarge the character "rabbit" from small to large. Through this design, we have made the form of the rabbit more diverse and also showcased the festivity and liveliness of the Spring Festival. For the color selection of the Spring Festival tote bag, we have still chosen orange as the main color to convey the joy and blessings of the Spring Festival.

In the design of the Spring Festival red envelopes, we have employed a creative technique of continuous two-sided and four-sided connections to transform and design the character "rabbit". This design not only brings a sense of novelty to people but also showcases the auspiciousness and beauty of the Year of the Rabbit. To create a cohesive series of Spring Festival red envelopes, we have also used orange as the main color to convey the festivity and liveliness of the Spring Festival.

By analyzing and designing the visual elements of Spring Festival auspicious phrases, we have created a series of modern and fashionable Spring Festival images. These designs not only satisfy people's aesthetic needs for Spring Festival images, but also reflect the cultural concepts and spiritual atmosphere of the times. At the same time, these designs can enhance the international dissemination of the Spring Festival, allowing more people to understand and participate in the celebration of the Spring Festival.



Fig. 4 Package design of the Rabbit Year gift box



Fig. 5 Design of cultural and creative products in the Year of the Rabbit

6 Conclusions

Visual image designs of the traditional Chinese Spring Festival are an important topic in research on China's cultural heritage and directions of development. The visual images associated with the Spring Festival demonstrate both cultural inheritance and innovation, which can generate new vitality and cultural evolution. In this paper, the key factors of traditional Spring Festival visual images were extracted through the analytic hierarchy process, color theme extraction method and image processing extraction method and then combined with modern visual expression forms to create a visual language for the aesthetic sense of symbol design. On the basis of culture, visual language can be innovated and inherited to create richer visual images. It may also provide design ideas for the internationalization of traditional designs.

However, this study also has some limitations. Firstly, the sample size of experts is small, which may affect the generalizability of the results. Future research can expand the sample size to increase the reliability and representativeness of the data. Secondly, this study primarily focuses on the application of the Analytic Hierarchy Process (AHP). Future research can incorporate other methods such as questionnaire surveys and field interviews for comprehensive studies. Additionally, in this study, there was not enough emphasis on the design process of visual image practice, with only a focus on extracting auspicious elements from the AHP. Future research can further explore the creative methods and techniques in the

design process to enhance the quality of the design works.

Therefore, future research can build on the above limitations and delve into innovative paths and practical methods for traditional Spring Festival visual image design. Additionally, it can integrate emerging technologies such as AI painting, virtual reality, augmented reality, etc., to explore new design tools and modes of expression, injecting more creativity and vitality into traditional Spring Festival visual image design. It is hoped that through these efforts, a greater contribution can be made to the inheritance and development of traditional culture.

Acknowledgements

None

Author contributions

Xiuli Su 1: Conceptualization, Methodology, Software, Field study, **Xuqian Ni 2:** Data curation, Writing-Original draft preparation, Validation., Field study

Conflicts of interest

The authors declare no conflicts of interest.

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