

Analysis of the Chinese Calligraphy Using Kansei Engineering

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Abstract

Chinese calligraphy is closely related to the Chinese cultural circle, and it is also the most important part of Chinese art history. "Regular script" is regarded as the morphological standard of Chinese characters, while "cursive script" has a strong artistic quality. For the analysis of Chinese calligraphy, this study uses the cursive script "Autobiography" and the regular script "The Inscription on the Sweet Spring in the Jiucheng Palace" as representative samples. 28 representative characters of regular script were selected as samples through the principle of Chinese character components; 24 characters were selected as samples of cursive script through the principle of Chinese character outline. The Kansei vocabulary is screened according to the structure and shape of the two types of calligraphy, and the Kansei engineering analysis is carried out in the form of relevant expert questionnaires. the Grey Relational Analysis (GRA) method is used to calculate the importance sequence of the related Kansei vocabulary of the two Chinese calligraphy. The analysis results can be used as an entry direction for Chinese calligraphy aesthetic education, as well as an important reference for metalworking design and creation courses, and provide a basis for product designers to use calligraphy as design elements.

Keywords: Analysis of Chinese Calligraphy, Chinese Character Components, Chinese Character Outline, Kansei Engineerin, Grey Relational Analysis (GRA)

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Introduction

Calligraphy is an art of writing, which has both practical and aesthetic aspects. Along with the continuous evolution of the history of Chinese civilization, Chinese calligraphy is the most important part in the history of East Asian art. In the history of calligraphy, from the pictographic oracle bone inscriptions, the structure of Chinese characters has been constantly changing, until the official script has been roughly finalized. The subsequent regular script and cursive script have pushed the artistry of calligraphy to its peak in the pens of calligraphers of all dynasties. Calligraphy is still active in every corner of the Chinese cultural circle. Therefore, we hope to understand the sensibility of the two representative fonts, regular script and cursive script, and apply them in the fields of design and teaching.

This study selects two masterpieces, "The Inscription on the Sweet Spring in the Jiucheng Palace" and "Autobiography" as samples, and samples and screens the works for words. Collect suitable adjectives as Kansei vocabulary, and collect data through expert questionnaires. Finally, Gray Relational Analysis (GRA) is used to obtain the ranking of the importance of adjectives. The analysis results are used as the basis for discussing the application of the two calligraphy styles and the form of educational entry.

Literature review

This chapter focuses on the research and discussion of important related literature, and the scope is divided into four aspects: The basic theory of research methods, Chinese characters appearance, Overview of Chinese calligraphy and Chinese Calligraphy Education, which serve as the basis for the relevant discussion, analysis, and development of this research.

The basic theory of research methods

This study uses the Kansei vocabulary derived from "Kansei Engineering" to measure the feelings and evaluations of regular script and cursive script for calligraphy viewers, and mainly uses the gray relational analysis (GRA) calculation analysis to rank the importance. In "Research on the Evaluation of Product Intrinsic Aesthetic Design Elements. (Jung-Chin.Liang, 2013)" and "Application of professional design perspectives in the design research of the external beauty of products" (Jung-Chin .Liang 2012), the method of applied kansei engineering combined with the gray relational analysis method is applied to the basis of product shape design; In "Application of Educational Measurement and Statistical Methods to Metalwork Design and Courses Strategy Analysis" (Hsiu-Jye .Chiang, 2016), it shows the flexibility and possibility of combining the Gray Entropy theory with various analysis methods.

Kansei Engineering

The theory of "Kansei Engineering" was proposed by Mituo Nagamachi (1970), which is a science that prioritizes the human point of view. "Kansei" is a Japanese phonetic word, and its meaning is the same as Sensitivity, Feeling, and Impression. Kansei is a cognitive expression based on feelings, and Mituo Nagamachi defines Kansei engineering as: "The technology that transforms the feelings or images consumers have about products into design elements" (Huang, 2014). When we see the appearance of a product, there will be many perceptual associations, among which the visual image association is the most obvious (Wang, 2002). We use adjectives to evaluate the shape, line, color, structure and other factors

of items, and these adjectives are called "Kansei vocabulary". After Kansei vocabulary is quantitatively analyzed through engineering methods, the perceptual elements of objects can be detected, which can be used as a strategy to convey and apply human psychology.

Grey Relational Analysis

Gray system theory was proposed by J. L. Deng in 1982. Its theory is mainly to conduct relational analysis for the ambiguity or incompleteness of the system model, and to explore the overall system by methods such as prediction and decision-making. Gray relational analysis is based on the change of each factor, combined with mathematical methods, to analyze the similarity of the geometric shape of the change curve, and develop a set of theories to solve the incomplete information system to judge the degree of correlation between factors. It can effectively deal with uncertain, multi-variable, discrete, and incomplete data. Gray relational analysis is the most effective analysis tool of gray system theory (Chiang, 2016).

Gray relational analysis has the following characteristics: (1) The established model is a non-functional sequence model; (2) The calculation method is simple and easy; (3) There is no excessive requirement on the number of samples; (4) It is not required that the sequence data must conform to the normal distribution; (5) It will not produce contradictory conclusions that are different from qualitative analysis (Chen 2021).

This study uses Nagai Masatake's gray relational formula to calculate Gamma. The advantage is that the calculated results will all Gamma values fall between 0 and 1. This method takes the origin as the coordinate distance, and the values can be correctly positioned and compared (Chiang, 2016). The gray relational method is widely used in various fields, especially for the clarification and sorting of ambiguous affairs. Gray relational analysis has the characteristic of sorting the importance of data, which is very suitable for screening and sorting design elements sorted out by Kansei Engineering.

Chinese Characters Appearance

There are many different angles for the analysis of Chinese characters. This section of the study discusses from two parts: Chinese character components and Chinese character outline. The relevant research on Chinese character components is based on the composition and structure of Chinese characters. The systematic study of Chinese character components was first published in "Analysis of Chinese Character Component" (Hsieh, 1972) and published in the journal of National Chiao Tung University. The Chinese character outline focuses on the shape of the text frame, which is more common in font design related research. Especially in "The knowledge of fonts" (Chiu, 1991) and "Chinese Typographers since 1949" (Liao, 2014).

Chinese Character Components

Chinese characters are composed of one or more components, while Chinese character components refer to the relative positional relationship between components. Taking the word "音" in Figure 1 as an example, the whole can be disassembled into a horizontal structure "音" + " | | ", and then "音" can be disassembled into a combination of "立" + "口". There are many classification and induction methods for Chinese character components, here is the classification of structure based on regular script characters in "Analysis of Chinese Character Component" (Hsieh,1972). The component structure is divided into four categories:

single body, horizontal structure, vertical structure and surrounding structure, as shown in the Chinese component structure form in Figure 2 (Hsieh, 1972). It is worth mentioning that there are also types of combination and change among the four categories. At this time, the classification is based on the sequence of disassembly. If you encounter a shape that can be divided into "田", the completeness of the radicals or the components connected by the radicals should be given priority for disassembly. For example, "鬚" is first disassembled into "髟" + "胡", and then further disassembled into "鬣" + "彡" and "古" + "月".

Figure 1: The components of "剖"

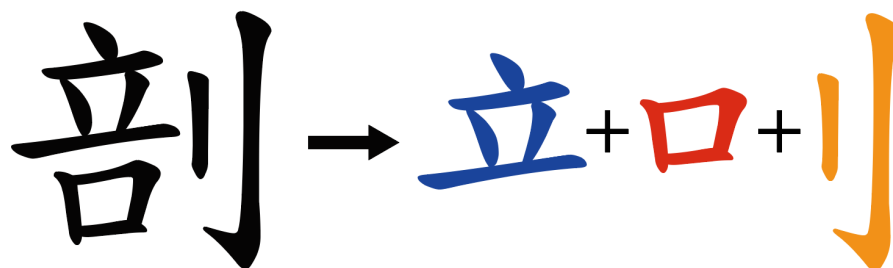
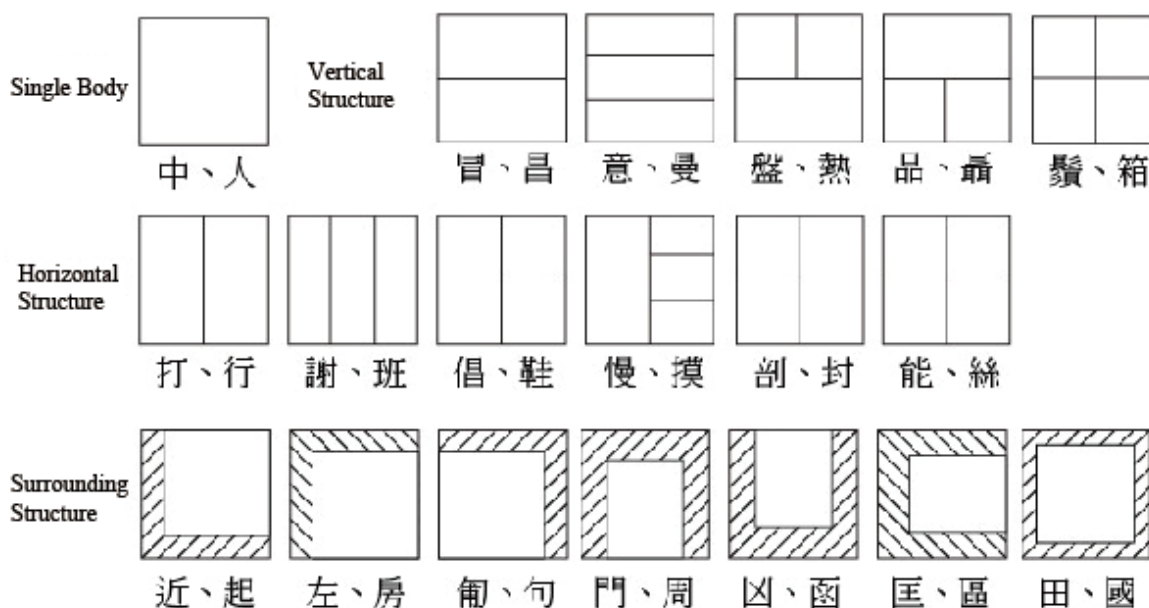


Figure 2: Chinese components structure

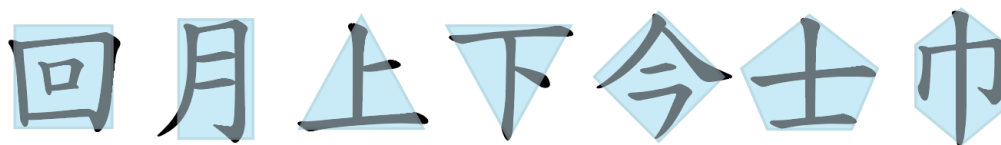


Chinese Character Outline

Chinese characters are famous for their square characters, but the stroke composition of Chinese characters also makes the characters visually produce different outlines. Yung-Fu and Chiu (1991) divided Chinese characters into six types of characters according to their geometric shapes: square, rectangle, triangle, rhombus, pentagon, and hexagon in Figure 3. Characters with different outlines will affect the visual size and the center of gravity of the font. For example, the center of gravity of the regular triangle sinks and has a sense of stability and strength, while the inverted triangle has a strong sense of dynamics. Miao-Yi, Huag (2012) mentioned in her research that teaching Chinese characters through the

combination of lines and geometric shapes can make it easier for learners to recognize and write Chinese characters.

Figure 3: *Types and Examples of Chinese character Outlines*



Overview of Chinese Calligraphy

Calligraphy and Chinese characters are closely combined and are inseparable from the life of the Chinese cultural circle. Different calligraphy styles have different temperaments. This section discusses the discussion related to calligraphy. It begins with a discussion of the history of calligraphy, followed by the aesthetics of calligraphy and calligraphy education. In this way, we can understand the current situation of calligraphy in a general way. "A Brief History of Calligraphy" edited by Lin.Ma tells the evolution of calligraphy art in order of Chinese dynasties. "Introduction to calligraphy fonts" written by Chien-Jung .Hsu describes the characteristics and changes of each calligraphy in detail. In terms of calligraphy aesthetics, the book "Chinese Calligraphy" edited by Jhen-Lian and Chen in 1994 has quite in-depth theoretical analysis and discussion on calligraphy aesthetics, calligraphy appreciation and calligraphy creation and techniques. "The Beauty of Chinese Calligraphy: Dancing Cursive" edited by Hsun, Chiang explains the evolution and charm of calligraphy in a more life-like way.

A Brief Hhistory of Calligraphy

Since the beginning of Chinese characters, calligraphy has entered the enlightenment. From the oracle bone inscriptions and bronze inscriptions in the pre-Qin period, the large seal script in the Western Zhou and Warring States periods, to the small seal script in the Qin Dynasty, a unified and standardized calligraphy art has emerged (Ma, 2005). The official script developed in the Qin Dynasty simplifies the structure and strokes of the small seal script, opening the era of calligraphy today, and the shape of Chinese characters was roughly the same at that time. During the Han Dynasty, the development of official script reached its peak, and the brushwork of regular script gradually took shape. The emergence of Wang Xizhi and Wang Xianzhi in the Wei and Jin Dynasties perfected the brushwork of regular script and created a precedent for "cursive script". Regular script reached its peak in the Tang Dynasty. It was easy to write and the fonts were regular, and it reached the peak in terms of practicality. "From the perspective of calligraphy art, the special style of brushwork is adopted, and regular script is the most exemplary meaning, which also makes the evolution of characters come to an end. (Hsu, 2004)" Regular script has hardly changed from the Tang Dynasty to today's computer standard script. Later calligraphers in the Song, Yuan, Ming and Qing Dynasties created different and interesting writing styles based on the scriptures left by the previous dynasties.

Calligraphy Aesthetics

"The same origin of calligraphy and painting is a beautiful talk in the history of Chinese art. It has two meanings. The origin of both calligraphy and painting is based on the imitation of

objects; the tools and materials used in both are the same. (Shao,2006)" Chinese characters are characters that combine shape, sound, and meaning. Due to the pictorial structure of Chinese characters, Chinese characters and visual arts have gradually established a connection after a long period of use and evolution. Starting from the initial image, it is gradually symbolized, gradually breaking away from the category of image and reaching the peak of structure and norms in regular script. Cursive script, on the other hand, is gradually departing from the norms and moving towards an aesthetic dimension of emotion and abstraction with more artistic conception. Calligraphy aesthetics is mainly an aesthetic artistic conception composed of external shape and internal meaning. The aesthetics of shape lies in the image formed by the interrelationships of brushwork, structure, composition, and ink. The internal meaning refers to the emotion and character contained in calligraphy. Both internal and external constitute the basic model of calligraphy aesthetics (Xie, 2003).

Chinese Calligraphy Education

Calligraphy was designated by Confucius as one of the "six arts", and it was an essential skill for a gentleman in ancient times. Most calligraphy education in ancient times began with writing education. In addition to school education, it also included family education and social education. In ancient school education, Chinese character writing education was a key subject set by almost all schools (Lo, 2016). The perception and application of calligraphy in today's society is also very different from the situation monopolized by class in the past.

Current Situation of Calligraphy Education in Taiwan

Taiwan and Hong Kong are the only countries where traditional characters are used as characters, and calligraphy education was one of the basic courses in elementary schools in the early days. However, with the changes of the times, calligraphy teaching has gradually developed from the original emphasis on writing techniques to the cultivation of temperament and aesthetic education (Lo, 2016). In terms of calligraphy education in Taiwan, the strength of the society is the main force supporting calligraphy education. The development of most calligraphers almost all come from private school-style folk calligraphy education. The education and inheritance of many calligraphy are advocated and promoted by non-governmental organizations (Lin, 1999). Calligraphy education has always been between the two subjects of Chinese and art in the education system. In the department of the university system that focuses on literature and history, its calligraphy course design is mostly based on traditional Chinese culture, emphasizing the continuation of calligraphy history and calligraphy theory, and focusing on cultivating students' cognition and literacy. Departments with art as the core of the curriculum tend to investigate the essence of calligraphy art, and it is difficult for ordinary people to study in depth. Such differences make it difficult for many people to deeply understand and appreciate calligraphy.

The Revolution of Modern Calligraphy

"Chinese calligraphy is a special case in the history of world art, and the reason why it is a special case is because it uses words as a medium to get involved in the field. The readability of calligraphy art has become the biggest feature compared to other art types. However, this feature has gradually encountered challenges and breakthroughs in modern calligraphy" (Li, 2000). However, the pure visual state of modern calligraphy after removing the meaning of words is closer to the essence of Chinese characters (Li, 2008). The biggest difference in the form of "modern calligraphy" is that it puts the importance of shape and space first. It is

"space, not recognition and reading" (Chiu 2008). Such changes have made the art of calligraphy more emphasis on spiritual symbolism and visuality, making the creation more inclined to less words, abstract, and unreadable development. This also enables the art of calligraphy to start to break away from paper, brush and ink, and to combine more different media. With the development of electronic equipment and the development trend of modern calligraphy art, perhaps the education and interpretation of calligraphy art may have more angles.

Method







The research process is roughly divided into three parts, the first is the collection and screening of regular script samples and cursive script samples, the second is the collection and screening of Kansei vocabulary, and the last is to make samples and Kansei vocabulary into expert questionnaires to collect data.

Chinese Calligraphy Sample Collection

Table 1 shows the samples of regular script, using "The Inscription on the Sweet Spring in the Jiucheng Palace" as the sample source, and screening by Chinese character components. Among them, the most common 14 kinds of components structures are selected, and in each structure, the two characters with the least strokes and the most strokes in the sample are selected, a total of 28 characters are used as samples.

Table 2 is based on "Autobiography" from the National Palace Museum collection in Taipei as the sample source. Use Chinese character outline as the screening basis. After discussion, 6 kinds of character outlines were selected, and the most obvious four characters were selected as samples, a total of 24 characters.

Table 1: Samples screened from "The Inscription on the Sweet Spring in the Jiucheng Palace"

Types of Components	Representative sample	Types of Components	Representative sample
	炎 覺		京 寶
	架 聖		昆 窮
	加 櫟		砌 榭



























Types of Components	Representative sample	Types of Components	Representative sample
	勃 頰		始 鏡
	戒 載		在 屬
	風 關		延 還
	回 圖		之 帝

Table 2: Samples screened from “Autobiography”

Types of Outlines	Representative sample
	國 在 筆 統
	女 心 止 也
	在 嘉 真 治

Types of Outlines	Representative sample			
				
				
				

Screening of Kansei vocabulary

After collecting 50 Kansei vocabulary from reference books and Internet materials. Discuss with experts on the screening of appearance characteristics of regular script and cursive script, and finally screen out the most suitable 20 Kansei vocabulary and make it into Table 3.

Table 3: *Kansei vocabulary table*

(1)Dynamic	(2)Heavy	(3)Density	(4)Harmonious
(5)Interspersed	(6)Hierarchical	(7)Precision	(8)Rigid
(9)Dignified	(10) Clear	(11) Balanced	(12) Delicate
(13) Structural	(14) Contrastive	(15) Stable	(16) Lively
(17) Symmetrical	(18) Plump	(19) Curved	(20) Rational

Questionnaire making and data collection

We divided the calligraphy samples into groups of 4 as shown in Figure 4. A total of 13 groups of calligraphy samples and 20 adjectives were made into questionnaires. A 5-point Likert scale was used to measure the subjects' scores for each Kansei vocabulary. Record gender, age, and experience with design or calligraphy as basic information. The questionnaire invites experts with more than 3 years of experience in calligraphy teaching and design to conduct the test. The final number of questionnaires is 16, one of which is an invalid questionnaire; the years of contact with design or calligraphy are distributed between 4 and 24 years; 7 males and 5 females. Finally, the questionnaire survey results are input into the gray relational data analysis program, and the final ranking is calculated.

Figure 4: Image Sample for Questionnaire

Results and analyses

In this research, 15 effective expert questionnaires were collected. First, all experts performed gray relational calculation and analysis on the Kansei vocabulary questionnaire results of individual images, and then integrated the Kansei vocabulary gray relational value (Gamma) of each image into the gray relational data table. in the calculation. The gray relational analysis method distributes the degree of correlation between the final perceptual vocabulary and all samples between 0 and 1, where 1 is the highest correlation and 0 is the lowest correlation.

GRA of Regular Script

The correlation between regular script and Kansei vocabulary is shown in Table 4. Through analysis and results, we define a vocabulary with a Gamma value greater than 0.7 as high correlation, and a vocabulary lower than 0.3 as low correlation. We found that in all Kansei vocabulary, the order of Gamma value is Clear (1.00), followed by Rational (0.82), and then Structural (0.73) and Stable (0.71); On the other hand, Kansei vocabulary with low correlation is Curved (0), Dynamic (0.15), Lively (0.17), Interspersed (0.19), Contrastive (0.29). From the analysis results, it can be seen that as a design element, regular script can be used to express information and give people a stable and clear image. It is difficult to express a dynamic feeling. Regular script is the entry point for almost all calligraphy learners. From the perspective of aesthetic education, we can focus on introducing the **structural relationship** and **composition changes** of the various parts of regular script. By analyzing the graphic space, it can be used as a good entry point for calligraphy aesthetic education.

Table 4: GRA of Regular Script

Adjectives	Gamma	Adjectives	Gamma
<i>Clear</i>	1.00	Delicate	0.50
<i>Rational</i>	0.82	Symmetrical	0.42
<i>Structural</i>	0.73	Hierarchical	0.34
<i>Stable</i>	0.71	Density	0.31
Precision	0.68	Heavy	0.30
Rigid	0.65	<i>Contrastive</i>	0.29
Harmonious	0.63	<i>Interspersed</i>	0.19
Dignified	0.61	<i>Lively</i>	0.17
Balanced	0.58	<i>Dynamic</i>	0.15
Plump	0.52	<i>Curved</i>	0.00

GRA of Cursive Script

The correlation between cursive script and Kansei vocabulary is shown in Table 5. Through analysis and results, we define a vocabulary with a Gamma value greater than 0.7 as high correlation, and a vocabulary lower than 0.3 as low correlation. We found that among all Kansei vocabulary, the ranking of Gamma value is Curved (1.00) the highest, followed by Dynamic (0.90) and then Lively (0.83), Interspersed (0.78) and Density (0.71); ; ; It is worth noting that there are as many as 10 items in the Kansei vocabulary part with low correlation, among which the four items with the lowest correlation are Precision (0), Heavy (0.01), Dignified (0.01) and Rigid (0.02). It can be seen from the analysis results that As a design element, cursive script can work well with curves or curved surfaces or on soft surface, giving people an organic, ornamental features. It is relatively difficult to express the feeling of being rigorous and rational.

The strokes of cursive script are connected to each other, making it difficult to read. Therefore, it is recommended to look at the whole work and analyze the shape, connection and texture changes of the lines in another aesthetic way.

Table 5: GRA of Cursive Script

Adjectives	Gamma	Adjectives	Gamma
<i>Curved</i>	<i>1.00</i>	<i>Structural</i>	<i>0.29</i>
<i>Dynamic</i>	<i>0.90</i>	<i>Stable</i>	<i>0.24</i>
<i>Lively</i>	<i>0.83</i>	<i>Symmetrical</i>	<i>0.18</i>
<i>Interspersed</i>	<i>0.78</i>	<i>Plump</i>	<i>0.17</i>
<i>Density</i>	<i>0.71</i>	<i>Clear</i>	<i>0.16</i>
Hierarchical	0.56	<i>Rational</i>	<i>0.13</i>
Delicate	0.55	<i>Rigid</i>	<i>0.02</i>
Harmonious	0.51	<i>Dignified</i>	<i>0.01</i>
Contrastive	0.46	<i>Heavy</i>	<i>0.01</i>
Balanced	0.43	<i>Precision</i>	<i>0.00</i>

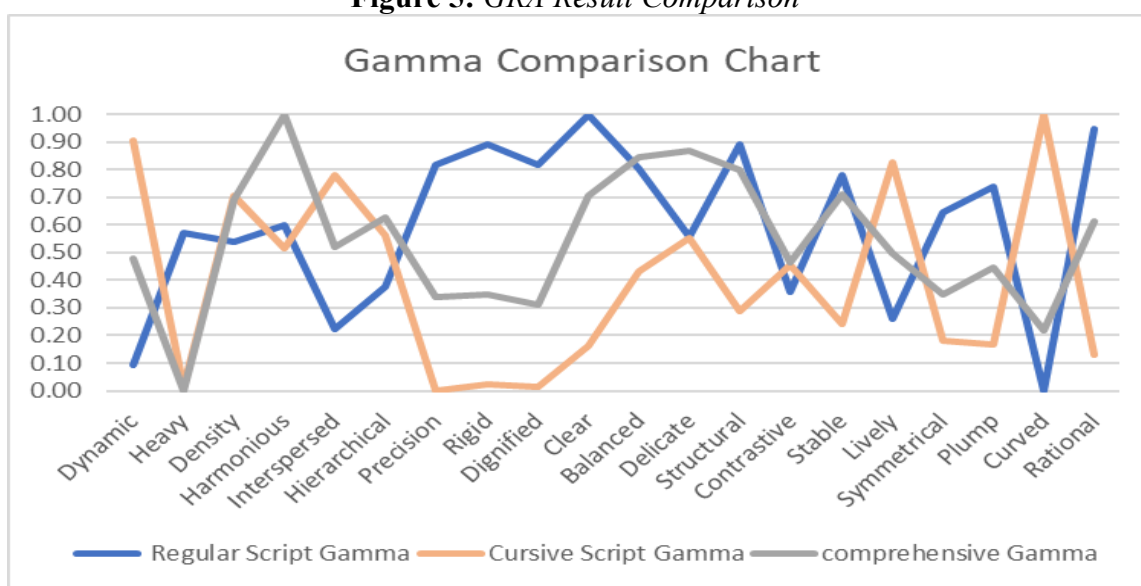
GRA of Comprehensive Chinese Calligraphy

Finally, we collected all the sample data, and made a gray correlation analysis on the sample data of regular script and cursive script, trying to find out the common correlation between the two. The final results are shown in Table 6. Similarly, Kansei vocabulary with a Gamma value greater than 0.7 are defined as high relevance, and with a Gamma value lower than 0.3 are defined as low relevance. The correlations, starting from the highest, are Harmonious (1.00), Delicate (0.87), Balanced (0.84), Structural (0.80) and Stable (0.71). Those with low correlation are Curved (0.22) and Heavy (0.00). Kansei vocabulary with high correlation can be understood as the common basic aesthetics of both regular script and cursive script, both of which are biased towards the overall balance and harmony of the shape. Heavy is a property that needs to be avoided, but a low value of Curved is a phenomenon worthy of further investigation. From Figure 5 GRA Result Comparison, we can see that there are obvious correlation differences among the three sets of data. This is a good representation of the characteristics expressed by different calligraphy, and the level of the comprehensive data represents the common characteristics of the two calligraphy.

Table 6: *GRA of Comprehensive Chinese Calligraphy*

Adjectives	Gamma	Adjectives	mma
<i>Harmonious</i>	1.00	Lively	0.50
<i>Delicate</i>	0.87	Dynamic	0.48
<i>Balanced</i>	0.84	Contrastive	0.47
<i>Structural</i>	0.80	Plump	0.44
<i>Stable</i>	0.71	Symmetrical	0.35
Clear	0.70	Rigid	0.35
Density	0.69	Precision	0.34
Hierarchical	0.63	Dignified	0.31
Rational	0.61	<i>Curved</i>	0.22
Interspersed	0.52	<i>Heavy</i>	0.00

Figure 5: *GRA Result Comparison*



Conclusions and suggestions

This study uses Kansei Engineering to analyze the difference in sensitivity between regular script and cursive script, conducts surveys with expert questionnaires and uses gray relational analysis to analyze the data. The analysis results serve as the basis for the learning and application of calligraphy in the field of design, and explore the possibility of applying it to calligraphy education. Considering that there is a cognitive threshold for calligraphy and modeling in the research process, data is collected through expert questionnaires, and the data is analyzed through gray relational analysis. The findings of the study are divided into three parts. First of all, regular script has the characteristics of clarity, rationality, and clear structure, and clarity is the most relevant feeling. When designing, you can use this feature to strengthen the design style, and it is very suitable as a starting point for understanding characters; then, cursive script is Full of the characteristics of Curved, Dynamic and Lively, this well explains the excellent adaptability of cursive script in combining fashion design and modern dance. In terms of aesthetic education, it is more difficult to identify, but it may be possible to start from the direction of graphic art, from pure modeling and aesthetics; the third part is to explore the common characteristics between cursive script and regular script, from the analyzed data As a result, it can be known that Harmonious, Delicate, and Balanced are the basic aesthetic cognitions that both styles must possess.

From the research results, we have a clearer understanding of regular script and cursive script, and can have more data support in application and education. The two kinds of calligraphy have the same structure of random characters, but the writing methods are completely different. A breakthrough in the process of this research is to find out the corresponding screening method through the difference in the appearance of the two calligraphy. In the way that regular script uses Chinese character components, cursive script uses Chinese character outline as the basis for screening samples. After this study, the feasibility of such a classification method can be preliminarily confirmed. Perhaps in the future, more in-depth research can be conducted on the difference in perception brought about by the composition of different Chinese character components and the difference in sensitivity brought about by different glyph outlines.

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