

Exploring Baroque Composition: Bach's Mathematical Logic vs Handel's Emotional Expression

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Abstract:

Focusing on the two brilliant Baroque Music giants - John Sebastian Bach and George Friedrich Handel, this paper explores the unique mathematical logic contained in Bach's composition deeply and carefully, and makes a deep excavation from its rigorous musical structure, accurate rhythm arrangement, and the symmetry and regularity of melody. Compare their differences in music structure, melody characteristics, rhythm application and other aspects, and analyze the deep-seated reasons for these differences from the perspective of personal experience, cultural background and the era environment.

Keywords:

Baroque Music, Bach, Handel, Mathematical Logic, Emotional Expression

1. Introduction

Baroque period is an important stage in the development of European music, during which the society is in the process of change. European countries are experiencing the evolution from conservative feudalism to free capitalism. People are eager to break the spiritual shackles and pursue a free spiritual life. At the same time, the religious reform movement had a profound impact on Baroque music. The division of Christian sects and the rise of Protestantism changed the demand for religious music. Baroque art and music are often used to express religious feelings and beliefs. Bach's music perfectly interprets this kind of music form which is spiritual and religious. However, Handel's music is export-oriented and public oriented. Unlike Bach's emphasis on instrumental music, Handel's music themes are mostly operas and oratorios, which fully use the vocals to express his thoughts.

Bach and Handel, as the representatives of Baroque music, their works not only show the music style at that time and provide an important reference for future music creation, but also leave an indelible mark in the long river of music history.

2. The Beauty of Mathematics in Bach's Music

2.1. Geometric and algebraic structures of Bach's music

2.1.1. The geometrical structure of music in The Art of Fugue

The Art of Fugue is an outstanding representative of complex counterpoint in Bach's music. In this work, musical lines are crisscrossed, just like carefully drawn geometric figures. Each voice part is like an independent line, which not only maintains its own characteristics and melody trend, but also coexists harmoniously with other voice parts. For example, in the 10th counterpoint in *The Art of Fugue*, the theme repeats in reverse order (end note → first note), and the melody line is folded in the time dimension, just like flipping a segment along the midpoint, and the path of the voice part forms a closed geometric ring.

2.1.2. The embodiment of algebraic structure in music

The transfer of themes in fugue between different modes (such as dominant, subordinate, parallel, etc.) can form a finite cyclic group. For example, the tonality conversion of a five degree circle can be regarded as the “addition operation” of group elements, such as the five degree increment of $C \rightarrow G \rightarrow D$, which is equivalent to the operation of element+7 in the addition group of module 12. Each pitch can correspond to the “interval number” in music theory (for example, pure fifth=7 semitones, minor third=3 semitones). The presentation of the theme in different tones is equivalent to linear transformation of the interval number (for example, tone shift=overall addition and subtraction of an interval number, transposition=numerical complement). This quantitative thinking is similar to the vector space theory in mathematics.

2.2. The mathematical principles in The Keyboard Music Collection of Twelve Equal Temperament

2.2.1. Mathematical partition of the law of averages

The Keyboard Music Collection of Twelve Equal Temperament is a classic of Bach's music. The core concept of the equal temperament is to divide an octave into 12 equal semitones. This kind of segmentation is not random, but contains profound mathematical principles. From a mathematical point of view, an octave interval can be described by an exponential function, and its frequency ratio shows a certain regularity. By dividing an octave into 12 semitones, the frequency ratio between each semitone is equal. This precise mathematical segmentation provides a stable basis for music creation. This segmentation method makes the relationship between different pitches more clear, and provides accurate pitch reference for musicians in their creation and performance.

2.2.2. Free transposition of music system

Bach's music system created through the average law has the characteristics of free transfer of tones in all tonality. This innovation has a far-reaching impact on later music theory and creation. In this music system, because the pitch of each semitone is precisely divided, musicians can easily switch between different tones without any deviation in pitch. This ability of free transfer brings great flexibility to music creation. Composers can express different emotions and atmospheres in different tonality according to their needs.

2.3. Fractal theory and Bach's music structure

2.3.1. The concept and characteristics of fractal

Fractal is an important concept in modern mathematics, which refers to the geometric structure showing self-similarity at different scales. Fractal has the following characteristics: self-similarity, that is, the local and the whole have similarity in morphology, structure and so on; The infinitely fine structure, no matter how small the scale is, can find complex details; The generation rule is relatively simple, but it can produce extremely complex graphics. These characteristics provide a theoretical basis for understanding the fractal structure in Bach's music.

2.3.2. Self-similar structure in Bach's music

Taking Bach's Fugue works as an example, we can clearly see the self-similar structure in music. In fugue, the theme will be repeated in different parts and time points. This repetition is not a simple copy, but through change and development, a similar and different musical structure is formed. For example, in the *art of Fugue*, the theme appears in turn in each voice part, just like the fractal graphics in nature, showing a similar shape at different scales. This self-similar structure has amazing similarity with fractal graphics in nature.

3. Emotional Tension in Handel's Opera and Oratorio

3.1. Emotional depiction in Julio Caesar

Handel's Opera *Julio Caesar* is one of the outstanding representatives of his emotional expression. In this work, Handel profoundly depicts the inner world of the characters through exquisite music design. Complex human themes such as power, love and betrayal are vividly displayed in music.

3.2. The generation of emotional resonance

Handel's music can arouse strong resonance among the audience because of his profound understanding of human psychology. Taking *Julio Caesar* as an example, the emotions of different characters in the play are delicately displayed through music, so that the audience can feel it. Ensemble plays an important role in opera. The alternation and overlapping of different voice parts constitute a strong and unique dramatic conflict. In terms of sound effect, the sound effect produced by ensemble singing is more three-dimensional than that of monophonic singing, and produces richer and diverse auditory experience.

3.3. Emotional synthesis in Messiah

3.3.1. The creation background and connotation of the work

Handel's oratorio *Messiah* was created at the low point of his life and career. At that time, Handel's opera career in England was frustrated and his life fell into poverty and hardship. At this time, London playwright Charlie Jennings sent him the script of the *Messiah*. The theme of this work is religion, including the contents of the Old Testament and the New Testament, focusing on spiritual practice, thinking about the story of the savior "Messiah", covering the birth, suffering and resurrection of Christ. Although there is no specific story plot, it deeply conveys the connotation of religious texts through indirect and symbolic narration.

In the process of reading and thinking about the script, Handel experienced a baptism of the spiritual world. He felt the power of God, and the sun and touch reappeared in his heart. After years of thought savings, he began to compose the

music of the Messiah in 1742. In the process of writing, Handel was often moved to tears, and even soaked the manuscript.

3.3.2. The artistic effect of multimodal stimulation

From the perspective of cognitive science, Messiah has a unique multimodal stimulating effect. This oratorio closely combines religious texts with music, while activating the brain regions responsible for language processing and emotional response.

In terms of music, the melody of Messiah is rich and original, often adding beautiful decorations and drawl to strengthen the expression of emotion. The chorus is simple and profound. Polyphony and main tone texture alternate, and the harmony is solid and powerful.

4. A Comparative Analysis of Bach's and Handel's Music

4.1. Differences in creative styles

4.1.1. The binary opposition between mathematics and emotion

Bach's music is famous for its mathematical accuracy and logic, while Handel's music is famous for its strong emotional impact. This duality is clearly reflected in the works of the two masters. Bach's music is like a rigorous mathematical formula, from the geometric aesthetics of counterpoint, to the mathematical principles in the "Twelve law keyboard collection", and then to the wonderful combination of fractal theory and music structure, all show the beauty of rationality in music. Handel's works, whether opera or oratorio, are full of strong emotional expression. Through exquisite music design, they deeply describe the inner world of the characters and arouse strong resonance from the audience.

4.1.2. Different emphasis on rational structure and emotional expression

The rational structure of Bach's music is mainly reflected in its creative techniques and musical forms. Bach's Counterpoint method can be called geometry in music. Through complex vocal part combination, a rigorous musical structure is constructed. The keyboard music collection of twelve average temperament is the ultimate application of mathematically accurate interval division, creating a music system that can freely shift tones in all tonality. This rational structure reflects Bach's precise control of musical forms.

4.2. The status difference in Baroque Music

4.2.1. Comparison of influence before and after death

In their lifetime, Bach and Handel had significantly different artistic activities, social status and influence. Bach never left Germany in his life. He mainly worked as a musician in churches and courts, and his life was relatively flat. His music did not attract widespread attention at that time, and his social status was relatively low. Bach spent his life writing silently, devoting himself to combining religious music with rigorous musical structure. Although his works showed high artistic value, they were not recognized before his death.

Handel, on the other hand, was born in Germany but with pioneering spirit. He traveled to various European countries and eventually became an Englishman. Handel was appreciated by the king in England and had superior living conditions. His opera career was very successful at that time, and his works were very popular. Handel's music attracts many audiences with its strong emotional expression and drama.

After their death, Bach and Handel's works have experienced different fates. Bach was almost forgotten by the world in the 50 years after his death. Until Mendelssohn rediscovered his works, Bach's music was gradually recognized and respected by people. Bach's music, with its mathematical accuracy and logic [1], has become an important cornerstone of music theory and creation in the future.

4.2.2. Influence on the development of music in the future

Bach's and Handel's music have had a profound impact on the music theory, creative style and performance skills of later generations, but the ways of influence are different.

Bach's music, with its rigorous structure and profound mathematical principles, has laid a solid foundation for the development of later music theory. His counterpoint method can be called the geometry in music [2]. The twelve average temperament keyboard music collection creates a music system that can be freely transferred in all tonality, showing the internal relationship between music and mathematics. Bach's music has a great impact on the polyphonic music creation of later generations. Many composers draw inspiration from his works and explore the beauty of music's structure and form.

Handel's music, with its strong emotional expression and drama, has a far-reaching impact on the creation of opera and oratorio in the future. He initiated the English oratorio, combining religious texts with music, creating a multimodal artistic effect. Handel's harmonic language is also an important tool for him to express his emotions. His skilled use of harmonic "emotional code" makes his music have a strong appeal. Later composers also used Handel's harmony skills for reference in their creations to better express their emotions and shape musical images.

Generally speaking, Bach and Handel have obvious differences in the status of Baroque music, but their music has made indelible contributions to the development of music in the future. Their works are like two bright pearls, shining with eternal light in the long river of music history [3].

4.3. Reference and Enlightenment of research

This paper explores the beauty of mathematics in Bach's music and the power of emotion in Handel's music in Baroque music composition, and makes a comparative analysis of the two. Bach's music shows the accuracy and logic of mathematics, from the counterpoint geometric aesthetics in the art of Fugue, to the mathematical principles in the collection of twelve temperament keyboards, and then to the wonderful combination of fractal theory and music structure, which reflects his precise control of music form. Handel's music is famous for its strong emotional impact. In opera and oratorio, through exquisite music design, it profoundly depicts the inner world of the characters and arouses strong resonance from the audience.

In terms of the status differences in Baroque music, Bach and Handel differ in the scope of artistic activities, social status and influence before their death, and the fate

of their works after their death is also different. But their music has had a far-reaching impact on the music theory, creative style, performance skills and other aspects of the future, and has made an indelible contribution to the development of music in the future.

In short, the beauty of mathematics in Bach's music and the emotional tension in Handel's music together constitute a brilliant chapter of Baroque music, which provides a unique perspective for us to understand the complex relationship between music, brain and emotion, and also provides reference and Enlightenment for the fields of modern music theory, artificial intelligence composition and music therapy.

5. Conclusions

5.1. Research conclusion

Although this study deeply explores the embodiment of Bach's mathematics and Handel's emotion in Baroque music composition, there are still some deficiencies.

First of all, the analysis of some works is not deep enough. Bach and Handel have a large number of works. This study only selects some representative works for analysis. There may be incomplete understanding of their other works.

Secondly, there is a lack of research on other aspects of the two masters. In addition to the mathematical and emotional elements in music, the creation of Bach and Handel was also influenced by many factors, such as society, culture, history and so on. The analysis of these aspects in this study is relatively few, and it fails to fully reveal the background and motivation of the two masters' creation.

5.2. Prospects for future research

Although there are some deficiencies in this study, it also provides a direction for the further study of Baroque music composition and Bach and Handel's music in the future.

More works of Bach and Handel can be further analyzed, especially those less concerned. Through the study of these works, we can have a more comprehensive understanding of the creative style and artistic achievements of the two masters, and enrich our understanding of Baroque music. Strengthen the study of Bach and Handel's creative background. A deeper understanding of the social, cultural, historical and other factors at that time can better understand their music creation motivation and intention.

Finally, with the continuous development of science and technology, future research can use modern scientific and technological means, such as artificial intelligence, music information retrieval and other technologies, to conduct more in-depth analysis and exploration of Bach and Handel's music. In short, future research can further expand and deepen the study of Baroque music composition and Bach and Handel music on the basis of this study, and provide richer theoretical and practical support for better understanding and appreciation of Baroque music.

Conflicts of Interest

The author declares that there is no conflict of interest regarding the publication of this article.

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