The Connection with Science and Renaissance Art

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Abstract. This article is about two artists who were both important in the history of Renaissance art, Leonardo da Vinci and Albrecht Dürer. They developed scientific research in their artistic production, combining art and science to make the results of their work more rigorous and to provide much material for future research in history as well as in many other fields. Leonardo da Vinci was not only a great painter but also an accomplished painter in many other fields. He used the study of the human body and the analysis of space in his paintings, and it was found after later studies that the proportions and perspective of the human body used by Leonardo da Vinci were drawn in perfect conformity with the golden ratio. The work of Albrecht Dürer, a representative figure of the Northern Renaissance, is a perfect interpretation of naturalistic scientism because he observed nature and his study of the proportions of the human body, and his study of nature influenced later painters in their treatment of natural details in the paintings. An analysis of Leonardo da Vinci and Albrecht Dürer reveals the relationship between art and science during the Renaissance, and it is also possible to observe that the scientific research that developed as a result of art had a great influence on the subsequent creation of paintings.

Keywords: Renaissance, Leonardo da Vinci, Albrecht Dürer, Art, Science, Naturalism.

1. Introduction

The Renaissance led artists to observe, study and record nature through art, and Leonardo da Vinci was undoubtedly the man who left much valuable research material from this humanist movement. Both Leonardo da Vinci and Albrecht Dürer are among the two important figures of the Renaissance who, in addition to their artistic contributions, left a profound legacy in a variety of other fields. Da Vinci, for example, worked in important areas such as anatomy, geometry, and mechanics, while Dürer left much material in anthropometry, geometry, and astronomy. Their research is inextricably linked to these areas of modern science. Art was based on the observation of the world of appearances and the practice of the mathematical principles of balance, harmony, and perspective developed at the time [1]. Leonardo da Vinci and Dürer were leaders in this field because they were drawn to the truth and would move forward in the pursuit of it. At the same time, the Renaissance established and shared a philosophy of fine art, where the creation of works of art was the most direct expression of nature [2]. In a similar way, Leonardo da Vinci and Dürer's act of studying nature in order to achieve a painting that presents nature in its truest form was also a step in the pursuit of truth. In order to produce the best possible picture, the use of scientific means is an essential step. In the context of the Renaissance period, art and science were both developing and progressing, and in the context of art, the development of art was inseparable from science, and the relationship between the two was mutually reinforcing. By examining the relationship between Renaissance art-making and science, it is possible to discover how artists combined science to present works of art, and what impact the study of scientific aspects in the process had on later generations.

2. Leonardo da Vinci & Albrecht Dürer

2.1. Leonardo da Vinci

Leonardo da Vinci was born in Vinci town, near Florence, Italy, and between approximately 1464 and 1470 he was apprenticed to the famous Florentine painter Andrea del Verrocchio in his studio, where he learned skills in painting, architecture, engineering, and mathematics [3]. During his life,

Leonardo da Vinci worked mainly in Florence and Milan, with brief stays in Rome and France respectively in his later years. His working and creative experience are divided into five periods, depending on his geographical location. The first period was located in Florence from around 1472 to 1482, working for the Medici family. The second period was probably from about 1482 to 1499 in Milan, as Leonardo da Vinci was sent there as an ambassador by Lorenzo de Medici, and it was during this period that the Vitruvius was created. The third period was from approximately 1500 to 1508, when Leonardo da Vinci traveled between Florence and other cities, where he was employed as a military architect and engineer. The fourth period was from around 1508 to 1513 when Leonardo da Vinci returned to Milan to continue his studies. In the fifth period, Leonardo da Vinci spent his later years in Rome and Milan respectively, circa 1513 to 1519. Leonardo da Vinci is a legendary figure in the history of art, known as a painter but still active as a draughtsman, engineer, scientist, theorist, and architect. This active mind led to an inability to concentrate, and the consequence of this inability to concentrate was probably that there were many plans in various fields that were not completed and many ideas had to be recorded in his notebooks, leaving no time to put them into practice [4]. He studied a wide range of fields and the research recorded in his notebooks shows that he also worked in anatomy, astronomy, botany, cartography, and paleontology. Although Leonardo da Vinci studied many fields, many of his studies were not published and did not influence the progress of science. He still made many small inventions that contributed to the history of science. For example, Leonardo da Vinci drew flying machines that were very similar in principle to today's helicopters, and Leonardo da Vinci's research on the *Vitruvian Man*, the study of ideal body proportions, influenced many people, Dürer being one of them. This is why Leonardo da Vinci is considered to be a bridge between ancient and modern science [5].

2.2. Albrecht Dürer

Born in Nuremberg in southern Germany, Albrecht Dürer was an icon of the Northern Renaissance, a fine painter, printer, and printmaker, and a brilliant art theorist. He possessed excellent engraving skills, which came from his family heritage. His father was a goldsmith, from whom he learned the art of goldsmithing, and his familiarity with goldsmith's tools and materials enabled Dürer to engrave very fine designs on copper and wood plates. Before Dürer, Nuremberg had not seen engravings of this scale. Two trips to Italy had a great influence on Dürer's work. After 1500 Dürer's style and worldview suddenly realized that his previous paintings lacked essential detail. In other words, they did not resemble real nature, so he began to pay attention to detail and began to study human proportions, animal proportions and the theory of perspective [2]. According to Dürer, the closer one comes to nature through imitation, the better and more artistic the work will be. Dürer began to study astronomy because, as a printer, he thought it could be a big seller, so before his second trip to Italy, in 1505, he published De Scientia Motus Orbis, the cosmology of the Persian-Jewish astronomer Mashallah ibn Attari [6]. Mashallah ibn Attari was an 8th-century Persian Jewish astrologer and astronomer from the city of Basra, and De Scientia Motus Orbis, meaning The Science of the Movement of the Spheres, contains an introduction to astronomy and Aristotle's physical studies. Dürer's research in these fields was fruitful, and in surveying, he wrote *The Four Books on Measurement* and *The Four Books on Human Proportions*. *The Four Books on Measurement* is the first German-language book on mathematics for adults published in Nuremberg in 1525, and *The Four Books on Human Proportion*, published after Dürer's death in 1528. In astronomy, he worked together with Stabius and the astronomer Konrad Heinfogel. He produced the first planes of the southern and northern hemispheres, as well as the first printed celestial charts [7]. A major contribution to Dürer's influence on the Renaissance and some painters was his selection of prints at the time, which were so well disseminated that he took advantage of their efficient rate of dissemination to make himself known in Europe.

3. The Combination of Art and Science in the Work

3.1. Leonardo da Vinci's Work

Much of Leonardo da Vinci's research was unpublished during his lifetime, and there are many studies discovered by later generations that would have contributed greatly to the development of science if they had been disseminated at the time, such as human anatomy. In contrast, the research that was disseminated in that era laid some of the foundations for art and science, such as this manuscript by Vitruvius. Proportion is the basis for the work of all artists and architects, and the most authoritative study of architectural proportion was published by the ancient Roman architect Vitruvius in his *Ten Books on Architecture*. His idea was that the human body with open arms and extended legs could be inscribed in two geometric figures, the circle, and the square. In this model, each part of the body could be treated as if it were organized by a different system of dimensions [8]. Leonardo da Vinci drew the *Vitruvian Man* using the proportional formula written by Vitruvius, and in later studies, it was found that all of da Vinci's paintings conformed to the Golden Ratio, and he was the first artist skilled in its use, although it was not discovered by da Vinci. Based on Leonardo da Vinci's painting of the *Vitruvian Man*, the concept of the divine proportion can be clearly understood. The width of a human neck is equal to the distance from the mandible to the eye; it is also equal to the distance from the mandible to the chin, which, when multiplied by 15 times, is equal to the width of the whole person. The distance between the tip of the thumb and the tip of the little finger is equal to the length of the footplate. Vitruvius believed that God created the universe and man created architecture. At the same time, that man was created by God and the human body conforms to the laws of the natural universe; the architecture created by man should also conform to the laws of the natural universe. The link between art and science is the observation and analysis of the natural rules of the universe, except that art follows the rules in its sensual creation, while science breaks down abstract truths into data and knowledge on paper. Leonardo da Vinci used geometric principles to analyze the proportions of the human body in addition to his use of geometric measurements to draw perspective effects. He invented air perspective, which is expressed by the blocking effect produced by air on vision. The further away the object is, the more blurred the image is portrayed. The object is bluish after a certain distance, the further away the heavier the color deviation. The salient features are the artistic effects that produce changes in the reality of the shape, the shades of hue, and the complexity of the shape.

3.2. Albrecht Dürer's Work

In Dürer's *Melancholy I*, the viewer can see that the print contains many scientific elements, such as herbology, geometry, surveying and astronomy. These elements are all things that Dürer was interested in and pursued throughout his life. In terms of geometry, Dürer's drawing of the Dürerian polyhedron in *Melancholia I* is not unlike the unusual polyhedron that mathematicians and scientists have been studying since Dürer's three-dimensional view departed from the classical Greek method, which was associated with applied science and mathematics in the late twentieth century [9]. While Dürer's *Melancholy I* shows the marriage of art and science, Dürer also uses the print to reflect his own spirituality. The polyhedra in the print show Dürer's excellent perspective measuring skills, the angel's wings and the dog sleeping on the ground reflect Dürer's observation and study of the details of animal proportions, and the golden crocus and watercress on the angel's wreath are thought to be herbs for melancholy, which corresponds to Dürer's study of natural plants [10]. Derived from the title, how does melancholy relate to geometry? According to the philosopher Henry of Ghent, people with a talent for geometry must be melancholic, because the realization that a field can never be brought to an end makes them mentally constrained. Dürer uses art to depict scientific forms and at the same time uses science to show artistic emotions.

In addition, in the final years of his life, Dürer wrote two books that were valuable to future artistic creation as well as being of great research value. The study of *The Four Books of Human Proportions* was based on Vitruvius' Ten Books on Architecture and many example studies of the human body

were written. Dürer's proportions follow the symmetry of the body parts, with the navel at the center and all body parts consisting of round and square geometric shapes. In addition, in Volume II, Dürer shows proportional drawings of the front and back of the human body, meaning that all parts of the body are symmetrical, with all body parts consisting of round and square geometric shapes for each part. Dürer analyzed the proportions of the human body from a scientific point of view. But from an artistic point of view, he believed that the perfect composition of the human body should consist of the face of man A, the chest of man B, the legs of man C, the arms of man D, etc. [11]. But in his later life Dürer said, he admitted that one person can think and create a more beautiful image than another, and can justify it on what people understand to be sound natural grounds; but not that it cannot be more beautiful [2]. Also, the author Panofsky believed that Dürer's theory of the proportions of the human body had reached a level unattainable by future generations [2].

4. Conclusion

An analysis of Leonardo da Vinci and Albrecht Dürer shows that their contribution to the development of art is based on the scientific research of Leonardo da Vinci and Dürer in different fields. The relationship between art and science is that art progresses based on science and technology, while art is a small part of the development of science, portraying objective facts as samples through the paintbrush. Above all, Leonardo da Vinci was an artist who studied the proportions and perspective of the human body through geometry and applied his discoveries to his paintings, allowing them to emerge through the scientific naturalism of the Renaissance. For example, in *The Last Supper*, da Vinci immersed the viewer in the scene by measuring and calculating so that the horizontal lines were perfectly aligned with the figures and table in the picture. Da Vinci used science to make his paintings more realistic, and in this process of studying science for the sake of art, his leap of faith led him to venture into different fields. Secondly, Dürer's *The Four Books of Measurements* reflect his deep understanding of geometry, as do *The Four Books of Human Proportions*, and the results of these studies are reflected in his paintings, perfectly illustrating how he combined the real and the fantastical without appearing abrupt. For instance, in Dürer's engraving of *Knight, Death and the Devil*, the horse and knight in the center of the print are perfectly proportioned, the rocks and plants in the background are realistically depicted, and the fictionalized Death and the Devil do not appear strange in the picture, as Death's head is composed on the basis of a skull and the Devil is created through the stitching together of several different animals. The basis of artistic creation is therefore based on the observation and study of natural science. From the works of Leonardo da Vinci and Albrecht Dürer, people can know an excellent artist must have a high standard of observation and also have the ability to use geometry skills fluently in the artworks.

The central themes of the Renaissance were the promotion of humanism, freedom and equality, and self-worth, which developed into philosophical ideas and a worldview. During the Renaissance, “knowledge is power” was promoted, which is why scientific research and experimentation were promoted, while the Renaissance's unanimously accepted aesthetic theory was that “artistic creation is nature” so triggering artists' enthusiasm for the natural sciences. Artists then combined art and science to show the reality of the world. Art and science go hand in hand, using science in artistic creation to present reality and emotion, and sometimes fantasy, and using art to objectively portray reality in notes on scientific theories. Thus, creation is not the only answer to the truth as science is. However, the existence of science kept the foundations of artistic creation unshaken. Artistic creation in the Renaissance provoked artists to explore nature in the pursuit of truth, which is both sciences. The Renaissance gave people a key to unlock the door to scientific exploration.

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