

Art and Science in Renaissance Works: The Beauty of Human Anatomy in Michelangelo's David

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Abstract: The integration of art and science remains a popular subject until now. There are many studies on the connection between art and other scientific disciplines of the Renaissance, but there is still room to explore the relationship between art and medicine, especially with anatomy. Therefore, the paper begins with a retrospective on anatomical progress during the Renaissance and a brief introduction to Michelangelo's life and his research experience in anatomy. Then, taking Michelangelo's *David* as a critical point, several manifestations in the sculpture related to human anatomy are precisely dissected by reviewing literature and analyzing artwork. This is followed by an exploration of the reasons to the connection between art and science, ultimately illustrating the impact of this trend on modern society. The conclusions of this paper demonstrate the relationship between art and science is that art carries science, and science inspires art. The interdisciplinary convergence of the two still has a powerful vitality and profound meaning nowadays.

Keywords: art and science, anatomy, human body, Michelangelo's *David*, Renaissance

1. Introduction

Across European history, there has been a thousand-year confluence of science and art. In the 6th century B.C., the ancient Greek philosopher and mathematician Pythagoras proposed the mathematical art of "Golden Ratio", which was applied to sculpture, architecture, painting, and other plastic arts, improving the comprehensive expression of each art [1]. The Golden Ratio, as an ideal model of the combination of art and mathematics, has been used to the present day, as often employed in framing photographic images.

After the darkness of the Middle Ages, the 14th century ushered in an era of rebirth, "the Renaissance". It was a cultural and artistic movement that was first active in Italy and then spread throughout Europe. For a long time in history, art was in the service of religion and power, with works presented mostly in unreality, flatness, and a single style. However, during the Renaissance, guided by the humanist ideology that emphasized human values, people were liberated from abstinence and returned to a concern for nature and the human body. At the same time, plenty of outstanding artists emerged in succession. The works of the art giants approached science from a practical aspect, bridging the gap between art and scientific disciplines through mathematics, anatomy, engineering, and astronomy. For instance, the painter Giotto was an early representative of the first to use perspective. The flourishing period is represented by the "three masters" of the Renaissance, including Leonardo da Vinci, the omnipotent genius; Michelangelo, obsessed with the power of the

human body; and Raphael, who excelled in creating perfect forms. Among the many works of Leonardo da Vinci, *Vitruvian Man* is the most mysterious and complex. It involves scientific fields covering astronomy, mathematics, geometry, and the human body, which is still being studied by many scholars today because the sketch is so rich in content.

This paper will put a spotlight on anatomy to further illustrate how art and science were linked during the Renaissance. Compared to Leonardo, later generations have studied relatively little of Michelangelo's attainments in anatomy. Thus, for the sake of more general research, the paper will select Michelangelo's work as the object of study. *David*, as Michelangelo's masterpiece, demonstrates the beauty of human anatomy and is a representative of the combination of art and science. Consequently, it is significant to analyze in detail the anatomy performance in *David* to understand the role of art and science in promoting each other during the Renaissance. Based on a documentary analysis approach, the paper mainly focuses on the connection between art and science as reflected in Renaissance artworks, around the famous piece *David*. Firstly, the paper introduces the background related to anatomy during the Renaissance. The second part, centered on sculpture, analyzes the link between its aesthetic features and anatomy as well as the science embodied within it, including discussions of David's pose, muscles, and proportions, as well as his hands and neck. Then, this paper explores the reasons for the move toward integrating art and science since the Renaissance. Finally, it concludes with the impact of integrating the two on current society.

2. Background

2.1. Anatomy in Renaissance

The Renaissance was a complete rebirth and development period that included innovations in all aspects, such as political, economic, philosophical, cultural, artistic, and scientific. The Renaissance was like a laboratory for extensive scientific and artistic creation, covering the study of the human body for medical and artistic purposes [2]. Alongside the quest for scientific naturalism among renaissance artists, scientific knowledge, particularly regarding anatomy, became increasingly significant in artistic creation. Thus, numerous artists had to conduct anatomical studies to understand the human form and provide material for their artworks. As a result, there was a new situation in which renaissance artists led medical progress and promoted anatomical development. At that time, there were strict restrictions on human dissection, for instance, prohibiting private dissections and only allowing public dissections by local physicians, as well as limiting the origin of cadavers, with only the bodies of criminals allowed to be dissected [3]. Despite this, many artists spared no effort to find ways to study human anatomy, of whom Michelangelo was one.

2.2. Michelangelo and Anatomy

Michelangelo Buonarroti was born in Caprese in 1475, and although he lived most of a lifetime in Rome, he still identified himself as a Florentine. He trained in painting with Domenico Ghirlandaio from age 13 and later in sculpture with Bertoldo di Giovannard [3]. Michelangelo had a life-long interest in anatomy, which commenced with attending public dissections in his teenage years when he entered the court of Lorenzo de' Medici and had access to physicians [4]. In 1493, when he was only 18, he started to dissect cadavers personally at the Santo Spirito Hospital in Florence [5]. His biographer, Ascanio Condivi, records that Michelangelo was placed in a room with cadavers by the priest to provide easy access for him to practice his dissections [6].

As one of the most representative figures of the Renaissance, Michelangelo's research covered many fields, such as natural science and art, and he made a breakthrough in applying anatomy to his artworks. This is reflected in his many masterpieces, such as *The Pietà*, *David*, and *The Last Judgment*. In *The Life of an Artists*, Vasari writes that Michelangelo was extremely drawn to artistic tasks. In

order to achieve complete perfection, he conducted countless anatomical studies, dissecting cadavers to understand the constructive principle and the combinations of bones, muscles, veins, and nerves, as well as the various movements and all the postures of the human body. He was eager to explore all the anatomical principles and rules related to art [7]. His keen interest in Michelangelo in anatomy gave him a deeper insight into the human body, which was conducive to his progress in artistic creation. Indeed, the application of his knowledge acquired through anatomy can be seen in many of his works, and *David*, the sculpture analyzed in this paper, stands as one of the testaments that he mastered the expertise of the human form.

2.3. *David*

Commissioned by the Guild of Wool Merchants of Florence, Michelangelo commenced to create *David* in 1501, when he was just 26 years old, over more than three years, and finally completed it in 1504 [8]. The legend of *David* is drawn from the *Bible*. For the first time in art, David is depicted before combat rather than in victory. *David*, reaching up to 5.5 meters in height and weighing approximately 6 tons, imparts a sense of majesty and force in visual terms. This valiant teenager is attentively focused on the battle. His head turned to the left, brows contracted, eyes sharply fixed on the opponent, nostrils dilated with tension, mouth closed with a slight strain, larynx visibly raised, muscles tensed all over the body, and his whole spirit is braced (see Figure 1). *David* offers a fascinating fresh vision, depicting a crucial moment when a “most beautiful young man ready to kill — not by savagery and brute force, but by wisdom and skill” [8-9]. *David* is not only regarded as the perfect representation of the male body in the history of Western art but also as the ideal symbol of Renaissance humanism. He embodies praise of the human body and a commendation of wisdom and willpower, which correspond respectively to the “vitality of life” and the “meditation of life”.

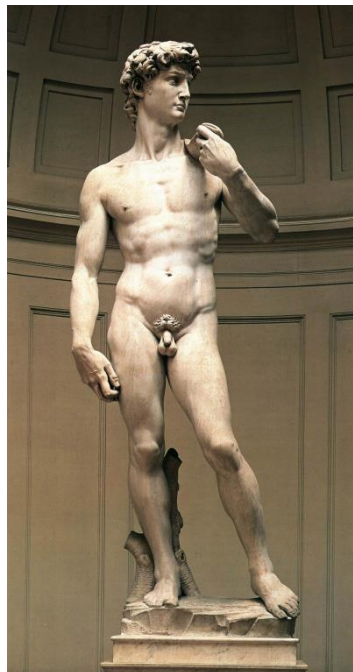


Figure 1: *David* [10].

3. Analysis

David is one of the typical artworks that reflects the anatomical attainment of Michelangelo. The following is a detailed analysis of the beauty of human anatomy and structure as presented in *David*.

The main analytical focus will be on several aspects, including the body posture, muscles, and proportions, the features of the hands, as well as the jugular veins.

3.1. Posture, Muscles, and Proportion

3.1.1. Posture

David's posture appears to be in motion, which is not only a result of Michelangelo's ingenious arrangement of timing but also a manifestation of his study of the antique arts. The posture that David is in is well known as "contrapposto", which was created by the ancient Greeks and is a pretty natural form of standing. Most of the weight is supported by the right leg, with the left leg slightly forward and bent, resulting in the hands, hips, and shoulders resting on the opposite side, which leaves David's whole torso with a slight S-curve (see Figure 1). The entire dynamic of David is in a stable triangle, and the whole figure is an ideal combination of movement and stillness.

3.1.2. Muscles

Apart from the dynamic posture, the well-developed muscles all over David's body are one of the features that emphasize his vitality. The muscles of the human body are symmetrical and correspond to each other in every direction, so when movement occurs, it causes certain relative muscles to be tense on one side and loose on the other [11]. Through the study of anatomy, Michelangelo mastered the principle of the muscular distribution of the human body, which was the key to maintaining a balanced state of the strength of David's whole body. Moreover, David's physical shape is perfect, with robust and well-balanced musculature that meets the standards of a toned physique. From the front, the lines and contours of his pectoralis, rectus abdominis, and external oblique abdominal muscles are distinctly visible (see Figure 1). In particular, the joint between his abdomen and pubic bone is a bit longer than life-size, which emphasizes the beauty of the pubic bone [12].

3.1.3. Proportion

David illustrates the giant-like tallness of the human body, with a head-to-body proportion of 1:8 and a body shape that conforms to the Golden Ratio. Likewise, he demonstrates the standard male physique features. A perfect inverted triangle shape, with a 2:1 ratio of waist to shoulders, corresponds precisely to the distance between the feet of the lower limbs (see Figure 1) [12]. The accurate mastery of human proportions in David is also a testament to his careful observation of the human body and his study of human anatomy by Michelangelo. The unusually huge head and hands of this figure, however, have been widely discussed in academic circles. It is known that Michelangelo had dissected many cadavers and that he understood the human body even better than many physicians of his time. Hence, this anomaly must not be caused by his lack of understanding of the human body. There are various opinions on the reason for this unusual proportion, among which the idea that Michelangelo took into account the placement location is more reliable. *David* was initially planned to be placed on the roof of the Santa Maria del Fiore [13]. Therefore, the sculpture's design by Michelangelo considered the viewing angle so that the hands and head were deliberately exaggerated to correct for the visual bias caused by the perspective as well as to adapt to the view from below.

3.2. Hands

The detailed handling of David's hands by Michelangelo is one of the striking focuses. Firstly, the placing of David's hands is quite special. His right hand is not close to the side of the thigh in the natural drooping state, as is the common logic. In contrast, his right arm is at a certain distance from

his torso, and there is an inward bend in the wrist owing to the stone held in his hand (see Figure 2). This can be contrasted with another manuscript by Michelangelo in the Louvre, in which an arm was drawn in the center (see Figure 3). Based on the angle of the shoulder to the arm, this arm drops naturally and the gesture of the hand accords more with natural, and visual tradition. Then moving the view to David's left hand, his arm raised, hand bent and resting on his chest, tugging on the straps, which are attached from the left shoulder against his back to his right hand. The whole left hand is presented in a hard folding position (see Figure 4) [14]. The arrangement of David's hands by Michelangelo presents a kind of "tension", which creates a tense atmosphere and puts the viewer seems to be in the scene. It is because of the observation and study of the human body for years that Michelangelo achieved the effect of conveying emotions through sculpture.

Secondly, from the carving of the subcutaneous veins in David's hand by Michelangelo, the progress of anatomy at that time also can be seen. There is a well-defined and irregular venous arch on the dorsum of the right hand that is overlapped with the tendons of the extensor muscles (see Figure 2). It is obvious that the origin of the basilic vein is on the ulnar side of the arch, which is the most prominent superficial vein in the upper limb. The initial trend of this vein appears like a question mark, and then its typical spiral trail on the posterior aspect of the forearm is also perfectly rendered [15]. Turning towards the back of his left hand, which is raised at shoulder height, the tracks of the veins are delicate and inconspicuous because the blood is drained by gravity (see Figure 4). This is exactly how real human hands would have blood circulation in the same position. Notably, William Harvey clarified the pathway and regulation of blood circulation as early as 1616, while more than a century earlier, Michelangelo accurately demonstrated the course of blood circulation in *David*, which made the world marvel at a depth of his study of human anatomy [16].



Figure 2: (Left Side): *David* (Partial Image) [14].



Figure 3: (Right Side): *Sketch of David in Bronze* [14].



Figure 4: *David* (Partial Image) [15].

3.3. Jugular Vein

Michelangelo went through anatomical studies and training, so it is evident that his presentation of the external jugular vein and the sternocleidomastoid muscle in David is consistent with the anatomy of today. While viewing David's head, it is easily noticed that the external jugular vein on the right side of his neck is swollen over the collarbone (see Figure 4). Generally, the external jugular vein is not obvious in the relaxed state of the body, but it can be observed to distend significantly during physical efforts because of its superficial layer of the skin. In recent years, a publication hypothesized that the phenomenon of the dilated jugular vein in David was the pathological marker of elevated intracardiac pressure and cardiac dysfunction [17]. However, the assumption was quickly disproved, considering that David was in a state of full-body muscle tension prior to the battle. Moreover, Michelangelo must also have been aware that healthy humans also experience temporary jugular vein distention during periods of excitement. In fact, apart from being in a tense state, David's head was turned to the left, and the tight skin caused the right external jugular vein to press against the sternocleidomastoid muscle, which also was one of the explanations for the distension of the external jugular vein. As a static sculpture could only display a single image, Michelangelo employed anatomical knowledge in *David* to represent this crucial moment to convey a sense of tension.

4. The Reason to the Connection between Art and Science

The above analysis surrounding David's posture, muscles, proportions, and veins by Michelangelo demonstrates the close connection between art and human anatomy. The American scholar Magner wrote that the development of both medicine and art relied on anatomy. During the Renaissance, perspective principles and anatomical knowledge were necessary for artworks to represent nature accurately, and a prerequisite for mastering these was the recognition that the human body was beautiful and worthy of research [18]. Indeed, the research of the human body is an eternal topic shared by art and medicine. This is because the origin of art and medicine lies in the human body observation, and through human anatomy, the two have a deeper integration. The following will discuss in detail the reasons for the convergence of art and science (medicine) during the Renaissance from the standpoint of their interaction.

4.1. Science to Art

Firstly, science influences the artistic performance style. Science brought rationality to art, changing the strict artistic style of the Middle Ages. Renaissance art was typified by realism and humanism, and with the birth of expression based on scientific theory and practical research, resulting in the emergence of more realistic works depicting nature, for instance, Leonardo da Vinci's Louvre version of *The Madonna of the Rocks*.

Secondly, science also provides creativity, inspiration, and motivation for the creation and development of art. Scientific discoveries offered references for artists, especially anatomy, which became an important source for artists to seek truth and excellence in art. During the Renaissance, artists employed anatomy to explore the human body by extending the observation below the skin to obtain a better and clearer understanding of the human structure and muscular tissues, and consequently to create works that were more realistic in posture, more precise in structure, and more closely resembling natural reality.

4.2. Art to Science

At first, artists frequently recorded the research findings with drawings. Medical art, anatomical illustrations, and sculpture model played an important role in documenting autopsy results and handing down medical knowledge before cameras and videotapes were available [19]. During the 14th-16th century Renaissance in Europe, humanism was advocated, and artists worked tirelessly to explore scientific approaches for the performance of the human body and portraits, hence the establishment of artistic anatomy [16]. Compared to textual descriptions, the visual presentation is more explicit because there is no need to process and transform the mind through imagination, which not only boosts the speed of comprehension but also enhances the accuracy of information delivery.

Moreover, artworks are one of the reference sources for medical research. For example, the detailed anatomical manuscripts of artists such as Michelangelo and Leonardo da Vinci laid the foundation for developing anatomy in later generations. Sculptures, such as *David*, who is main analyzed in this paper, has the phenomenon of dilated external jugular veins as one of the medical research subjects, giving scholars reference sources to help such patients. Thus, all kinds of artworks are rich documentary resources for the study of medicine.

5. Conclusion

The tight relationship between art and science, particularly medicine, originated from their shared concern for the human body. Subsequently, the two are continuously developing in intermingling, with science taking art as the carrier and art taking science as the source. During the Renaissance, the integration of the two reached a new stage. The scientific disciplines, represented by anatomy, generated a more profound interplay with art, which continued into a later era.

To the present day, the scope of the integration between art and medical science is still expanding. For instance, art therapy, medical museums, and biomedical art are all emerging products of cross-disciplinary development that combine art and medicine. Art therapy is a kind of treatment method based on medicine and treating mental illness through art activities. As for medical museums, the majority serve as public welfare venues to popularize medical knowledge in a more artistic way and convey humanistic care. Besides, if the prior art was for medical interpretation, the new century artists directly apply advanced science and technology to create art. Biomedical art, for example, is a relatively novel trend of combining art and science, although it is still under controversy because of some ethical issues involved. Throughout the history of humanity, the development of science and technology has always been a double-edged sword. Today, either scientists or artists should stand for universal values and make good use of science and art to achieve beneficial aspects. In the

development of modern society, the scientific practice shows the fabrics of art, and the artistic creation maps the principles of science. Art should not be just a symbol and demonstration of aesthetics; science should not be a mere statement of numbers and theories. There are infinite possibilities for integrating art and science still waiting for humankind to explore.

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