



## Michelangelo's Sistine Chapel Frescoes: communications about the brain

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### ABSTRACT

Renaissance creativity was a great intellectual development, and Michelangelo Buonarroti's frescoes of the Sistine Chapel were among the most spectacular. Further, it is likely that there were many unrecognized undercurrents of thought at the time. One example was suggested in a 1990 JAMA cover story in which Frank Meshberger reported his impression that Michelangelo's central composition on the Sistine Chapel ceiling (1508–1512), *The Creation of Adam*, portrays God in the form of a brain, and the overall image implies that the brain gives Man his spirit. This report prompted numerous observations that Michelangelo had depicted other anatomical parts in the Sistine Chapel frescoes. But, as Meshberger suggests, Michelangelo's messages may transcend anatomical depictions. The five images on the ceiling of the chapel showing *Creation* may be interpreted as describing the course of vertebrate brain development. Further, on the front wall of the Sistine Chapel behind the altar, within the work titled *The Last Judgment* (1525–1541), the central ellipse, in which Jesus is sitting, making judgments about good and evil, could represent a mid-coronal cross-section of a human brain. By associating this fresco with neuroanatomical features, Michelangelo may have been implying that the brain is man's instrument for making decisions. Michelangelo was known for his anatomical dissections and unconventional ideas. In the Sistine Chapel frescoes, Michelangelo may have communicated basic stages of brain development, that the brain generates man's spirit, and the brain is an instrument for making moral decisions.

### KEYWORDS

Renaissance; Michelangelo; art; decision; executive function; brainstem; god

"In the fresco traditionally called the '*Creation of Adam*' (on the ceiling of the Sistine Chapel), but which might be more aptly titled the '*Endowment of Adam*', I believe that Michelangelo encoded a special message ... the shape of the image surrounding God and the angels ... (is) the unmistakable outline of the mid-sagittal cross-section of a human brain."

- Frank Meshberger, An interpretation of Michelangelo's *Creation of Adam* Based on Neuroanatomy (Meshberger, 1990).

(Note: Sistine Chapel images are widely available, but due to copyright issues, reproductions are not shown here)

### Introduction

Standing in the Sistine Chapel and gazing at the frescoes on the ceiling and behind the altar, millions of people have felt a tremendous reverence for the greatness of the creations of Michelangelo Buonarroti (1475–1564). While Michelangelo's genius has long been appreciated, what has been less clear is what inspired him to depict these images. It is known that Michelangelo was a master of anatomical dissection, portraying muscles and other anatomical structures in ways that could only be done by someone with intimate knowledge of such structures. An author of Michelangelo's time wrote a book about him, and described Michelangelo's experience with dissection, "Michelangelo was a guest of the convent of Santa

Maria del Santo Spirito (Florence) when he was seventeen years old, after the death of his protector Lorenzo de' Medici. Here he could make anatomical studies of the corpses coming from the convent's hospital ... Through dissection Michelangelo studied every known animal and did so many human dissections that it outnumbers that of those who are professional in that field. This is a considerable influence that shows in his mastery in anatomy that is not matched by other painters." (Condivi, 1553)

While art historians and critics have extensively analyzed Michelangelo's works, it was not until 1990 when Frank Lynn Meshberger (Meshberger, 1990), an obstetrician-gynecologist, published a seminal paper in the widely circulated *Journal of the American Medical Association* in which he made a novel interpretation of Michelangelo's *The Creation of Adam* fresco, the centerpiece of his Sistine Chapel ceiling opus (commissioned by Pope Julius II in 1508 and completed between 1508 and 1512). Meshberger displayed drawings demonstrating that the composition of God and the surrounding figures form the anatomy of the human brain, while the flowing cloaks of wine-colored robes represent the meninges. The perception that Michelangelo embedded God within a brain in his depiction of *The Creation of Adam* was apparently unnoticed until described by Meshberger. With this suggestion, the perception of a brain in this fresco occurs suddenly to any individual able to identify the mid-sagittal section of the human brain. Thus, in *The Creation of Adam*, when the brain structure is perceived, God appears to be reclining within and forming the central,

subcortical structures of a human brain. Once this observation is made, questions arise as to why this perception was not recognized sooner and what related images and messages Michelangelo might have disguised in his other frescoes in the Sistine Chapel.

Following Meshberger's (1990) seminal, perception-changing publication, there have been over two decades of descriptions of anatomical features in Michelangelo's art. Observers have claimed to see numerous specific anatomical images in Michelangelo's Sistine Chapel frescoes, including the brain, kidney (Eknoyan, 2000), brainstem (Suk & Tamargo, 2010), and more (Tatem, 2013). In *The Creation of Adam*, "Eve's knee" is in the position of the pineal gland (Binkley, 1995). It was further suggested that the composition of *The Last Judgment* has the symmetry of a frontal representation of a face (Binkley, 1997; Tatem, 2013). Gonzalez (1951, 1954, reviewed in Abrahams (2005) (Gonzalez, 1951, 1954)), proposed that there is a profile of Dante hidden in *The Last Judgment* and also commented on the face composition. Another anatomical observation was by art historian Wallace (Wallace, 1998), who saw that the "backside" of God was painted by Michelangelo in the left image within *The Creation of the Sun and Moon and Plants* panel of the Sistine ceiling. Barreto and de Oliveira (Barreto & deOliviera, 2007) interpreted this image as the brain viewed from below. Eknoyan (Eknoyan, 2000) claimed that the representation of a bisected kidney was in the mantle of the Creator in Michelangelo's painting of the *Separation of Land and Water* (which may actually represent the *Creation of Creatures* given its position in the sequence) in the Sistine ceiling. Bondeson and Bondeson (Bondeson & Bondeson, 2003) offered the observation that the neck region of the God figure in the *Creation of Light* might show a goiter echoing a poem by Michelangelo where he refers to a "a goiter I got from this backward craning" (Nims, 1998). Suk and Tamargo (Suk & Tamargo, 2010) offered an alternate explanation of the middle region in *Separation of Light from Darkness* proposing that a rendition of the brainstem and spinal cord span the neck into the chest area. However, none of these observations offer a conceptual basis to explain or justify Michelangelo's *Days of Creation* works, and so provide only general efforts at anatomical level explanations.

The following outline of several of Michelangelo's Sistine Chapel works provides, for consideration, an additional perspective on what Michelangelo might have been thinking. Meshberger commented that God's reach from his finger to that of Adam actually suggests that it was the brain which gives man his spirit (Meshberger, 1990). There is possibly a similarly unifying philosophical concept across all of Michelangelo's *Days of Creation* in the suggestion that the vertebrate brain progressively developed during the eons of creation. Many years later, after years of papal cajoling and artist reluctance, Michelangelo agreed to complete the wall behind the altar of the Sistine Chapel. However, against general wishes and tradition, Michelangelo depicted *The Last Judgment*. In this composition, Michelangelo may have disguised a new message, extending what he may have been pondering in the years in between these works, that the brain is the human instrument for deciding what is good and what is evil.

## Report of observations

The Days of Creation may relate to the Development of the Vertebrate Brain

There is a commonly accepted relationship between the Biblical descriptions of Creation and several of Michelangelo's ceiling compositions. Relevant fresco panels to consider are:

Day 1: *The Separation of Light and Darkness*, (above a panel showing Jonah and fish, no angels are portrayed in this panel),

Day 2: (Separation of water and sky, no image is apparent, though see (Eknoyan, 2000))

Day 3: *The Creation of Plants*, (no angels are portrayed in this panel)

Day 4: *The Creation of the Sun and Moon* (to the right of Day 3), (4 angels are portrayed)

Day 5: *The Creation of Living Creatures* (above Day 2 and 3, God is suspended above an apparent ocean of water. Though no creatures are shown, God, with his hands stretched out, may be presumed to be creating fishes (3 angels are portrayed)

Day 6: *The Creation of Adam* (10 angels and Eve are portrayed)

The five portrayed *Days of Creation* frescoes are placed backward from the altar and *The Last Judgment* ending with the *Creation of Adam* in the middle of the ceiling. In each of the five frescoes, there is an image in which God is placed on wine-colored robes with God's legs protruding from the bottom. With consideration for comparative neuroanatomy, each of the images can be interpreted as a brain with God's mid-section and lower extremities "homologously" representing the brainstem, cerebellum, and upper spinal cord. Further, Michelangelo shows an apparent appreciation of the relative growth of the telencephalon/cerebrum across the five images from the edge of the ceiling above the altar to the middle, with a progressive increase in the number of accompanying angels .

In the fresco that suggests God's first act, *The Separation of Light and Darkness* (the first day, *Genesis* 1:3), the swirling red robe appears to contain the outline of a small, ancient brain, resembling the brain of a fish (for example, the dogfish, with large olfactory bulbs outstretched). While that same structure has been previously suggested to be a goiter (Bondeson & Bondeson, 2003) or a human brainstem (Suk & Tamargo, 2010), those comparisons are not as consistent with the structure of the image as is that of the fish brain, and the fish brain is one of the earliest vertebrate brains.

In the next portrayals of God away from the front altar, there are adjacent figures representing Day 3 and Day 4 of Biblical Creation. The left image depicts the *Creation of Plants* (the third day, *Genesis* 1:11), and the image suggests a brain with amphibian features (the frog brain in particular has a large optic tectum that is shown analogously with God's buttocks). No angels are shown in these sub-mammalian depictions.

In the image to the right, "*The Creation of the Sun and Moon*" (the fourth Day, *Genesis* 1:16), the image of God appears to represent a non-primate mammalian brain (comparable to the brain of a cat, an animal that Michelangelo would easily have had opportunity to dissect). In this image, four angels are depicted.

In the panel between these latter two images of God and the image of the *Creation of Adam*, there is a view of God in *The*

*Creation of Living Creatures* (the fifth day, *Genesis* 1:23). In this image, the configuration of God may be viewed also as brain possibly of a non-human primate. An alternative interpretation is that the picture represents a different era and the lack of any gural suggestions and the fewer number of angels, three, could also be interpreted as a more primitive, lissencephalic (smooth) mammalian brain (like that of a rabbit).

The human brain image, originally noticed by Meshberger (the sixth day, *Genesis* 1:27) when God is shown creating Adam, is larger and more complex than is shown in prior creation days. Of note, there are now depictions of 10 angels surrounding God and an image of Eve. With the depiction of progressively larger numbers of angels, Michelangelo appears to suggest the appearance and growth of the cerebral cortex in mammals.

Considering the temporal sequence from creating light to creating Adam, Michelangelo appears to portray a progressive increase of brain complexity. The links to the creation timeline may reflect an early conceptualization of either Michelangelo or others with whom he was conversing, comparable to what later became an accepted sequence of vertebrate brain development. Consequently, Michelangelo may have had an early conceptualization of the development of the brain over eons of time (cf.: discussion of brain evolution, Jerison (Jerison, 1973; 1991)).

*The Last Judgment* – The Decision-Making Function of the Brain (painted 1535–1541)

Soon after the completion of the Sistine Chapel ceiling, the Medicis in Florence had increased their political power, and Michelangelo returned to Florence. In the meantime, more paintings were added around the walls of the Sistine Chapel by other famous painters of the Renaissance. In 1534 Michelangelo returned to Rome, and Pope Clement VII, shortly before his death, commissioned him to paint a fresco in the Sistine Chapel behind the Altar. This work, *The Last Judgment*, produced between 1535 and 1541 under the papacy of Paul III, is placed on the wall at the front end of the Sistine Chapel behind the altar, where popes and cardinals would direct their attention during long masses and other ceremonies. Some scholars have come to believe that Michelangelo had succeeded in clandestinely portraying several anatomical parts and displaying numerous secret messages on the ceiling of the Chapel between 1508 and 1512. Presumably, if such renderings did reflect his proclivities, Michelangelo continued to be interested in conveying his ideas about the function of the brain. However, Michelangelo was likely aware that many of his ideas would be considered by some to be heresy, so renderings of his beliefs had to be disguised carefully. Due to the volatile political climate, if he were to embed his conceptualizations in this creation, he needed to place his concepts within highly complex designs.

*The Last Judgment* is extremely elaborate, showing dozens of figures beautifully drawn and containing numerous obvious messages and depictions of human conditions. High above in Heaven is a chorus of angels, and down below is Earth, with Hell to the right, and with a vibrant depiction of Jesus shown at the center passing judgment on all men and women. The scene is accomplished in a typical renaissance style with events transpiring sequentially from the left of the composition to the right. The major distraction to the human eyes

viewing the artwork as it was being created was the nudity of the bodies. This concern was raised by the Pope's own Master of Ceremonies, Biagio da Cesena, before the completion of the work. Michelangelo retaliated by portraying this individual in Hell, as Minos, judge of the underworld, with donkey ears. However, the concern with modesty led to the hiring of another artist, Daniele da Volterra (nickname, *Il Braghettone*, "the breeches-painter") to cover much of the nudity. There are hundreds of other such details and issues of controversy found throughout *The Last Judgment*, drawing attention away from a perceptual analysis of the larger outline of the scene.

The complexity of *The Last Judgment* distracts a viewer's eye away from noticing any overall composition. However, one interpretation of the overall image is that there is a "Grand Face" covering the whole of the work, as noted by Binkley/Tatem (Binkley, 1997; Tatem, 2013). This view of the composition is achieved by filling the negative spaces with blue whereas on the ceiling separation of compositions was achieved by division with architectural structures. In *The Last Judgment*, the lunettes may be considered to be the eyes of the Grand Face and the eyebrows come from the original chapel structures. Jesus and Mary compose the nose. Michelangelo's flayed skin is a hanging drop of nasal mucus. And Mary's transparent blue skirt is a tear falling along the nose from the right eye. Saliva, a boat, and figures blowing horns are the mouth in this interpretation. However, such interpretations could also signify additional distractions which Michelangelo placed in the composition to keep those sitting in the Sistine Chapel and facing the altar from recognizing a deeper subject hidden in the complexity.

Viewing *The Last Judgment* from a neuroanatomical perspective, scrutinizing the details of the painting from the back of the chapel and gazing at the whole front wall, *The Last Judgment* appears to show a cross-section of the human head, showing the brain, in the proper frontal orientation. Considering a coronal section of the human brain, this central ellipse may be interpreted to represent the cerebrum, appearing to portray Jesus in the position of the basal-ganglia, thalamus, and hypothalamus, as an active figure in the center of symmetrical cerebral hemispheres. This central position is analogous to the location in which Michelangelo placed God in the images on the ceiling. There are blue spaces in anatomically correct positions around Jesus which may represent the lateral ventricles and a triangular blue space below that appears in the position of the third ventricle. Two figures below Jesus have their legs moving downwards and toward the center, just in the position expected for the internal capsules to transition into the cerebral peduncles. Large clouds appear to represent the primitive structures of the medial temporal lobe, the hippocampus and amygdala. Just outside of the blue spaces surrounding Jesus and within the ellipse is a collection of saintly figures. The arms of these figures form irregularities that remind those familiar with neuroanatomy of cerebral gyri. These numerous figures can be considered to represent the cerebral cortex, a view consistent with the increased numbers of angels in the *Creation of Adam*, yet consistent with an era many years after Adam's "creation". A blue space below the central ellipse is in the position of the fourth ventricle or cisterna magna, and

a cloud of figures below this is in the position of the brainstem and cerebellum.

Considering a possible statement about brain function, from the ellipse, Jesus is directing the events of the whole scene, while he is carefully attended by the figures within the ellipse. This view suggests that the human brain involves attention and has the role of making moral judgments.

Michelangelo's *The Last Judgment* has some similarity to similar renditions depicted by his contemporary artists which appear to be based on brain images. (Paluzzi et al., 2007) suggested that David (1460 to 1523) and Raphael (1483 to 1520) also used the compositions suggestive of coronal sections of the brain in their *Transfiguration* paintings. Though all were undoubtedly influenced strongly by Michelangelo, they were probably unaware of the functional concepts Michelangelo appears to have encoded in his art.

On the bottom right of the ellipse in *The Last Judgment*, Saint Bartholomew displays a flayed skin. It is commonly noted that Michelangelo portrayed his own face and "flayed skin" as dangling from St. Bartholomew in *The Last Judgment* (La Cava, 1925). This self-portrait by Michelangelo may be a symbolic acknowledgment that his views could be regarded as sacrilegious, and that he recognized that the expression of these ideas could lead to grave consequences.

Outside of the ellipse, Michelangelo portrays many complicated regions, showing numerous other human activities in which only a few of the characters are attending to Jesus. Many art critics have written about what various figures in this area might represent. This part of the painting could refer to the perceptions and memories of the brain, and the numerous vignettes do represent the full range of man's experience from good to evil, from pleasant to unpleasant, and from important to trivial.

The view that the brain makes decisions is consistent with modern Neuroscience concepts of neocortical functions and networks, particularly the attribution of executive function to the frontal lobes and the perception of good and bad to the amygdala (Ashford et al., 1998). Good and evil and the making of moral decisions, as portrayed in *The Last Judgment*, represent concepts which are rooted in culture and are learned by the brain over the life of the individual, perhaps a view that could reasonably have been considered by Michelangelo.

## Discussion

### *Perception of representations in art*

The neuroanatomical interpretation of Michelangelo's *Creation of Adam* in the Sistine Chapel is quickly perceived when pointed out to individuals familiar with neuroanatomy (personal observation by JWA), though there have certainly been millions of such knowledgeable individuals who have carefully viewed this artwork over the centuries without noticing this relationship. The experience of not seeing an item in a complex field, then suddenly perceiving it, is a classic phenomenon in psychology. Experience can create "schemata" that allow certain objects to be perceived, though in a misdirected context, images and meanings can be deeply hidden. However, once visualized, the characteristics of an image become obvious to

the experienced viewer (for example, the ambiguous picture of the young woman or old woman described by Boring (Boring, 1930) (see for discussion: (Rumelhart & McClelland, 1986)). Playing on such psychological effects, artistic double entendres and hidden images are common in the art world. They have been claimed for da Vinci, Gerard, Raphael, Vesalius, David, Archimboldus, Holbein, Schon, Monet, Gauguin, Van Gogh, O Keefe, Dali, Pollock, and others. The issue presented here for consideration is that Michelangelo presented more than a sagittal view of the human brain with the opinion that the brain gives man his spirit, as suggested by Meshberger, that Michelangelo provides many more such ideas, including a series of brains implying a sequence of temporal development of the vertebrate brain over time, the progressive growth of the cerebral cortex, and portrayal of good versus evil judgment making, suggesting that the brain makes such decisions.

Views that anatomical parts or hidden meanings lie disguised in Renaissance works could be the result of a cultural ideation superimposed on otherwise non-descript images (Salzman, 2006). Ruth Benedict says (Benedict, 1934, p. 2) "No man ever looks at the world with pristine eyes. He sees it edited by a definite set of customs and institutions and ways of thinking" (Benedict, 1934). Most of the anatomical representations in Michelangelo's art are described by physicians and scientists, who have special training to perceive anatomical patterns, which may represent a bias. However, such individuals have a specific acumen. Benedict's perspective is balanced by Karl Popper (Popper, 1972), who proposed that "objective knowledge" does exist. The view that Michelangelo used brain images and other anatomical schemata is plausible given the anatomical dissections that Michelangelo was known to have performed and new conceptualizations developing during the Renaissance.

For the last 500 years, the preponderance of comments on Renaissance artists has concerned raw beauty and mastery. However, Meshberger's publication was a paradigm-changing observation, in the tradition of Thomas Kuhn (Kuhn, 1962). Many of the subsequent observers who have noticed anatomical renderings in the works of Michelangelo have had the benefit of direct experience with dissection. The reports of anatomical representations in the art of Michelangelo and their psychosocial implications is a change in the thinking about the art of Michelangelo.

The use of anatomical representations in the Sistine Chapel and descriptions suggesting development of the brain and its functions could not be discussed or appreciated in the political climate of Michelangelo's time. Such ideas could easily have led to his censure as a heretic and imprisonment or death by the church of the time. Consequently, there must be appreciation for his presumed attempt to disguise his ideas. However, considering these perspectives in a 21<sup>st</sup> Century context, the breadth of Michelangelo's works can be appreciated in a new light.

### *Historical context*

As part of new thinking in the Renaissance (14<sup>th</sup> to 17<sup>th</sup> centuries), free and inventive use of compositional arrangements in architecture appeared and new compositional rules were

developed based on human dimensions. During the Renaissance humanism was born as artists strove to portray the human form, and experiments and evidence and scientific method began. The key artists in this movement were Leonardo da Vinci, Botticelli, Michelangelo Buonarroti, Donatello, Raphael, and Titian. Leonardo da Vinci drew a man with dimensions derived from the Roman architect Vitruvius. Botticelli painted lungs in *Primavera* (Bleck and Doliner, p. 33 (Bleck & Doliner, 2008)). There were also new conceptions about man and the Universe. Michelangelo liberally incorporated anatomy in his art and arguably attempted to convey Avant Garde concepts.

### **Observations of anatomy and neuroanatomy in Michelangelo's art**

There are many anatomical observations regarding Michelangelo's Sistine Chapel renditions. It is a well-known fact that Michelangelo made anatomical studies of cadavers and was well acquainted with the composition of the internal organs. Baretto and de Oliviera (Baretto & deOliviera, 2007) observed that Michelangelo scattered his detailed knowledge of internal anatomy in over 90 depictions across 34 of the chapel ceiling's 38 fresco panels. One example is that the lung is represented as a cloak on the God figure in the *Creation of Eve*. Blech and Doliner (Bleck & Doliner, 2008) published a book about Michelangelo and also commented on God's backside. An astute observer of medical conditions as well, Michelangelo is even considered to have accurately sculpted a misshapen breast indicative of breast cancer (Stark & Nelson, 2000). There are now many observations of diverse anatomical portrayals in Michelangelo's art, not just faces and brains, but lungs and kidneys and more, from scientists and others with diverse backgrounds. The anatomy found in Michelangelo's art appears to have been composed to confer a deep layer of meaning to his Sistine chapel frescoes.

### **Metaphysical interpretations of Michelangelo's Sistine Chapel Frescoes**

Once Michelangelo's use of brain anatomy is considered, it can be inferred that he is conveying important messages, the brain evolved (contemporaneous increase of complexity from the *Creation of Light* to the *Creation of Adam*), the brain gives spirit to man (depiction of the *Creation of Adam*), and the brain directs man's life decisions (*The Last Judgment*). Clearly the brain is capable of a range of perceptual analyses and executive decisions that has infinite potential (Ashford et al., 1998). Michelangelo's concept might have been considered heresy in his time, but in our modern age, it now provides the supportive concept that Man's brain is capable of making good decisions to direct the developments of the world.

There is continuing controversy as to whether the images that many perceive as anatomical structures were used intentionally by Michelangelo or just represent modern cultural biases. Additional interpretations support the inference that not only were the anatomical images present, but there are also hidden philosophical implications. The concept that God rests in a human brain, which delivers Man's spirit, is more

complex than a simple study of anatomy, this is a philosophical statement. Thus, the next consideration is whether elaboration of this philosophical statement can be found further in other parts of Michelangelo's works in the Sistine Chapel. These new perceptions of Michelangelo argue for a change in thinking about Michelangelo's art and possibly about the communications of other Renaissance artists.

After consideration of what Michelangelo thought of the relationship between nature and religion in his own time (cf. Grimm (Grimm, 1896)) the question arises: does this possibility, that Michelangelo saw a relationship between the brain, God, and Man's spirit, as interpreted from the *Creation of Adam*, lead to additional new perceptions or understandings in other components of his Sistine Chapel frescoes? Later observations led to a theory that tied together a number of brain images on the Sistine Ceiling in the order of Creation (Ashford, 2006; (2006)). Further, using the concept that Michelangelo was linking brain anatomy and function, a view of the *Last Judgment* led to the observation that the "ellipse" area, that includes the central figures of Jesus and Mary, is a coronal section of the brain. These views provide a perspective that is complementary to the "Creation of Adam," arguing for the hierarchical development of the brain across the eons of Creation from an organ capable of the simple conceptualization of light to a complex system providing spirit to man and the brain as the decision-making organ distinguishing good and evil.

### **Conclusion**

This report and review have provided a perspective that Michelangelo made knowledgeable portrayals of the brain and other anatomical structures with specific considerations as to how they functioned. It is unknown whether Michelangelo envisioned the images suggestive of anatomy as hidden at all. However, the images are not known to have been discerned as anatomy during 500 years of viewing by admirers from around the world, until the 1990 publication by Meshberger. Once the anatomical images are seen in Michelangelo's frescoes, it is difficult to "unsee" them. It now remains for the viewers to reconsider Michelangelo's likely messages of the relevance of the brain to man's evolution, spirit, and decision-making capacities. These perspectives offer a basis for Man to better understand interactions with the world and improve life in general.

### **Disclosure statement**

The authors report no conflicts of interest.

### **References**

- Ashford, J. W. (2006). *The Michelangelo code*. Retrieved May 10, 2011, from <http://www.medafile.com/MichelA.html>
- Ashford, J. W., Coburn, K. L., & Fuster, J. M. (1998). Functional cognitive networks in primates. In R. W. Parks & D. S. Leine (Eds.), *Fundamentals of neural networks: Neuropsychology and cognitive neuroscience* (pp. 33–60). The MIT Press.
- Baretto, G., & deOliviera, M. G. (2007). *A Arte Secreta de Michelangelo. Uma Licao de Anatomia na Capela Sistina*. Editoria Arx.
- Benedict, R. (1934). *Patterns of Culture*. Houghton Mifflin.

- Binkley, S. (1995). *Endocrinology*. Harper Collins.
- Binkley, S. (1997). *Biological clocks: Your owner's manual*. Harwood Academic Publishers.
- Blech, B., & Doliner, R. (2008). *The Sistine secrets: Michelangelo's forbidden messages in the heart of the Vatican*. Harper Collins.
- Bondeson, L., & Bondeson, A. G. (2003). Michelangelo's divine goitre. *Journal of the Royal Society of Medicine*, 96, 609–611. <https://doi.org/10.1177/014107680309601214>
- Boring, E. G. (1930). A new ambiguous figure. *The American Journal of Psychology*, 42, 444–445. <https://doi.org/10.2307/1415447>
- Condivi, A. (1553). *Vita di Michelagnolo Buonarroti (Life of Michelangelo)*.
- Eknoyan, G. (2000). Michelangelo: Art, anatomy, and the kidney. *Kidney International*, 57, 1190–1201. <https://doi.org/10.1046/j.1523-1755.2000.00947.x>
- Gonzalez, J. D. (1951, 1954). *Quello che ho visto nel Giudizio Universale di Michelangelo, (quoted in Abrahams, Michelangelo, Part I.)*. [www.artscho lar.com](http://www.artscho lar.com)
- Grimm, H. (1896). (Life of Michael Angelo).
- Jerison, H. J. (1973). *Evolution of the brain and intelligence*. Academica Press.
- Jerison, H. J. (1991). *Brain size and the evolution of mind. The 59th James Arthur lecture on the evolution of the human brain*. American Museum of Natural History.
- Kuhn, T. (1962). *Structure of scientific revolutions*. Univ. of Chicago.
- La Cava, F. (1925). *Il voto di Michelangelo scoperto nel Giudizio Finale*.
- Meshberger, F. L. (1990). An interpretation of Michelangelo's Creation of Adam based on neuroanatomy. *JAMA: The Journal of the American Medical Association*, 264, 1837–1841. <https://doi.org/10.1001/jama.1990.03450140059034>
- Nims, J. F. (1998). (The complete poems of Michelangelo (translated)).
- Paluzzi, A., Belli, A., Bain, P., & Viva, L. (2007). Brain 'imaging' in the renaissance. *Journal of the Royal Society of Medicine*, 100, 540–543.
- Popper, K. (1972). (Objective knowledge: An evolutionary approach).
- Rumelhart, D. E., & McClelland, J. L. (1986). *Parallel distributed processing. Vol. 1. foundations*. MIT Press.
- Salcman, M. (2006). The creation of Adam by Michelangelo Buonarroti (1475-1564). *Neurosurgery*, 59, N11–12. <https://doi.org/10.1227/01.NEU.0000253176.46348.FB>
- Stark, J. J., & Nelson, J. K. (2000). The breasts of "Night": Michelangelo as oncologist. *New England Journal of Medicine*, 343, 1577–1578. <https://doi.org/10.1056/NEJM200011233432118>
- Suk, I., & Tamargo, R. J. (2010). Concealed neuroanatomy in Michelangelo's separation of light from darkness in the Sistine Chapel. *Neurosurgery*, 66, 851–861. discussion 860-851. <https://doi.org/10.1227/01.NEU.0000368101.34523.E1>
- Tatem, S. (2013). *Michelangelo's secret anatomy book*. Xlibris.
- Wallace, W. (1998). *Michelangelo: The complete sculpture, painting, architecture*. Hugh Lauter Levin Associates, Inc.