Trajectories of Blood: Artemisia Gentileschi and Galileo's Parabolic Path

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TRAJECTORIES OF BLOOD

Artemisia Gentileschi and Galileo's Parabolic Path

By David Topper and Cynthia Gillis

"All that blood...." They always come back to the blood that Artemisia was painting.[1]

Sometime during the summer of 1611 Artemisia Gentileschi viewed the frescoes in progress in Santa Maria Maggiore in Rome. Most surely she saw the depiction of the *Assumption of the Virgin* on the dome of the Pauline Chapel, then being executed by Lodovico Cigoli.[2] In the conventional iconography of the *Assumption*, the Virgin's foot rests on a crescent moon. Cigoli's moon, shown in partial shadow, had a jagged line separating the dark from the light areas, with the lit area presenting a rough, pock-marked surface. Such a depiction was contrary to the belief—canonical at least since Aristotle—that the moon must have a smooth near-perfect surface.[3] So Cigoli's heavily cratered moon was like no other—at least, none ever seen in art. It was, however, like the moon described by his friend, Galileo Galilei.[4]

About a year and a half earlier, in the winter of 1609-10, Galileo had made his celebrated telescopic observations of the cratered moon and other celestial objects, which he described in his book, *Siderius Nuncius* (1610). Included were five engravings of the moon, which were based on seven watercolor drawings now believed to be drawn by Galileo himself. The precise source of Cigoli's depiction of the moon for the *Assumption* is unknown. He certainly did not copy directly Galileo's drawings and engravings; neither an extant preliminary drawing by Cigoli nor the fresco itself is a direct copy of Galileo's illustrations.[5] Nevertheless Cigoli did, we contend, depict the moon according to Galileo's written description—namely, as "uneven, rough, and full of cavities and prominences."[6]

During her visit to Santa Maria Maggiore, Artemisia must have noticed Cigoli's cratered moon.[7] This would have been her first contact with the ideas of Galileo. Then, sometime within a year or so, Artemisia and Galileo met—probably at the Accademia del Disegno in Florence.[8] At the time Galileo was court mathematician and philosopher to the Grand Duke Cosimo II, a position he had secured in September of 1610. Galileo was an amateur artist (hence the probability that the watercolors of the moon are his), and he was elected to the Accademia in 1613. Artemisia moved to Florence in 1613[9] and started attending the Accademia around 1614; she was elected a member in 1616. Of their relationship, which apparently spanned several decades, one written fragment remains: a letter dated October 9, 1635, from Artemisia (in Naples) to Galileo, who was then under house arrest (in Arcetri) after his trial before the Inquisition. As Mary Garrard points out in her study of the artist, "the tone of Artemisia's letter implies that they had maintained friendly contact over the years."[10] Although this is the only extant written evidence of their relationship, there may be other—unwritten (i.e., visual)—evidence as well.

In the letter Artemisia requests Galileo's help in obtaining payment for two paintings she had recently sent to Cosimo's successor, Ferdinando II. She does not name the paintings, nor have scholars been able to identify them; neither do we know whether Artemisia ever was paid, or what effort, if any, Galileo made in this endeavor.[11] But of more importance here is the fact that she says she is writing to Galileo on this matter because, as she reminds him, he had made a similar plea on her behalf 15 years before. This earlier painting (for which Artemisia says she "obtained an excellent remuneration" because of Galileo's help), she identifies as "the painting of that Judith which I gave to His Serene Highness the Grand Duke Cosimo."[12] This most surely is the *Judith Beheading Holofernes* (Fig. 1), painted in Florence, probably started in 1620 and completed before Cosimo's death in 1621.[13] The painting depicts the episode in the apocryphal story of Judith when, with the help of her maidservant, Abra, she decapitated the Assyrian general, Holofernes.

Fig. 1. Artemisia Gentileschi, *Judith Beheading Holofernes* (c. 1620-21), oil on canvas, 78" x 63". Uffizi, Florence. Courtesy Alinari/Art Resource, New York

Not surprisingly, comparisons are often made between Artemisia's *Judith* and a similar version executed by Caravaggio some 20 years earlier. The comparison is warranted, not only because of their obviously similar themes but because Artemisia was influenced by the realism of Caravaggio and his followers, one of whom was her father, Orazio. In Caravaggio's *Judith Beheading Holofernes* (1598-99; Fig. 2), Judith is depicted as an attractive young woman who, repelled by the violence of her act, almost cringes at the sight of blood. Abra is shown as an old woman left literally holding the bag for Holofernes's head. The blood in Caravaggio's picture flows rather like ribbons of red. In contrast, what is striking about Artemisia's

Judith is the sheer intensity and concentrated energy with which both Judith and Abra (the latter, now much younger) are engaged in the vicious act. Especially eye-catching is the splattering blood gushing in all directions.

The Florence *Judith* is not Artemisia's only painting on this theme. In fact, it is really a replica of an earlier painting done in Rome (c. 1612-13; Fig. 3), an apparently uncommissioned work.[14] A major difference between Artemisia's two *Judiths* is that in the first version the blood from Holofernes's wound merely drips and flows over the bedsheet.[15] The comparison shows without doubt that Artemisia purposely introduced the spattering blood in the later painting. In her book on Artemisia, Garrard speaks of the blood this way: "[In] the second version, the blood does not merely stain the bed, but spurts explosively from Holofernes's neck....[This creates] an image of high theater....chilling in its evocation of absolute silence and a horrible moment forever frozen in time."[16] The splattering blood surely is high theater, but why was it now depicted this way?

Fig. 2. Michelangelo Merisi da Caravaggio, *Judith Beheading Holofernes* (1598-99), oil on canvas, 57" x 76½". Palazzo Barberini, Rome. Courtesy Scala/Art Resource, New York.

Artemisia painted other variations of the Judith theme, notably the *Judith and Her Maidservant with the Head of Holofernes* (c. 1625; Detroit Institute of Arts). Garrard relates this work to Artemisia's relationship with Galileo, which, by this time, was more than a decade old. Employing dramatic chiaroscuro (Caravaggio's trademark) in the Detroit *Judith*, Artemisia carries this technique even further by placing the face of Judith almost entirely in shadow and lighting it from behind with a single candle. The resultant head appears to Garrard to resemble a crescent moon, leaving her to speculate that perhaps Artemisia saw Galileo's watercolors of the moon; this may, moreover, entail symbolism, since the crescent moon is the attribute of Diana (Artemis, in Greek). Garrard thus contends that Galileo's drawing of the moon "may have been the stimulus for a highly sophisticated personal conceit on the part of his friend Artemisia, who was able to translate scientific fact into a poetic private emblem."[17]

There also may be a Galilean conceit in the second *Judith Beheading Holofernes*, where the splattering blood seems to take on geometric, almost parabolic, forms. This is most suggestive, since one of Galileo's major scientific discoveries was the parabolic law of projectiles—although he more likely was thinking of cannonballs, not blood.

In retrospect, Galileo's law seems simple enough: a projectile follows a symmetrical arc specifically shaped according to the basic curve from Euclidean geometry. But, in fact, it took almost 2000 years for the parabola to rise out of the ashes of Aristotle's theory of projectile motion. In Galileo's time it still was generally thought that the flight of a cannonball began as a relatively straight line at the angle at which it was shot; then, after losing its "impetus" (its quality of motion, rather like momentum today), it made a short arc, after which it fell straight down to earth.[18] It was the symmetrical form of Artemisia's rendering of the streams of blood that initially suggested a possible link with Galileo.

Following up this observation, we made tracings of the geometrical paths of the blood (Fig. 4); these were then transferred to graph paper, where the forms revealed a close approximation of true parabolas.[19] Since the streams of blood were probably painted freehand (perhaps copied from some more geometrically accurate drawings), their extreme proximity to actual parabolas cannot be accidental. Artemisia, it seems, indeed did paint parabolic trajectories of blood in the second *Judith Beheading Holofernes*.

Moreover, since the first version of the *Judith* was done before Artemisia met Galileo and the second version after, one can further conclude that Galileo's work on projectile motion was the source of Artemisia's spattering blood.[20] Such a connection between art and science is less cryptic than the crescent moon trope of the Detroit *Judith*, yet more subtle than Cigoli's cratered moon.

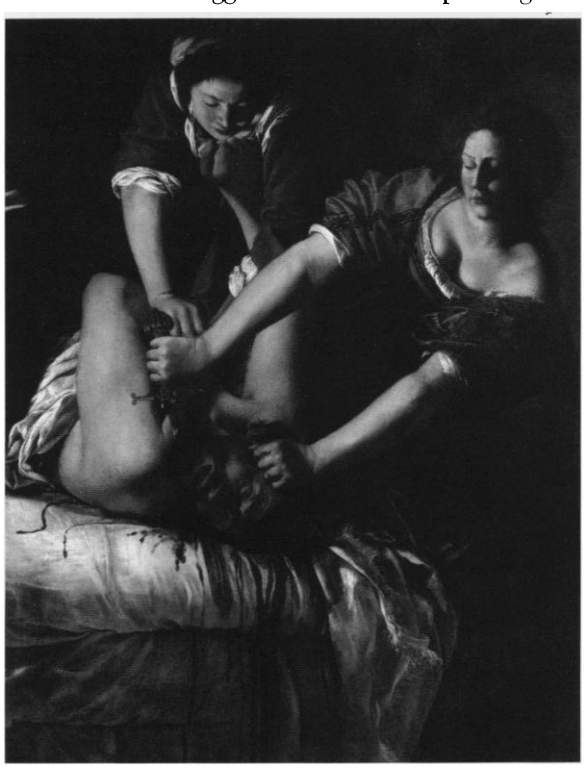

Fig. 3. Artemisia Gentileschi, *Judith Beheading Holofernes* (c. 1612-13), oil on canvas, 62³/₁₀" x 49⅕". Museo Nazionale di Capodimonte, Naples.

The influence of Galileo's telescopic observations on Cigoli's depiction of the moon was pointed out by Erwin Panofsky in his classic 1952 essay on art and science in the Renaissance, "Artist, Scientist, Genius."[21] The following year he published the essay "Galileo as a Critic of the Arts," which was based in part upon a long letter Galileo wrote to Cigoli on a hotly debated topic at the Accademia—the relative superiority of sculpture and painting.[22] In the letter and elsewhere, as Panofsky showed, Galileo revealed himself as a "classicist," being opposed to the mannerist tendencies in art still in vogue; he preferred clean, clear lines and objected to the popularity of anamorphic "tricks."[23] What Galileo therefore thought of Artemisia's Caravaggesque paintings—particularly the second *Judith Beheading Holofernes*—we unfortunately will never know.

It is not surprising that Cigoli asked for Galileo's opinion on a matter of art criticism. Galileo was no stranger to the arts. His father was an accom-

Fig. 4. Tracings of the blood spurting from Holofernes's wound in Artemisia Gentileschi's *Judith Beheading Holofernes* (Fig. 1).

plished musician and music theorist. Galileo too was an amateur musician and, as noted, an artist; he also wrote critiques and lectured on poetry. Since the Liberal Arts, of which mathematics (geometry and arithmetic, specifically) was a central component, were an essential part of Galileo's education, his transposition between science and art was not incongruous.

Mathematics was at the core of Galileo's science. Unlike the "natural philosophers" of his day, who searched for "causes" of phenomena, Galileo maintained that a mathematical description of the world was the primary aim of science. The book of nature, as he said metaphorically, was written in mathematical characters. Thus, for example, instead of asking *why* a heavy object falls to earth, he began with the fact that it does so and rather asked *how* it falls; this led to his discovery of the law of acceleration—specifically that an object falls independently of its weight, and the distance fallen is proportional to the square of its time of descent. The other key discovery that followed from these laws—and that we contend Galileo shared with Artemisia—is that the path of a projectile is a parabola.

Galileo's discovery was published in *Two New Sciences* (1638), the manuscript having been written in the early 1630s. The dates are significant for several reasons. In 1632 Bonaventura Cavalieri, a mathematician who studied under Galileo's best pupil, Benedetto Castelli, published a book on parabolas in which he put forward Galileo's law for projectile motion, the first publication of the law. Galileo was extremely upset initially, since at the time the law was in his manuscript; but he seems to have been placated upon learning that Cavalieri thought that Galileo had already announced the law.[24] This incident reveals that although Galileo was "saving" the law for publication in his book, nevertheless he was not hiding the discovery from his pupils—nor for that matter, we may speculate, from Artemisia.

But, since the Florence *Judith* was done c. 1620-21, there still is a gap of ten years in the record—and hence in our argument—between the painting and Galileo's manuscript. However, about two decades ago Stillman Drake (perhaps the foremost Galileo scholar) began combing Galileo's manuscripts at the National Central Library of Florence. Interpreting several manuscripts, especially f.116v in volume 72 (Fig. 5), Drake concluded that Galileo discovered the parabolic law much earlier than previously thought; Drake set the date at 1608, probably during the summer months.[25]

Further evidence comes in the form of an actual diagram (Fig. 6) that Galileo drew the following winter. It is found in a letter, dated February 11, 1609, to Antonio de'Medici, in which Galileo apparently was trying to impress this potential patron.[26] The diagram is impressive: it clearly delineates the simple, symmetrical paths of projectiles.[27] These very arcs materialize as streams of blood in Artemisia's second *Judith Beheading*

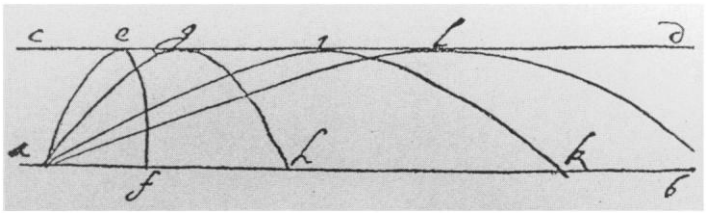

Fig. 5. Galileo, first notes on the parabolic path of projectiles (c. 1608), Galilean manuscripts. National Central Library, Florence.

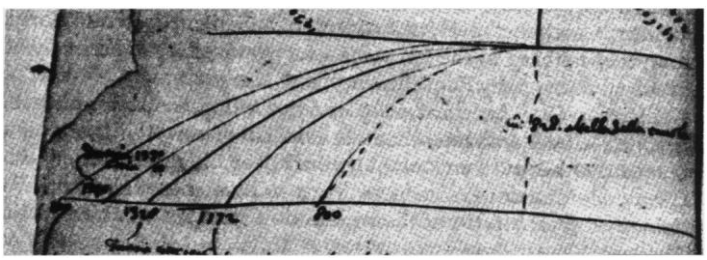

Fig. 6. Galileo, drawing of projectile motion, detail from letter of February 11, 1609. Courtesy National Central Library, Florence.

Holofernes. The remarkable similarity between the two sets of arcs in Figures 4 and 6 seems to bear out our inference that Galileo shared his discovery with Artemisia, who, in turn, used it in depicting the splattering blood.[28]

Hence the following scenario seems plausible: Artemisia painted the first version of the *Judith* in Rome, c. 1612-13; upon moving to Florence in 1613, she met Galileo, perhaps at the Accademia, where he was a newly elected member. At the time, his discovery of the still-unpublished law of projectile motion was about six years behind him. Thus when Artemisia received the commission from Cosimo II for a replica of the *Judith*, about 1620, she drew on Galileo's discovery for a realistic depiction of the splattering blood. That Galileo was familiar with the painting is documented in the 1635 letter she sent to him.

Not until his last and major text, *Two New Sciences*, did Galileo finally publish his discovery: "It has been observed that missiles or projectiles trace out a line somewhat curved, but no one has brought out that this is a parabola. That it is...will be demonstrated by me."[29] Galileo probably penned that sentence about 1630 or 1631, in his first draft of the manuscript. But this written description, we now believe, was antedated by Artemisia's visual depiction; for in her second *Judith*, about 18 years before its formal announcement, she had illustrated Galileo's parabolic law of projectile motion.

As to Artemisia's rationale for employing Galileo's law, perhaps it is another symbolic reference to Galileo's science, like the crescent moon in the Detroit *Judith*, made in gratitude for some favor.[30] It also points to the artist's quest for bold realism, of the sort found within the circle of Caravaggio.

If this thesis is correct, perhaps John T. Spike may appreciate Artemisia's realism more, since, in his review of the recent Gentileschi show in Florence, he complained that "the gratuitous spatterings of red paint look like special effects, not blood."[31] Probably more than Spike realized, the term "special effects"—even if he used it pejoratively—was not so far off the mark. For that "horrible moment forever frozen in time" (in Garrard's apt phrase) also "freezes," (as a time-lapse photograph does) the parabolic path of projectiles—rather like an illustration in a science text. ●

NOTES

1. Anna Banti, *Artemisia*, Shirley D'Ardia Caracciolo, trans. (1953; reprint Lincoln, Neb.: University of Nebraska, 1988), 45.

2. At her father's direction, Artemisia visited several churches in Rome.

Cigoli worked on the Pauline chapel between 1610 and 1612. See Mary D. Garrard, *Artemisia Gentileschi: The Image of the Female Hero in Italian Baroque Art* (Princeton, N.J.: Princeton University, 1989), 18.

3. The moon, being the celestial body closest to the imperfect earth, was not "required" to be as perfect as the sun and the planets. But its blemishes, which are clearly revealed to the naked eye, could only be minor.

4. Cigoli and Galileo became friends in the 1580s, when they were both studying mathematics under Ostilio Ricci, court tutor to the Medicis. See Miles Chappell, "Cigoli, Galileo, and *Invidia*," *Art Bulletin* (March 1975), 93.

5. Erwin Panofsky, in "Galileo as a Critic of the Arts: Aesthetic Attitude and Scientific Thought," *Isis* (March 1956), 4, erroneously said that the fresco depicts the moon "exactly as shown in the illustrations" in Galileo's book. See also Mary G. Winkler and Albert Van Helden, "Representing the Heavens: Galileo and Visual Astronomy," *Isis* (June 1992), 195-217. An illustration of Cigoli's preliminary drawing appears as fig. 7 in Chappell, "Cigoli, Galileo." For more discussion on Galileo's depiction of the moon, see Samuel Y. Edgerton, Jr., "Galileo, Florentine 'Disegno,' and the 'Strange Spottednesse' of the Moon," *Art Journal* (Fall 1984), 225-32, reprinted as Chapt. 7 in his *The Heritage of Giotto's Geometry: Art and Science on the Eve of the Scientific Revolution* (Ithaca: Cornell University, 1991). For a reproduction of Galileo's watercolor drawings, see 241.

6. Galileo's *Siderius Nuncius* is translated in Stillman Drake, *Discoveries and Opinions of Galileo* (Garden City, N.Y.: Doubleday Anchor, 1957), quotation from 31.

7. Garrard, *Artemisia*, 558, n.128.

8. Elizabeth Cropper speculates that Artemisia and Galileo may have met earlier, in Rome; see her "New Documents for Artemisia Gentileschi's Life in Florence," *Burlington Magazine* (November 1, 1993), 760-61.

9. Ibid., 760.

10. Garrard, *Artemisia*, 38.

11. Ibid., 384, n. 25. The entire letter is reprinted in Appendix A, no. 9, 383-84.

12. Ibid., 383.

13. Ibid., 383, n.24. On the iconography of the story of Judith, see Elena Ciletti, "Patriarchal Ideology in the Renaissance Iconography of Judith," in Marilyn Migiel and Juliana Schiesari, eds., *Refiguring Women: Perspectives on Gender and the Italian Renaissance* (Ithaca: Cornell University, 1991), 35-70.

14. Since this earlier *Judith* was self-motivated and painted not long after Artemisia's rape trial (the rape having occurred probably in May 1611 and the trial in 1612), the painting is often seen as exemplifying an act of psychological retribution.

15. X-rays of the Naples *Judith* reveal that the faces were overpainted and that the women's original expressions may have been more intense, not unlike the Florence version. Mary D. Garrard, *Artemisia Gentileschi* (New York: Rizzoli Art Series, 1993), n.p.

16. Garrard, *Artemisia*, 323.

17. Ibid., 334.

18. There was, however, some speculation that perhaps this was not true and that the path was more symmetrical; also, Niccolo Tartaglia (the teacher of Ricci, Galileo's first tutor in mathematics) found that a 45° angle of projection produces maximum distance. But only Galileo discovered and proved the parabolic law. See Stillman Drake, *History of Free Fall: Aristotle to Galileo* (Toronto: Wall and Thompson, 1989), 24-25, 49-58.

19. More specifically, once the tracings are on graph paper, individual (x,y) pairs can be identified and then fitted to the equation for a parabola (i.e., $y = Qx^2$, where the constant Q is a function of the particular shape or pitch of arc of the given parabola). The "fit" for Artemisia's forms were, in most cases, too close to be accidental; the one shape that departed most from a real parabolic shape (the least symmetrical form), interestingly enough, is similar to one drawn by Galileo (see fig. 6). However, it is impossible to prove *a posteriori* that any curve is an actual parabola; indeed, this is true for any mathematical figure or ratio (e.g., the golden section). Unless we know *a priori* that the specific geometrical form was intended as such by the maker, it can be problematic inferring such inductively. Nevertheless, we are more than reasonably sure that the forms are indeed parabolas in Artemisia's painting, mainly because of the high improbability of them being otherwise.

20. Before Garrard's work, the Florence *Judith* was considered the original, but she has argued for the present dating. See Garrard, *Artemisia*, 32, 494-95, n.35. Accordingly, the logic of the narrative of this paper may be viewed as providing further evidence for Garrard's chronology.

21. Erwin Panofsky, "Artist, Scientist, Genius: Notes on the 'Renaissance-Dämmerung', " in Wallace K. Ferguson, et al., eds., *The Renaissance: Six Essays* (New York: Harper Torchbooks, 1962), 164-66. This is a revision of the original essay.

22. The letter, dated June 26, 1612, is reproduced in Erwin Panofsky, *Galileo as a Critic of the Arts* (The Hague: Martinus Nijhoff, 1954), 34-37. Galileo opted for painting as being superior. See also Mario Biagioli, "Galileo the Emblem Maker," *Isis* (June 1990), 237.

23. Panofsky's aim in *Galileo* was to relate Galileo's art criticism to his "style" of science; for example, Galileo remained committed to the circle as the fundamental geometrical form for astronomy, and accordingly he rejected the "mannerist" ovals (ellipses, to be exact) proposed by Kepler for the orbits of the planets. That Galileo also objected to anamorphism in art is interesting, since it too entails an elliptical distortion. See also William R. Shea, "Panofsky Revisited: Galileo as a Critic of the Arts," in Andrew Morrogh, et al., eds., *Renaissance Studies in Honor of Craig Hugh Smith*, I (Florence: G. Barbera, 1985), 481-92. On some historiographic issues pertaining to Panofsky, see Topper, "On a Ghost of Historiography Past," *Leonardo* (no. 1, 1988), 76-78, and related to this Topper, "The Parallel Fallacy: On Comparing Art and Science," *British Journal of Aesthetics* (October 1990), 311-18.

24. Drake, *History*, 51, n.68. Fig. 5 can be found on p. 57 of this book and is reproduced courtesy of its publisher, Wall and Emerson, and the National Central Library, Florence.

25. Ibid., 56. Since Drake's pioneering work, several historians have scrutinized Galileo's manuscripts on motion: the result is a protracted debate regarding how Galileo arrived at this law of motion, much of which centers around various interpretations of the diagram and calculations in f.116v and elsewhere.

26. The letter and the drawing are reproduced in Antonio Favaro, ed., *Le Opere di Galileo Galilei*, X (Florence: G. Barbera, 1934), 228-30. See also Stillman Drake, "Galileo's Experimental Confirmation of Horizontal Inertia: Unpublished Manuscripts," *Isis* (September 1973), 303-04, and Ronald H. Naylor, "Galileo's Method of Analysis and Synthesis," 6 (December 1990), 707.

27. It is interesting to note, however, that Galileo, despite his artistic skills, was a bit sloppy with this diagram, for the longest parabola (a, l ,b) is not symmetrical!

28. Artemisia may have painted something significant with respect to the history of medicine too. In order for blood to squirt the way she depicts it, the blood would have to flow in the body under pressure, something only accepted long after William Harvey's work in 1628 on the circulation of the blood and the realization that the heart acts as a pump. On the Galenic theory—medical dogma since ancient times—blood sloshes back and forth in the arteries and veins and hence flows out of the body through a wound rather as Caravaggio depicted it—and as Artemisia did in her first *Judith*. We thank David Dyck, who teaches history of medicine at the University of Winnipeg, for pointing this out and for other comments throughout the manuscript.

29. Galileo Galilei, *Two New Sciences*, Stillman Drake, trans. (Toronto: Wall and Thompson, 1989), 147. Galileo ignores Cavalieri's publication in his text.

30. Mary Garrard, in her review of this manuscript, suggested this possibility.

31. John T. Spike, "Florence, Casa Buonarroti: Artemisia Gentileschi," *Burlington Magazine* (October 1991), 732-34.

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