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4.

Leonardo's Point

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Emphatic trust and consistent doubt are intricately bound together within the history of visual experience in Western culture after the thirteenth century, and have inevitably led to prolonged reflections upon the organ of vision. Both the invention of increasingly powerful optical devices, which overcame the apparent invisibility of very remote and very small objects, and the development of scientific tools that ultimately made the presence of a perceiving eye obsolete[1] are grounded in a conception of the eye as a natural, but inherently limited, instrument of observation. In this history of faith and mistrust surrounding the visual organ, a specific form of "romance" between man and his eyes, Leonardo da Vinci, the paradigmatic artist-scientist of the Renaissance, plays a prominent role. What still remains largely overlooked, however, is his surprisingly persistent interest, culminating in the

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years around 1505, in the interpenetration of the visible and the invisible in the act of vision—and his reflections on the paradoxical nature of physical reality itself. In the following, I rapidly sketch out Leonardo's persistent focus on this paradoxical ontology and its reverberations in some major fields of his intellectual endeavors: optics, cosmology, physics, and art theory.[2]

In the context of the present volume, Leonardo's approach to vision and its instruments holds an important position. It was the artist's emphasis on imitation that led Leonardo to a revision of his representational convictions and to an acknowledgment of the dramatic pervasion of being and nonbeing (zero, nothing, naught)[3] in the majestic performance of nature. Far from becoming an armchair skeptic in a time of very limited research technologies and mathematical understanding—the right man in the wrong era[4]—Leonardo pursued scientific and artistic strategies to comprehend the world as transition, a world that dies and is reborn at any moment in time, in short, a world that *reinvents* itself continuously. Following the line of his major argument, it would have been quite natural for Leonardo to embrace the technical support of optical devices. But Leonardo's reflections upon the inclusion of the invisible in vision also hint at a phenomenology *avant la date*. Despite some recent studies, this aspect of his work still demands further clarification.[5]

Nothing

In the first paragraph of his unabridged, posthumously edited *Treatise on Painting*, written circa 1500–1505,[6] Leonardo claims that painting is a science (scientia) because, like geometry, it is founded on an ultimate principle (ultimo principio): the point. "Therefore, the point is the first principle of geometry, and no other thing can exist either in nature or in the human mind that would be more fundamental than the point [che possa dare principio al punto]. If you were to say that the creation of a point is the final contact made with the point of a stylus on a surface, this is not true; we would say such contact is a surface that surrounds a center, and in that center is the location of the point."[7]

All the points of a surface, even of the world, would not create "more" than a single point, Leonardo continues. The point is not materially part of the picture surface (non è della materia di essa superfitie); nevertheless, it mysteriously creates the image. By comparing the point to zero, Leonardo seems to equate the point with "nothing," but the fact that the "addition" of zero, as Leonardo puts it, changes the value of numbers—from 1 to 10 to 100 ad infinitum—provides an analogy to the dynamic qualities of the point, namely, its extension into line and surface on a picture's plane.[8]

Lines and surfaces are created by the transit of the point (la linia è il transito del punto). Consequently, lines and surfaces also have no extension; they are "something spiritual rather than substantial" (cosa spirituale che sustantia).[9] The point is thus intimately connected to movement and therefore to Leonardo's categories of physics. I will return to this issue.

In the light of the apparently abstract quality of the point, Leonardo's bold assertion that "painting is mental" (la pittura è mentale)[10] comes as little surprise, yet it is, nevertheless, only one side of the coin. Leonardo also emphasizes again and again the importance of visuality, leaning strongly toward an identification of sensory activity as a mental activity per se, thereby circumventing the traditional hierarchy between "outer" and "inner"

senses.[11] However, as is well known, Leonardo's remarks on the point as an invisible principle of painting contrast significantly with those of Alberti, Filarete, and Piero della Francesca. All three authors describe the first element of painting as a *visual* point, as the smallest *perceptible* element on the picture surface.[12] Alberti categorically denies the relevance of invisible entities for any discourse on painting: "Nobody would argue against the fact that the things that we cannot see are irrelevant for the painter."[13] Following the Aristotelian tradition, Piero della Francesca calls the point a product of human imagination (inmaginativo).[14]

Leonardo, instead, seems to follow closely the authority of Euclid, who defines the point, at the very beginning of his *Elements*, as "that which has no part."[15] But the paradox in Leonardo's argument is obvious. Identifying the first principle of painting as a mathematical point seems to be a negative answer to the question that Leonardo poses in the aforementioned passage, as to whether or not painting is a science: "That mental discourse is termed science that originates in first principles beyond which nothing else can be found *in nature* as part of this science."[16] Later in the same paragraph, Leonardo once again relates mathematics to nature or visibility, emphasizing that all the sciences have to be transparent to mathematical demonstration. However, only those that do not begin and end in the mind, but are based on sensory experience, are true sciences.[17] The question is, how can an "abstract" quality like the point be part of nature, and therefore belong to sensory experience?

In his brilliant article "Leonardo da Vinci e il 'nulla,'" Fabio Frosini reconstructs the artist's ideas about *nulla*, *punto*, and *zero*, and locates them in classical, medieval, and contemporary discourses on mathematical entities, cosmology, and metaphysics. According to Frosini, Leonardo developed and accepted paradoxical formulas in his definitions of the point for at least two reasons: first, to overcome the categorical difference between mathematics and nature; and second, to depart from this traditional juxtaposition in order to develop an ontology that interprets nature as a transition between being and nonbeing. In his meditations on the paradoxical nature of the point, Leonardo established an interpretive model that permits reflection upon the continuity and, at the same time, discontinuity of bodies. Within this dramatic monologue, the *punto* emerges as a term used to describe the transitional world of objects in contact, movement, and metamorphosis. This chapter focuses on these *dynamic* qualities of the point and its impact on art and science. Leonardo conceives of the point not as a mathematical, nondimensional entity, nor as the smallest visible sign, but rather as an infinitesimally small entity that motors the transition of nonbeing into being, and vice versa.[18]

In a series of fascinating meditations that can be dated—following Carlo Pedretti[19]—around 1505–8, and which are found mostly in the Codex Arundel of the British Museum, Leonardo struggles with the paradoxical properties of point and "nothing." At the beginning, he defines "nothing" as an abstract and static concept that is completely separate from the natural realm of bodies and space: "What is called naught [niente] can only be found in time and in words; in time it is between past and future, while it is not part of the present, and also in the names of things that do not exist or are impossible . . . and its [nothing's] power is not extended to the things of nature."[20] According to this traditional view, *nulla* is just the negation of any continuous and extended object, pure

"nothingness," a semantic construction that defines the ontological status of time (past and future) and imagination. This reflects earlier passages in Leonardo's notebooks, for instance, the Codex Trivulzio, fol. 34v: "The point is not part of the line. / The water that you touch in rivers is the last of the one that passed, and the first of the one that comes; similarly the present instant."[21] The point as *niente* does not reside in nature (e la sua potestà non s'astende infra le cose di natura); like the infinite, it merely provides an analytic tool to investigate nature.[22]

The ontologically *positive* role, the actual presence of "nothing" in the midst of "being," emerges only in Leonardo's subsequent reflections. On the same folio of the Codex Arundel, Leonardo writes, "Among the magnitude of things that are among us, the being of nothing is the main principle, and its domain [ofitio] extends to the things that have no being."[23] In this more complex view, the point, and the lines, namely, the surfaces it creates, are "limits," the common "border" of two things or the "border" between an object and "nothing." One of Leonardo's favorite examples in this context is the common surface of water and air. While there is actually "nothing" (materially) between both elements, they are nevertheless "in contact." What differentiates them is neither water nor air; it is "nothing": "Therefore there's one surface as a common border of two bodies that are not continuous, and it does not participate either in one or in the other. Because if this surface would be part of [one or either of them], it would have a divisible extension, and since this [border] is not divisible, the nothing [el nulla] separates those bodies from each other."[24] It is the inclusion of the definite article that transforms, as Frosini has shown, "negative nothing" (as a semantic placeholder for absence), or empty space (the vacuum), into the *positive* nothing, an intrinsic category of physical reality that ensures both separation (autonomy, coherence) and continuity of bodies at the same time.[25]

At the end of this breathtaking intellectual exploration, Leonardo defines the point as a third, liminal entity *between* nothing and something. "Nothing can be called smaller than the point, and it is the common border [termine] of naught and line, it is neither naught nor line, and it does not occupy any space between naught and line. Therefore, the end of nothing [!] and the beginning of the line are in contact, but not connected. And in this contact the point is the divider between the continuity of naught and line."[26] There is not an identity but an intimate relationship between point, the infinitely small, and naught.[27] It is striking that whenever Leonardo tries to establish a complex and dynamic relationship between identity and difference (for instance, among the "four powers" in nature—force, movement, gravity, and percussion—or painting and music), he uses metaphors of kinship. "Therefore, the end of the nothing and the beginning of the line are in contact, but not connected; and in this contact is the point. Naught is the brother of this point."[28]

The point ensures, to put it somewhat differently, continuity and discontinuity *at the same time*. As the "extension" of the point, the surface itself oscillates between nothing (pure absence) and something: "Air is conjoint with water, and the end of the one is shared with the other, in a way that it could be called continuous quantity because they are connected, and discontinuous because they have two different natures."[29]

However, by defining the point as the infinitely divided, smallest unit *in nature*, a unit that constitutes the irreducible core of lines, surfaces, and bodies, and by ultimately reducing all positive data to one single point,

Leonardo had to face the collapse of the part and the whole, of naught and infinity: "all the things that do not occupy any space are similar among themselves . . . and each of them is equal to all of them. Therefore, it follows in this case that the part is equal to the whole, and the whole to the part, and the divisible to the indivisible, and the finite to the infinite. Because of this, the surface, the line, the point are nothing, because they do not occupy any space, and all the nothings [zeros] are equal to all, and all to each, as arithmetic demonstrates. . . . The body is draped in surfaces, the surfaces are surrounded by lines, and the lines are terminated by points."[30] Frosini concludes that this paradox (the identity of the infinite with the whole, and the visible with the invisible) marks the major achievement of Leonardo's intellectual journey,[31] a natural extension, we might conclude, of Neoplatonic theology and its notion of God as "everywhere and nowhere" (ubique et nusquam).[32]

The Dynamics of the Point

Following but also diverging from Frosini's main argument, I would like to emphasize that Leonardo introduced his discussion of dynamics (movement) in an attempt to dialectically reconcile the terms of the paradox that he had previously established. Leonardo conceived of the point as a liminal entity between "something" and "nothing," an entity that not only ensures continuity and discontinuity but actively (in atto) oscillates between the two states. In other words, at the core of physical reality, an immanent principle works constantly against nondimensional "unity" in an effort to achieve "multitude" and also, simultaneously, wears down the distinctions and plurality of the three-dimensional world. The point, in this view, is the chief agent of the continuous drama of a world that "contracts" into the infinitely small, that collapses into the principle of unity, *and* that reemerges at every infinitely small moment of time and at every infinitely small point of transparent space. It is through his identification of the point with the principle of movement that Leonardo reintegrates "nothingness" and nature in her capacity for transformation. In the point, as a principle of every process, nature dies away and is reborn *continuously*. It is hardly surprising that Leonardo develops this argument further after around 1500 in the context of his general focus on antagonism in major fields of his scientific exploration: hydrology, geology, and art (*Battle of Anghiari*).[33]

Without naught, objects in the world would not be differentiated from one another. But without naught, movement would also be impossible. The classic Epicurean argument already emphasized that there would be no "space" for change if "void" did not separate the positive data of objects (atoms).[34] But Leonardo's approach is more complicated and risks even more contradictions. At the beginning of his subsequent investigation into this concept (ca. 1506–8, according to Pedretti), Leonardo clarifies the identity between point and moment, line and *ispazio di tempo*. Since it has no surface, or body, time is not a continuous "quantity" but is instead comparable to point and line and therefore one-dimensional. Time is the result of the movement of "nothing"—the point of pure presence, the instant—comparable to the movement of the point creating the line (Lo instante non ha tenpo. El tenpo è causato dal moto dello instante).[35] In the continuum of time, the point of the instant works as the connecting and separating unity between past and future, which are also "nothing," as Augustine had already demonstrated.[36]

Implicitly critical of his own earlier attempt to ground the *scienza* of painting in the principle of the point as an invisible entity, Leonardo continues, "the point is nothing [nulla], but on the nothing one cannot build up any *scienza*. And to avoid this principle we will say: Nothing can be smaller than the point, and the line is created by the movement of the point, and its ends are two points, and the surface is generated by the transversal movement of the line, . . . and the body is created by movement [e il corpo è fatto dal moto]."[37] But the converse of the argument also holds. In the latter case, privation (i.e., "nothing" in action) *reduces* the dimensionality of bodies, surfaces, and so on.[38] As will soon become clear, this understanding of a gradual negation as a privation of dimensions determines Leonardo's description of major processes in nature as well as his interpretation of the painter's creations.

Therefore, in contrast to the opposition between space that is filled and the empty space within a vacuum, nothing and something are everywhere *gradually* connected by the infinitely small: "Where nothing ends, the thing is born, and where the thing disappears [dove manca la cosa], nothing emerges."[39] The relationship between naught and things does not dissolve in a simple teleology—God's *creatio ex nihilo*, as the most powerful paradigm, or the "almost nothing" (ultima pene nihil; Matthaeus Frigillanus, *De nihilo*, Paris, 1562) of the *prima materia* in Christian and Neoplatonic thought[40]—but Leonardo conceives it as a continuous, oscillating, ambivalent process, open to movement in both directions. Corporeal nature, in other words, is entirely, permanently permeated by nothing, but *nulla* is—through the borderline activity of the point—continuously "emanating" into space and time. It is the point that creates and negates the dimensions at the same time.

Leonardo's point, in other words, is the power of transition itself—a liminal entity connecting and dividing, a paradoxical being, the all-pervasive "One," a motor that works against its own integrity, identical with itself only through permanent self-transcendence: "because movement is of the same nature as line, and the line initiates in a point, therefore movement, too, originates in the point."[41] Consequently, the end of movement in percussion, for instance, is also a point, the liminal entity that marks the completion of a change between two states: "Percussion is the end of movement in indivisible time, because percussion is caused in the point, the end of the line of movement."[42] We will soon see how this argument continues in Leonardo's reflections on the nature of impetus as the fundamental, punctiform entity of his theorization of dynamics.

At this juncture, it is useful to situate, albeit briefly, Leonardo's paradoxical notion of point and naught in the extended history of the idea of nothing. Indeed, it would be especially interesting to outline the implicit nonindifference of naught, the concept of an absence that awaits its transition into presence, or, in other words, a history of the dynamics of the void. Hebrew thought radicalized the nonbeing of nothing (to use a tautology), but already the early Christian conflations of *nihil* and evil (for instance, in Augustine) qualified the void not simply as an absence but as absolute negativity.[43] However, the Christian substitution of the precreational naught with Aristotle's *prima materia* (*hypokeimenon*) and the mystic's conflation of God and *nihil* overcame the odd negativity of radical nonbeing.[44] In Greek cosmology, Plato's mysterious concept of the primordial "nurse of coming-to-be" (*Timaeus* 52d–53a) and his definition of space as receptacle (chora) indicate a teleological understanding of absence as a gap

waiting to be filled.[45] Brian Rotman and Robert Kaplan traced the persistence of this idea of zero as a "pregnant void"—the hollow circle waiting to be filled with pebbles on the calculator's table or on the Mancala board; the substitution of zero's circle by the egg; the name *theca,* signifying "container," for zero (see Giovanni da Sacrobosco); but also the sign burned into the skin of criminals;[46] the invention of the pause in Western musical notation;[47] or "'nothing' as slang for vagina in Elizabethan English."[48]

This could be compared, as John Barrow showed, to Hindu meditations on naught (kha) as the lodge of an object, as a figure in mathematics, or directly as receptivity (sunya).[49] Indeed, despite the lack of any positive connections, Hindu thought provides probably the closest affinity to Leonardo's reflections. Among the rich Indian vocabulary for zero and nothing, the concept of *bindu* (or *vindu*)—the point—reflects three decisive features of Leonardo's argument: the motion of the primordial unit, creating lines, planes, and three-dimensional bodies (i.e., the creation of space); the conception of *bindu* as a generational force; and the regression of being into nonbeing as a general trajectory of Hindu thought.

In our context, the dynamics of naught or, better, its impact on the realm of being are of particular importance. Again, paradoxical theological thought provides the most detailed materials for the interrelation of the partners in this dialectic, naught and being (negative theology; God as the one who embraces nonbeing, etc.), as the texts in Colie's and Ossola's works amply demonstrate.[50] Of course, one could add the ethical paradoxes of naught, so wonderfully explored in Shakespeare's *King Lear.*[51] Quite obviously, in both areas the central notion of imperfection includes by definition a lack, an absence, the impact of negativity *in action* (as in every privation). In Pico della Mirandola's short treatise *Of Being and Unity,* naught enters the stage precisely as the force of the immeasurable distance between God and his creation, but also as the necessary category that distinguishes the units of individual bodies from one another.[52] Closer to Leonardo's world, however, are the dynamics of zero in two intimately connected areas, computing and economy. Mathematicians soon recognized the power of *theca vel circulus vel cifra.* While zero passively takes the value of every figure it is added to or subtracted from ($12 + 0 = 12$; $12 - 0 = 12$)—the perfect example of the benevolent indifference of naught—its annihilating powers appear when the figure is involved in multiplication and division. Here, zero sets free exactly those implosive and explosive energies that are mirrored in Leonardo's identification of the infinitely small (the point) with the whole ($12 \times 0 = 0$; $12 : 0 = \infty$). But as a result of calculation in double-entry bookkeeping, the revolutionary invention of the late medieval Italian marketplace, zero is the equivalent of the merchant's sigh of relief, the fragile *balance* of credits and debits that keeps the trader's ship afloat.[53]

One consequence of Leonardo's meditations on *punto* and *nulla* is quite obvious: without the infinitely small (the point, as a transitional element between being and nonbeing), there would be no distinction between objects in nature, but also no multitude in the visual field; objects would be indistinguishable, and therefore invisible. Only "nothing" allows for the possibility of vision.[54] At the same time, it is true that *no thing* is really visible (because of the invisible nature and the lack of extension and quality in points, the final constituents of bodies and time). The major impact of this idea on art and representation in general cannot be underestimated. However, instead of following this line of thought, I would like to rapidly

situate Leonardo's insistence on the immanence of the point in the broader horizon of his scientific thought, which extends to optics, hydrogeology, and physics. As I hope will become clear in the following rough outline, in each of these fields the notion of the point is directly linked to dramatic processes on a macroscopic level. The reversible action of the point—creating extensions, and establishing, at the same time, the presence of naught, of an absence in nature—leads to oscillations between being and nonbeing on a cosmological scale. In each case, the point appears as a motor of transition, as the transitional entity through which being (movement, the irregular shape of the earth, images) collapses and is—marvelously—re-created.[55]

Optics

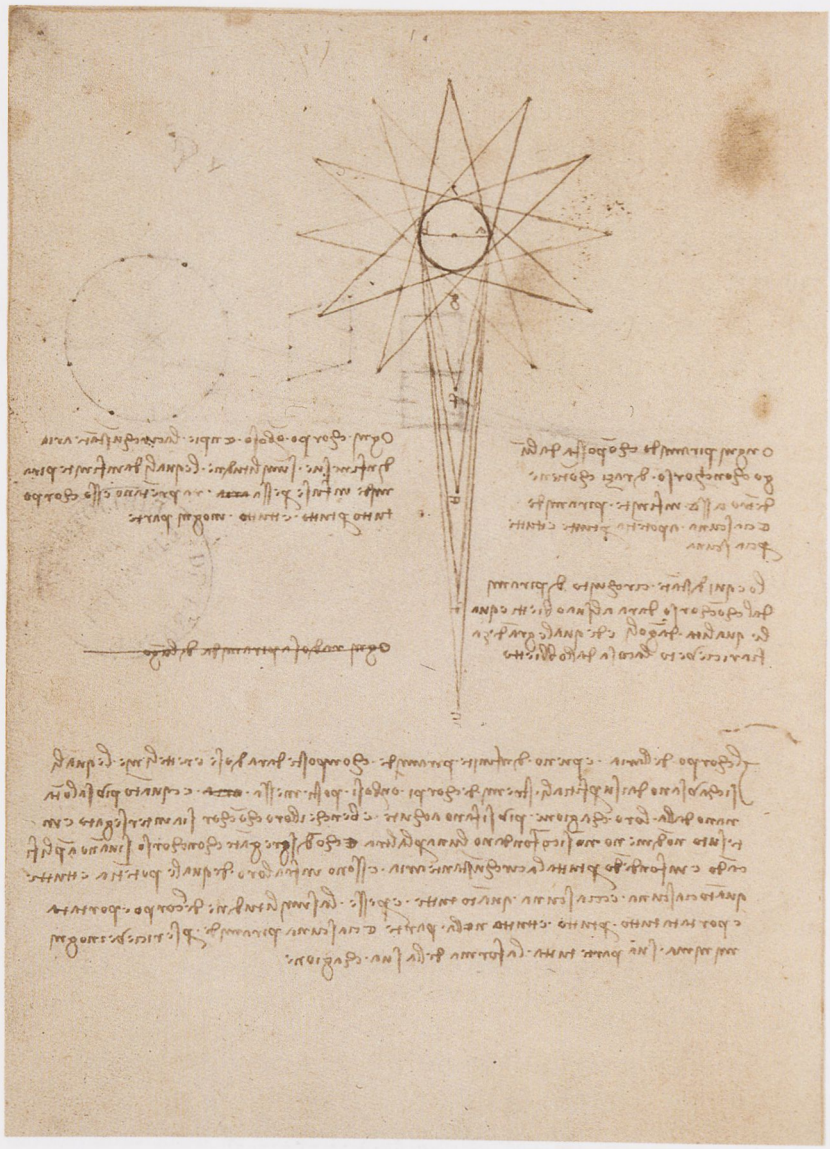
How is the point related to optics? Perspective and its reliance on the transformation of three-dimensional bodies into punctiform marks on the "window pane" of the picture surface played a fundamental role not only in Leonardo's theory of painting, but also in other major fields of research.[56] Leonardo reconceptualized Alberti's main goal—the description of a constructive device for painters—by interpreting perspective as a fundamental phenomenon of nature itself. Since late medieval optics, the linear transmission of punctiform surface properties (rays) was reconciled with the linear transmission of object *forms* (*eidola, spetie, simulacra*) in transparent media.[57] Alhazen's influential concept of *physical* Euclidian rays that transport surface relationships (mainly form and size) reliably to the eye (as long as they are projected perpendicularly on the pupil's convex surface) did not contradict the Western (Epicurean) model of image emissions.[58] In other words, the division of the homogenous optical field in single rays of light provided primarily an *analytical* model, especially for the geometrical reconstruction of reflections (catoptrics) and refractions (dioptrics). But the de facto continuity of punctiform surface emissions still allowed late medieval perspectivists to conceive of these emissions as coherent *images*. Leonardo's optical studies embraced this twin model. In his diagrams, he visualized the optical process by lines (light rays), while his texts refer mostly to *spezie* and (less frequently) *similitudini*.[59]

Alberti remained explicitly undecided in the long and complicated debate about the direction of visual rays.[60] But Leonardo, following the mainstream of late medieval optics, emphasizes that it is the lit object that sends out two-dimensional images of its "true form" through transparent media (air, water, glass, etc.). These image emissions diminish regularly, by straight lines, ensuring the fundamental law of perspective—the inverted ratio of distance and apparent size of objects. The problems of constructing space and the apparent convergence of orthogonals occupied a much lesser rank in Leonardo's thought. This does not mean that he was not interested—theoretically and practically—in Alberti's (or Brunelleschi's) perspective construction. However, constructing an image of an architectural space (with the main problem of the regular diminution of the transversals) became just a special case within the broader framework of Leonardo's optics. Or, as Leonardo stated categorically, "The eye does not see if not through a pyramid. The perspective of painters is unfounded without the pyramid."[61] Instead of developing geometrical models to create fictive space (a tradition that culminates in Piero della Francesca's and Albrecht Dürer's writings), Leonardo highlighted the complementary

aspect of perspective—the diminution of object images on their way through space.

The exceptional state of physical light does not consist in its almost instantaneous swiftness and geometric order alone; it is also proved by its unique independence from the natural vertical movement of the four basic elements and the mixtures of them. Light is free to radiate through transparent space in every direction. But why do visual rays converge? Light sources behave differently; they *spread* light in space. One of the most powerful cosmological paradigms of the thirteenth century, Robert Grosseteste's model of creation, describes the emergence of space as the expansion of light from God's *punctus lucis*, a point that marks the transition from naught into being.[62] Indeed, emissions of light, sound, or odor (as "rarefied" substances, Leonardo refers to them sometimes as "spiritual")[63] proceed in this way. In an early passage of his Codex Trivulzio (ca. 1487–90), Leonardo writes, "All the spiritual powers, the more they move away from their first or second cause, the more space they occupy, and the more they diminish in force."[64] The accompanying diagram shows a candle whose flames emit a cone *diverging* in space.

Alhazen explained the convergence of visual rays by the "physiological" necessity of perpendicular rays in perception. A passage in Leonardo's MS A, fol. 27r (ca. 1490) seems to reflect this idea; here, the eye appears as "target and magnet" of species (dalle quali spezie l'occhio si fa berzaglio e calamità). But is the decrease of apparent size in space different from the diminution of other object qualities (color, sound, odor, etc.)? In other words, is the expansive diffusion of surface images in transparent space irreconcilable with the regular diminution of individual *species*? Obviously not, as a diagram in the same MS A demonstrates (fig. 4.1).



Leonardo da Vinci, Manuscript A, fol. 86v, Institut de France, Paris. **4.1**
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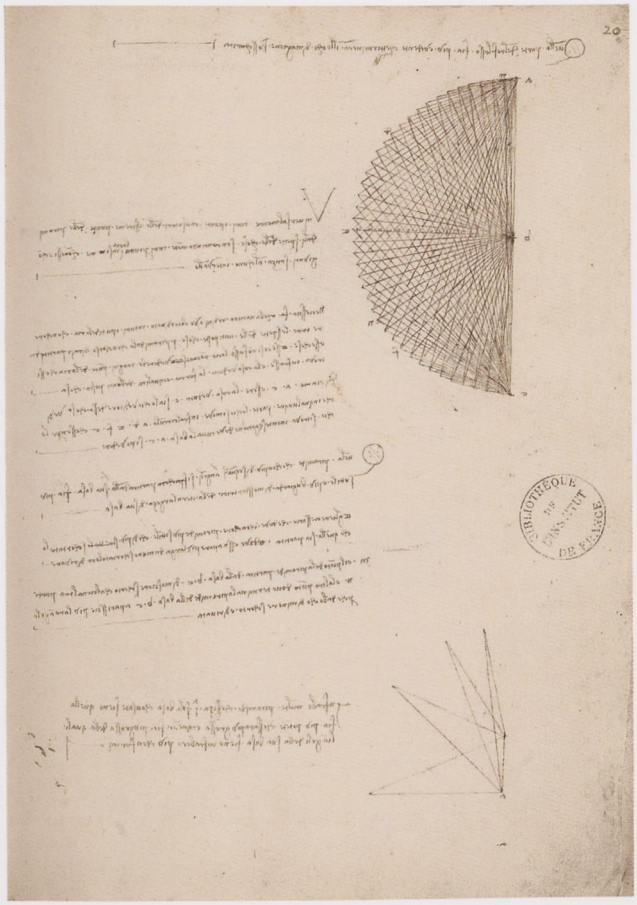


4.2 Leonardo da Vinci, Manuscript C, fol. 20r, Institut de France, Paris. © Bibliothèque de l'Institut de France, Paris.

As two-dimensional images of three-dimensional objects, the simulacra become, in the end, the apex of the visual pyramid and are reduced to points. Undeniably, the whole process has a sublime character. Activated by light, objects emit images of their "true form" that diminish at every point across the transparent medium. The semiosis of nature, as I feel tempted to say—the permanent communication of forms in space, the fundamental mechanism of every lit object to flood space with images of itself—creates countless, regularly diminishing simulacra of surface forms, an ocean of *visible* points.[65] "Pure air is capable of receiving in itself, outside the interval of time, every likeness of a corporeal nature that is hit by the rays of the sun or is illuminated by another agent. . . . Every [minimal] part of the air receives in itself all the images/simulacra of bodies that see it [this part of the air] and that are seen by this part of the air at the same time" (see fig. 4.2).[66]

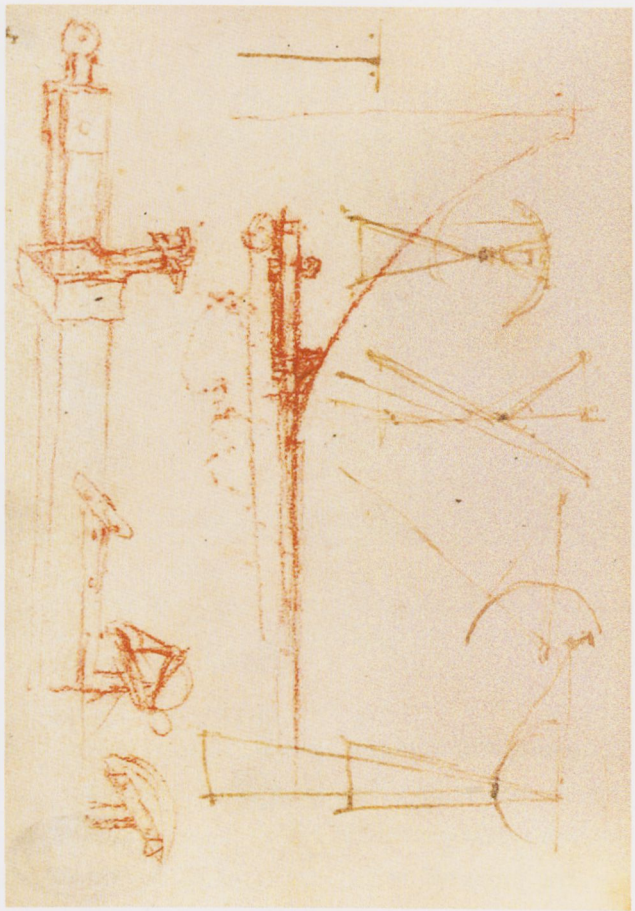
The particular nature of these points and of their relationship to the optical process concerned Leonardo for many years—and not only because the emission process seems to transform being into nonbeing, thereby extending the topos that large objects (entire mountains, the starry sky, etc.) appear miraculously diminished within the space of the minuscule eye.[67] First of all, Leonardo had to clarify whether perception is located at the apex of the visual pyramid or not. Some artists writing in the fifteenth century answered in the affirmative.[68] Leonardo's early optical texts followed this tradition, in the context of a "correct" reconstruction of space via perspective. Therefore, the center point of the eye became the point of reference for the establishment of the distance between eye and object—i.e., the distance point of perspective—a mobile point hit by image points in space, the place where the shapes and colors of objects are transformed into perception (fig. 4.3).[69]

However, in his later optical studies, conducted after 1500, Leonardo realized that there would be no perception of magnitudes if the place of perception were a nondimensional point. This is an argument that had already motivated Alhazen to speculate about the complex refractions caused by the complicated layers, spheres,

and densities of the eye. The site where three-dimensional objects are transformed into perception must therefore necessarily be extended, an argument that blurs the mathematical simplicity of perspective and contributes decisively to Leonardo's sharp critique of perspectivists in the years around 1500.[70]

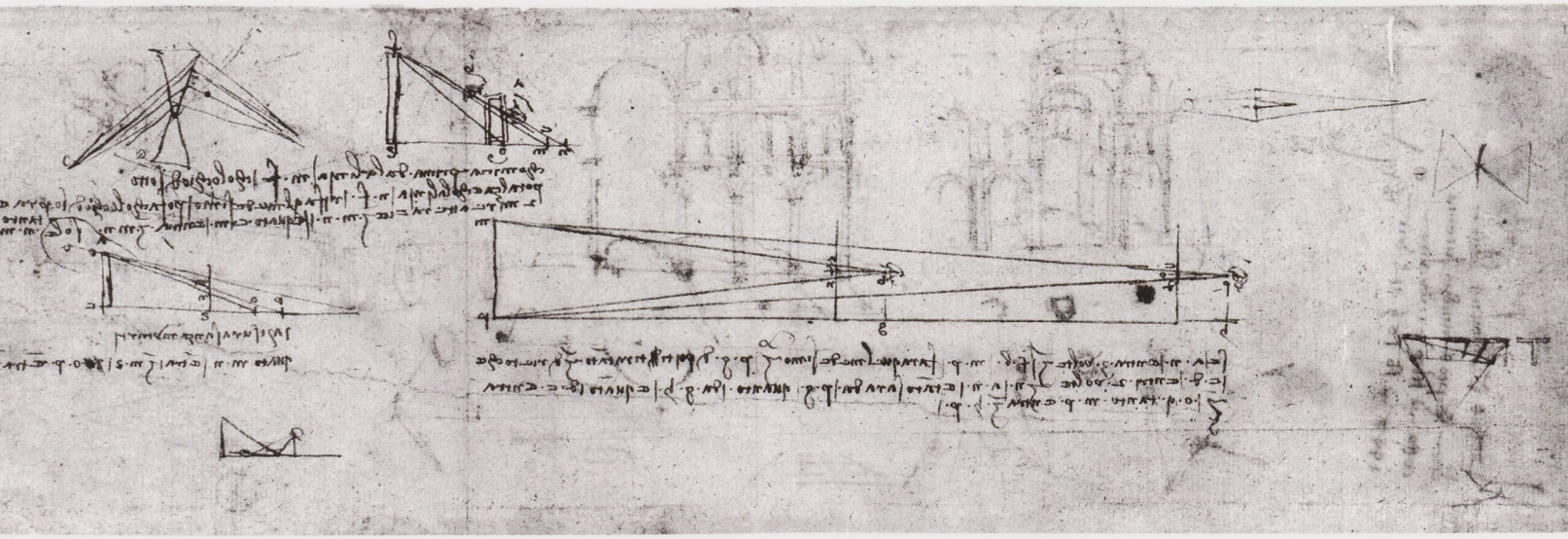
Leonardo's struggle for an alternative model included the traditional hypothesis that the *virtù visivia* should be located at the surface of the eye or at the front surface of one of its "humors," that is, *before* the rays intersect in a point.[71] However, since nature produces nothing in vain, how could this solution explain the complicated structure of the eye? Aristotle had already posed the same question.[72] Relying strongly on medieval optical texts like those by Roger Bacon and John Pecham (both of whom he referred to directly in his writings),[73] Leonardo had to accept that the eye's apparatus redirected the visual rays (fig. 4.4). During the very same years of his reflections on point and nothing (ca. 1505–8), Leonardo felt more and more convinced that the most important site of perception was the rear part of the organ, the place where the optical nerve penetrates the eyeball. But how could this observation be reconciled with the intersection of the visual rays in the eye's transparent *humores*?

The major problem was the necessarily inverted projection of the species in the rear part of the eye, Alhazen's and Bacon's main argument *against* the intersection of rays.[74] Leonardo was quite inventive in overcoming this apparent dead end (which was only accepted some one hundred years later by Johannes Kepler). He postulated a double intersection of the rays (fig. 4.5), or a plurality of intersections, in order to rectify the projected image, for some time even speculating on a first intersection in front of the eye, caused by the reflection at lash and lid (fig. 4.6).[75]



Leonardo da Vinci, Manuscript I, fol. 97v, Institut de France, Paris. © Bibliothèque de l'Institut de France, Paris. **4.3**

In all of these observations and thought experiments, however, one thing remained undisputed: the fact that a two-dimensional image is one or several times reduced to a point, the infinitesimally small transition between body and naught. In a text that tries hard to differentiate between natural and mathematical points, a text that can be dated around 1508, Leonardo states, "All the minimal parts of the species penetrate each other without



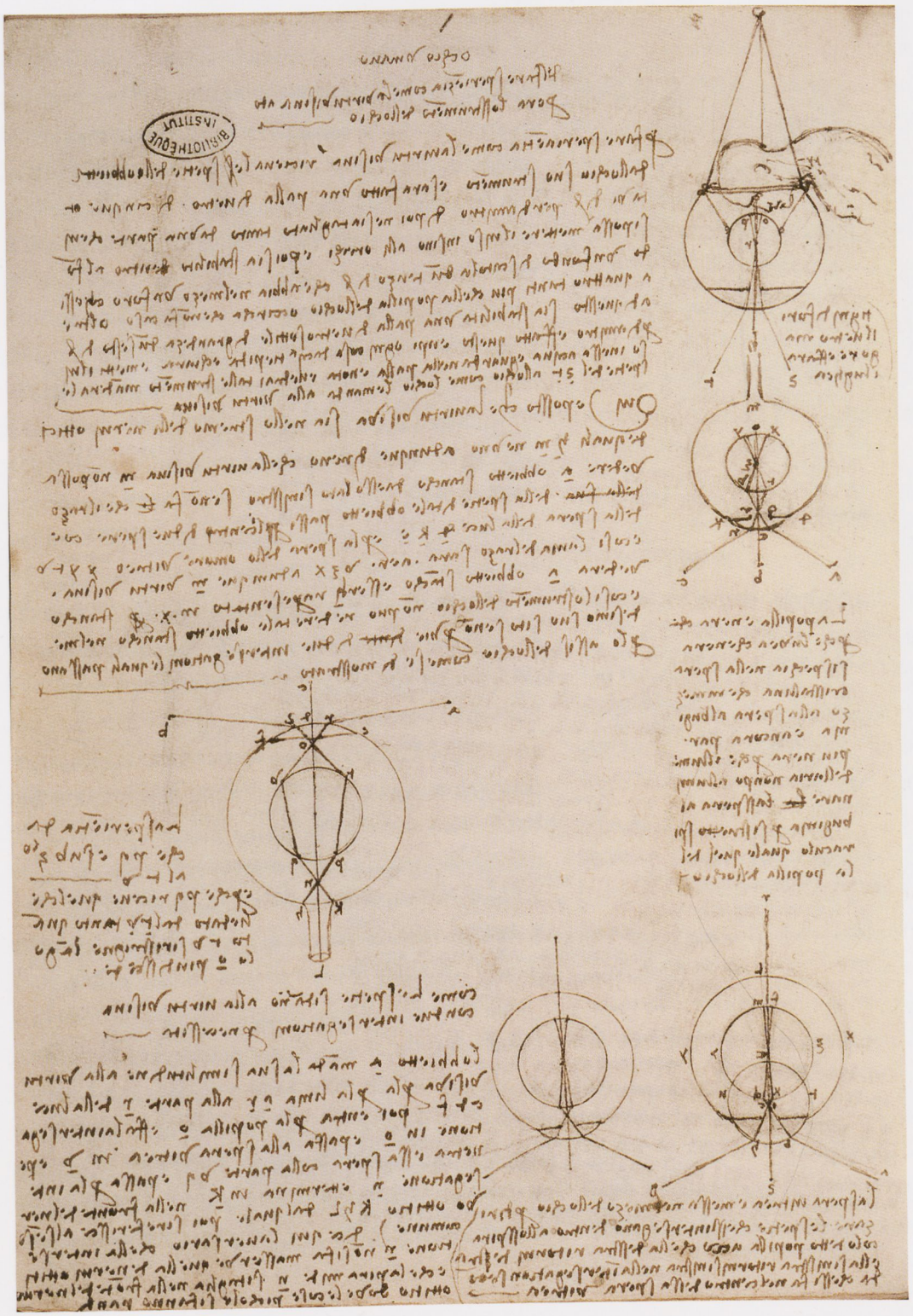
4.4 Leonardo da Vinci, Codex Atlanticus, fol. 119r. © Veneranda Biblioteca Ambrosiana, Milan / De Agostini Picture Library.

'occupying'/displacing each other. . . . So that we conclude that the surface [of objects] is reduced to a point . . . in order to be incorporeal."[76]

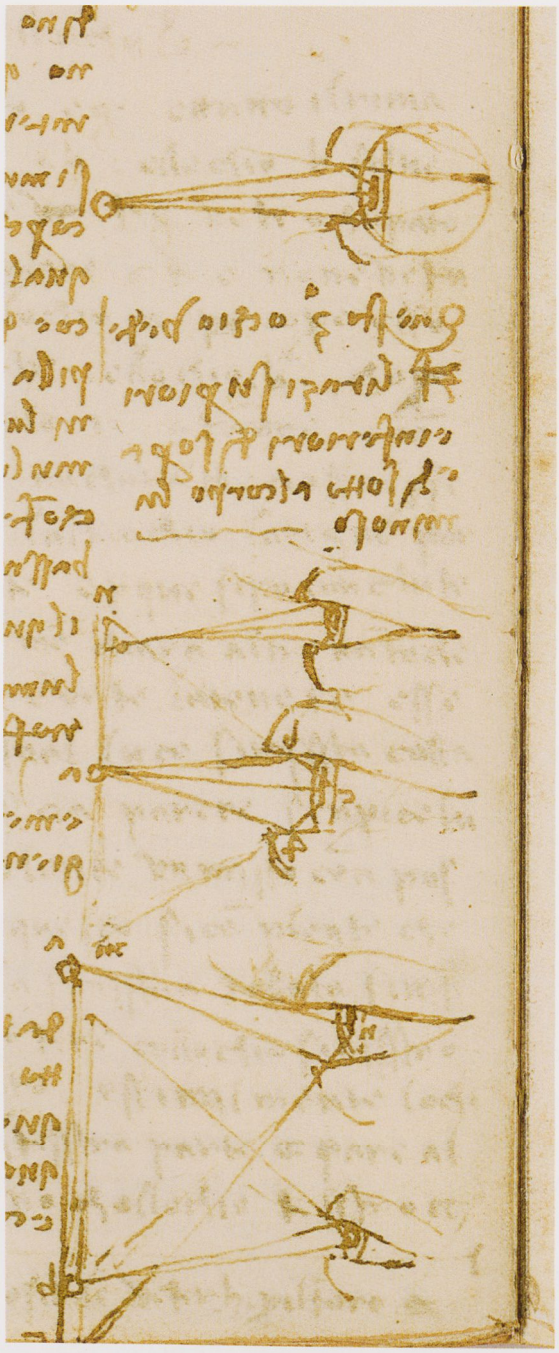
The projected image emissions of objects within the eye pass through a nondimensional point. Thus the self-images that nature "paints" proceed through "nothing." The optical process reveals itself as a proof of the point's presence in nature, a majestic, continuous spectacle of loss and rebirth of dimension, form, and beauty, an oscillation between being and nonbeing, a permanent model for artistic reinvention. The optical process provided the sublime paradigm for some of Leonardo's most intimate poetic lines, written at about the same time as his late studies of point and eye. It is no coincidence that these lines paraphrase a passage in Lucretius's long poem on atoms and void: "Look at the light and consider its beauty. / Close your eye and look at it again. / What you see of it, was not before, and what has been, is not anymore. / Who makes it anew, when its cause [the flame] continuously dies?"[77]

The Earth

In addition to optics, the point occupies a central position in other important fields of Leonardo's studies, namely, hydrogeology and physics. In both cases, the power of the point does not lead to the loss and rebirth of dimensions but to a similar regression to "nonbeing" and reemergence of "multitude": geometric irregularity in the case of hydrogeology, and movement in the case of dynamics. Especially after 1505, Leonardo's hydrogeology centers around concerns about the earth's transformations.[78] This is, to be sure, a natural consequence of his more than decade-old studies of erosion—the antagonistic struggle



Leonardo da Vinci, Manuscript D, fol. 3v, Institut de France, Paris. © Bibliothèque de l'Institut de France, Paris. **4.5**



4.6 Leonardo da Vinci, Manuscript D, fol. 9v, Institut de France, Paris.

between water and earth—but also of his long pursuit of the analogy between micro- and macrocosm and the implied "death" of the earthly organism (or machine, for that matter).[79] At about the same time that Leonardo was meditating on the point as a paradoxical entity in nature and abandoning the idea of optical perception at the apex of the visual pyramid, he was also developing potential scenarios for the earth's past and future (especially in Codex Leicester, ca. 1506–8, and MS F, ca. 1508). In both cases, Leonardo conceptualizes an equilibrium of the elements that is related to rest, geometric order, and death.

In this context, Leonardo's conceptual background likewise derives from the influential Aristotelian tradition and, more precisely, from the idea that movement in nature is the result of the mixture of elements in bodies and/or the effect of "accidental," "violent" intervention of external agents (for instance, organisms). While the globe of the earth at some point in the past lost its initial equilibrium (probably because of the movement of the ocean's waves),[80] the movement of the elements, and especially the erosive actions of water, are nothing other than a tireless and long effort to reestablish primordial equilibrium and rest. Following Aristotle's layering of the four elements, rest is achieved only when the lighter elements (water, air, and fire) find their proper place and return to their concentric spheres around the earth's center.[81]

In his earlier manuscripts, Leonardo had already referred to late Scholastic ideas about the earth's equilibrium, elaborated especially by Jean Buridan and Albert of Saxony.[82] According to these scholars, God's providence separated the center of the earth's gravity from the center of its geometrical magnitude, in order to allow for a global disequilibrium that, in turn, perpetuates movement,

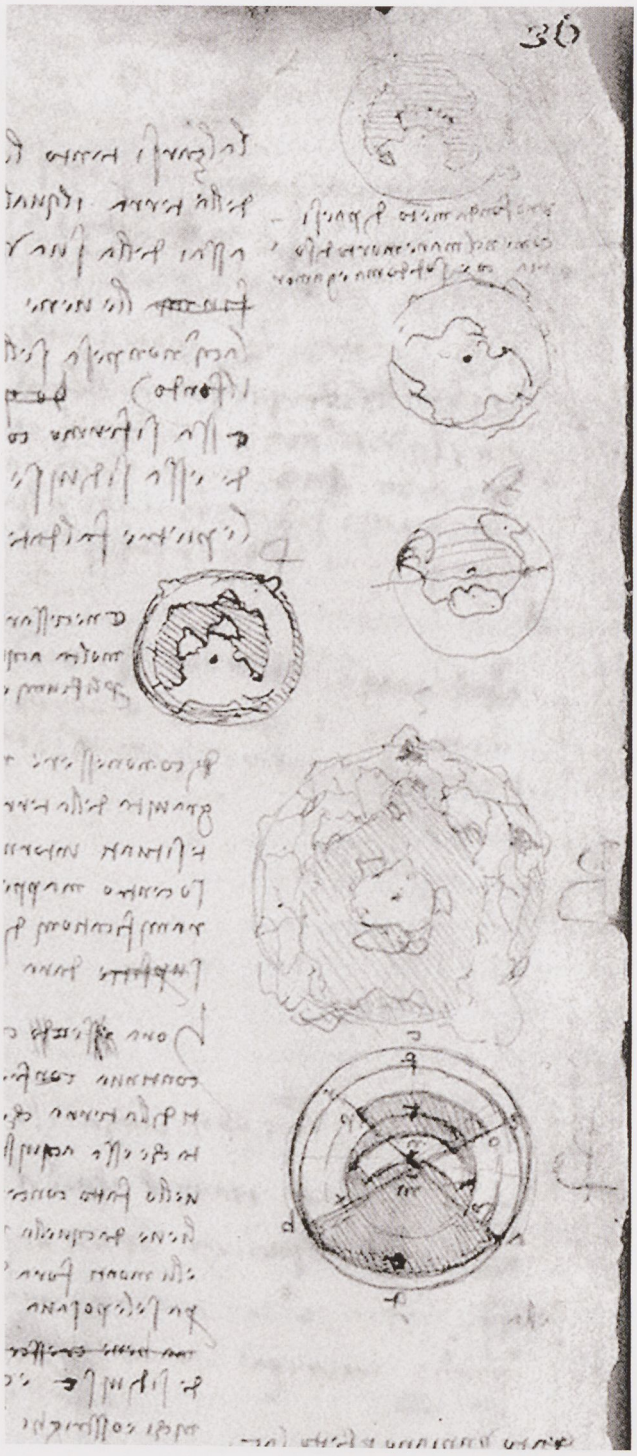
diversity, and life. Leonardo's doubts about the permanency of this constellation increased when he considered the erosive effects of moving water. Codex Leicester and MS F document another of Leonardo's fascinating intellectual journeys, this time a monologue about the validity of the Scholastic argument. Toward the beginning of MS F, Leonardo translates and quotes (!) a passage in Albert of Saxony's commentary on the pseudo-Aristotelian *De mundo:* "On the world. Every weight tends towards lower places, and high objects will not remain on their height, but by and by all of them will descend; and therefore by and by the world will remain spherical and consequently everything will be covered by water."[83]

For Albert, this remains an improbable hypothesis and serves mainly to praise God's *providentia* (the separation of the two "center points"). But Leonardo takes the assumption with deadly seriousness. His two emendations of Albert's Latin text (two times *col tempo*) emphasize the *time* it takes for the erosive powers of water (and air) to level the earth's surface. Mapping out a future in which all the mountains are worn away, allowing water to cover the earth's surface completely, he concludes that the four elements will be stratified spherically. The point of magnitude will then merge with the point of gravity, and all life on earth will be extinguished. This dreadful consequence of the terrestrial mechanism is outlined in the middle of MS F. Here, Leonardo repeats an abbreviated version of the passage on MS F, fol. 84r, adding laconically, "and it [the earth] will be uninhabitable" (e sarà inabitabile).[84]

Again, the permanent reduction of natural diversity becomes visible—the power of the point. Already in Codex Madrid I, fol. 146v (ca. 1495), Leonardo insists upon the fact that the center of gravity of every single body is *unica e sola,* and that this center is a point without extension. This center point in each object is the punctiform "soul of weights" (anima de' pesi). In projectiles it can be located in their front part, as the "guide of their movements" (guida de' lor moti; Codex Madrid I, fol. 146r). If the elementary spheres on earth would be concentric, the "odd concept"[85] of the earth's twin center would disappear, the two points would merge, perfect geometric order would be established, there would be no motion on earth, and terrestrial life would be extinct. In this process, the "accidental center" (the center of magnitude) of the earth would have to "die" (more) while merging with the "anima" of the earth's weight.[86] The history of the earth would be nothing but a very slow counterpart to the almost instantaneous loss of dimensions in the first part of the optical process, a global *contraction* of diversity, and another triumph of the point (fig. 4.7).

Thomas Leinkauf has convincingly demonstrated that the idea of a spatial and, at the same time, nonspatial (*illud paradoxum*), liminal, punctiform center of the world was crucial to the major geocentric argument of a much later scholar's astonishing work on the subterranean world: Athanasius Kircher and his concept of *centrosophia.*[87] However, as in the paradigm of optics, Leonardo embraced *and* complicated the idea of the point as an immanent (physical) element.

A close reading of Leonardo's manuscripts reveals that even at this moment of fusion of the two points, in the state of perfect geometry, global rest and death will only be transitional. On Codex Leicester 16A:21v (15), Leonardo assumes that the center of gravity of the watery sphere changes continuously as a result of the impact of winds.[88] By introducing the powerful activity of sun and moon, Leonardo acknowledges the dynamics of external



agents that will make sure that disequilibrium on earth continues. This culminates in a monumental *lalde del sole* in MS F (fols. 5r–4v), a hymn that digests countless classical and medieval sources, as Cesare Vasoli has shown. According to this text, not only the light of the stars but also the warmth in the universe and the "souls" of living beings originate in the sun. Equally important, the sun works against the merging of the earth's center points, as other texts of this period claim.[89] Even a spherical, water-covered earth would remain geometrically imperfect, because the sun heats and distends the equatorial seas, while allowing the polar seas to freeze and condense.[90] The equatorial waters are therefore "higher" than the northern and southern areas. Together with the moon's influence on the tides, the sun's heat works against the "perfection of the [watery] sphere" (perfezzione alla sua spera). This means that the merging of the two center points will be challenged, and the unique point *continuously* split in two, an oscillating rather than a restful entity. The consequences of the sun and moon's impact on the earth are dramatic; higher areas of the oceans are continuously set in motion (e piglia moto da ogni parte del colle).[91] Leonardo leaves it to the reader to conclude that disequilibrium will continue and that new agglomerations of soil under water will be most probable, eventually leading to new islands, larger areas of uncovered land, and so on. The telos of the earth—to become centered around a single point—can be conceived only as a moment of *transition,* like the convergence of image emissions, the intersection of rays in the eye, and the point *in atto* that is always neither nothing nor something, "the common border [termine] of naught and line, . . . neither naught nor line." In natural philosophy, optics, and cosmology, the point is *always* about to overcome its own

paradoxical being, thus creating the line or collapsing into nothing.

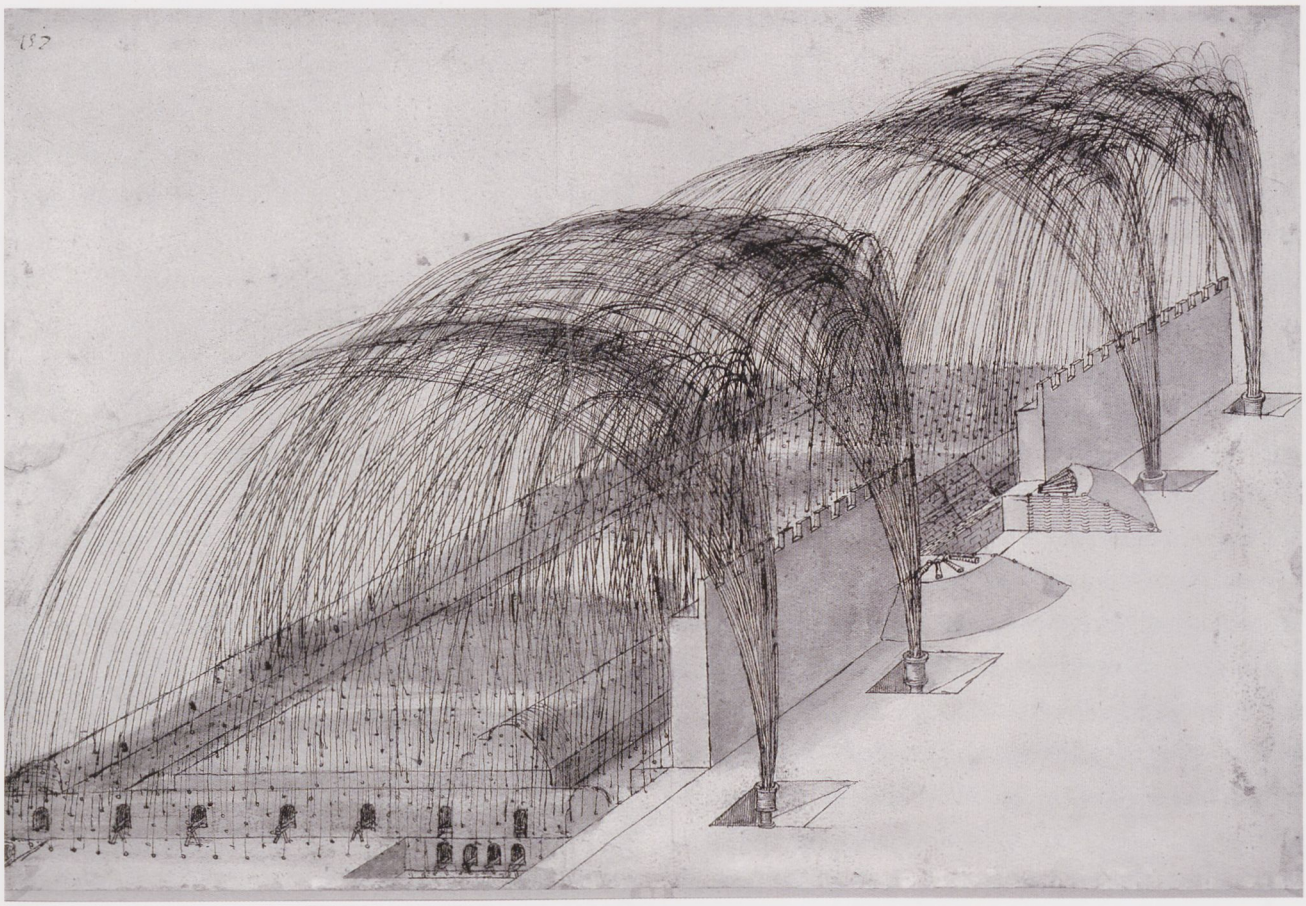
Physics

In physics, Leonardo relied equally on Scholastic predecessors, a common foundation for fifteenth-century ideas about force and "nonnatural" movement, the central agent of which was *impetus*.[92] The concept of impetus as a force transmitted from the moving body to a passive object originated in late antique natural philosophy (John Philoponus, sixth century A.D.) and was reformulated, at the end of the thirteenth century, in the context of commentaries on Peter Lombard's *Sentences*. Two Franciscans were the first to rediscover the idea, Peter John Olivi, the head of the Spirituals, and Franciscus de Marchia, the rector of the order's *studium* in Paris.[93] In contrast to Aristotelian (and Platonic) natural philosophy, both Franciscans negated any decisive role of the medium surrounding an object moved by a "counternatural" force. Instead, they came up with the idea of a force actively transmitted by the mover into the passive mobile, a force that pushed the mobile further even after it lost its contact with the mover. This force was called *vis impressa* by Olivi and *vis derelicta*, the force "left back" in the moved object, by de Marchia. Future debates focused on the question of whether this force—now called *impetus*—diminishes "by itself" or whether it would be perpetual without the counterforces of gravity and friction. Impetus theory was powerfully elaborated by Nicolas Oresme and, again, by Jean Buridan and Albert of Saxony; one of its major exponents in Italy around 1400 was Biagio Pelacani of Parma.

Following this tradition, Leonardo described impetus as something added to each body in a state of nonnatural movement, the paradigmatic example being a stone thrown by an external mover. As a projectile, the stone follows a trajectory that is different from its natural inclination perpendicularly downward, virtually toward the earth's center point (fig. 4.8).[94] However, the force infused into a stone moving "nonnaturally" is not "corporeal"; it neither adds weight to nor changes the form of the moving body. Impetus affects the whole body of the projectile (as the soul in its organism), but its center occupies the *anima del peso*, the center of gravity of the object (in arrows, for instance, in the tip). Impetus adds to its object the resemblance of life, as Nicholas of Cusa had already observed: "The child takes the top which is dead, that is, without motion, and wants to make it alive; . . . the child makes it move with rotational motion as the heavens move. The spirit of motion, evoked by the child, exists invisibly in the top; it stays in the top for a longer or shorter time according to the strength of the impression by which this virtue has been communicated; as soon as the spirit ceases to enliven the top, the top falls" (*Dialogus trilocutorius de possest*).[95] These links between the moving force and life refer to Plato, who defines, in his *Laws*, autonomous movement as the main criterion of life.[96] Plato argues that the elements would be alive if they could move themselves. Consequently, the ubiquity of movement in nature manifests the activity of a living soul of the world. In *Phaedrus* 245c, Plato states that the object that moves, and is moved by others, participates in "life."[97]

For Leonardo, impetus remains a transitional, and, as a point, continuously self-transcending entity.

Leonardo da Vinci, Codex Leicester, fol. 36r. Courtesy of the Bill and Melinda Gates Foundation, Seattle. **4.7**



4.8 Leonardo da Vinci, *Military Project*, ca. 1503. Windsor Castle, Royal Library, inv. 12275. Collection Trust / © Her Majesty Queen Elizabeth II 2013.

Significantly, in the majority of his impetus-related texts, he describes impetus as a dynamic entity desiring its own death. Impetus (or force, *forza*) consumes itself, aided by the resistance of the medium (air, water, etc.) and "natural" gravity. "What is force? Force, I say, is a spiritual power, incorporeal and invisible, existing for a short life in such bodies that are, for some accidental violence, outside of their natural being and rest. Spiritual I called it, because in this force there's active life; incorporeal and invisible I say, because the body in which it is born grows neither in weight nor in form; short-living [I say] because [force] always desires to defeat its origin/reason, and, after having defeated it, [this force] kills itself."[98] Or, in a beautiful late observation: "this impetus, evader of the body where it is created, consumes itself and dies together with the movement of this body."[99]

A close parallel to the suicidal qualities of the impetus can be found in Seneca's *Naturales quaestiones* (7.9.3), where the antique philosopher describes a hurricane, concluding that every violent movement desires its own ruin. For Leonardo, suicidal impetus is the origin not only of bodily but also of sensory movement: "Force [forza] is complete and whole throughout itself and in every part of it. Force is a nonmaterial [spirituale] power, an invisible potency which is imparted and infused by accidental violence from animated bodies to inanimate bodies, giving to these *the semblance of life . . . it speeds in fury to its undoing.* . . . Retardation strengthens and speed weakens it. *It lives by violence and dies through liberty* . . . great power gives it great desire for death. . . . *It likes to consume itself* . . . nothing moves without it . . . *no sound or voice is heard without it.*"[100]

Its desire to rest characterizes the animating point of impetus as a liminal quality, the force that connects two states of rest through movement. Leonardo's poetics of movement locate the driving force of objects in a pointlike entity "pushing" (spinge) against the body that created this force (dove è nata);[101] the object's movement thus results from the dynamic point's desire "not to be" (disiderio di non essere).[102] To extinguish themselves, these physical forces must squander their energies through movement, leading to the object's rest, which is conceived as a form of "death" of force, or stasis. For the physical world as a whole, this would be a futile desire, of course, because nature is by definition a realm of continuous movement and unrest.[103]

The parallels to Leonardo's meditations on the natural point are obvious. Each point transcends itself, tirelessly connecting, dividing, and overcoming nonbeing and being, a force creating *and* annihilating bodies (dimensions), time, and movement. Every point—the infinitely small entity in which all and nothing coincide—is identical with itself only through nonidentity. The point's desire to overcome its own being, to oscillate continuously to "the other side" (its continuous "suicide," the death of "nothing" being the birth of "something" and vice versa), creates multitude and movement. "Where 'nothing' ends, the thing is born, and where the thing disappears [dove manca la cosa], 'nothing' emerges."[104]

Painting

This chapter could not end without some hints at the importance of the point in Leonardo's art and art theory. It is extremely important to realize that what appears to be a mere mind game on Leonardo's part establishes not only optics but also painting itself as a paradigm and continuation of the most fundamental paradox in nature, a paradox with dynamic implications. Leonardo's style is what first comes to mind. No stylistic trait is more characteristic of Leonardo than the blurred boundaries and transparent substances of his soft bodies and surfaces, his almost weightless draperies and vaporous atmospheres. *Sfumato* can indeed be related to Leonardo's observations regarding the complexity of the visual process, particularly in relation to his optical treatise, the Manuscript D, of about 1508.[105]

Leonardo inherited the standard conviction of traditional optics, namely, that only the centric ray being emitted from or reaching each eye establishes a "sharp" perception of the object's form. However, following his ideas about the paradoxical status of the point and the nonexistence of contour lines, Leonardo went on to challenge this formula. Around 1508, Leonardo came to understand

4.9 Leonardo da Vinci, *Study for the Virgin with Child and St. Anne*, ca. 1508. Pen and ink and wash, black and red chalk, heightened with white, 8.6 x 17 cm. Windsor Castle, Royal Library, inv. 12532. Collection Trust / © Her Majesty Queen Elizabeth II 2013.

the line of the centric ray as a liminal entity in a continuity of more or less sharp perceptions. More important, Leonardo observed that this liminal entity oscillates continuously in order to "scan" the object's boundaries and internal differentiations of detail.[106] *Sfumato* exaggerates the fact that physical boundaries are "nothing," paradoxical entities connecting and disconnecting bodies and their surroundings. In this revolutionary view, nothing (the centric ray) meets nothing (the contours of objects), creating a dynamic field of gradual differentiation and a negation of any positive location of forms (fig. 4.9).

Leonardo's oft-repeated formula for the ubiquity of punctiform object emissions in optics (*spezie*, *similitudini*) derives from one of the most influential Neoplatonic attributes of the soul: "tutto per tutto e tutto in ogni parte."[107] While Leonardo applied, at some point in his early anatomical research, the geometry of the Golden Section to determine the site of the *sensus communis* in the brain, he insisted, following the predominant view on the subject, that the human soul is undivided and omnipresent in its body. The soul is a point, indivisible and everywhere (in the body); it has, as Marsilio Ficino explains, a temporal existence without a spatial (material) extension.[108] In his fascinating study *Leonardo nella Roma di Leone X*, Domenico Laurenza has shown that the late Leonardo in particular would not have agreed with the supposed


Leonardo da Vinci

nonmateriality of the Neoplatonic soul. Nevertheless, Leonardo continued to conceive the soul—a liminal, spiritual substance—in paradoxical terms, as indivisible and entirely present at every minimal part of the animated body, as a ubiquitous point.[109]

How does the pointlike character of soul relate to art? Brian Rotman compellingly compared the pinhole at the vanishing point of Brunelleschi's first perspective panel to zero. According to this interpretation, the organizing principle of perspectival space is a nonsign and at the same time the condition of every pictorial sign—like zero in postmedieval Western mathematics.[110] But Leonardo goes further. As we have seen, he defines the utmost principle of painting as the infinitely small point that creates the line. *Every* single point of the picture surface is marked by the point, by this paradoxically identical element of transition, just as the soul permeates the entire body. Leonardo discovered one of the most fascinating principles of pictorial representation, namely, that every point of the picture plane is at the same time a positive element on a surface *and* transparent to the fictive appearance of represented objects, figures, atmospheres, and so on. The material element of color is thus added to a material surface in order to transgress material factualness, to become "nothing" (non è della materia di essa superfitie), and vice versa.[111] This becomes even more evident if the depicted surfaces are themselves "nothing," like Leonardo's favorite objects of the *paragone* with sculpture: water, veils, dust, mist, etc., or the transitional states of movement.[112]

The creations of the painter originate in the movement of the point,[113] leading to visual forms on the picture surface (visible points, lines, surfaces) (fig. 4.10). One of Leonardo's texts begins, "If you portray, or if you move some principle of a line," thereby locating the point precisely at the inception of the pictorial act.[114] The transition from naught to being embraces, in this perspective, the paradigm of *creatio ex nihilo* and therefore complements Leonardo's definition of the painter as *signore e dio* of his creations.[115]

The emissions of nature (creating perfect self-portraits) do not simply end in a complete loss of dimensionality—they are transformed, in the eye, into a new image that passed through "nothing." In the eye, the "first" nature becomes a point, negating corporeality, in order to be constituted as a "second" nature.[116] To be sure, this is Leonardo's honorary title for the perfect painter, a painter who transforms himself, like a pure, rational mirror, into the mind of nature.[117] Leonardo's ideal painter overcomes the idiosyncrasies that force him to continually produce *figure come fratelli* and, in the end, nothing but self-portraits.[118] Instead of being a particular "line," one could extrapolate, the painter should become a "point," capable of being the *interprete* of "everything" in nature. At the same time, the perfect painter exploits the category of *possibility* that is so intimately connected to the *tertium ens* of the point: "a Medium between Being and Naught, or the Possibility of Being," as Jacques Gaffarel put it in 1634.[119] The perfect painter would be, to extend Leonardo's analogy further, a "point," capable of creating every *possible* line—everything "per essentia, presentia o' immaginatione."[120] This painter's works would

4.10 (*overleaf*) Leonardo da Vinci, *Study for a Kneeling Leda,* ca. 1508. Black chalk and pen and ink, 12.5 x 11 cm. Museum Boijmans Van Beuningen, Rotterdam. Loan: Museum Boijmans Van Beuningen Foundation (Collection Koenigs).

document the triumphs of the point (the permeation of being and naught) in nature. "Necessity forces the mind of the painter to transform himself into the actual mind of nature, and to become an interpreter between nature and art, in order to consider with her the reasons of his demonstrations, forced by her laws, and *in which way the similitudes of the objects that surround the eye converge [concorrino], with their true simulacra, at the pupil of the eye.*"[121]

Notes

1. On "images without viewer," see the essays in Bredekamp and Werner, *Bilder ohne Betrachter*.

2. Given the extent and depth of Leonardo's work in each of these fields, my chapter can be only a rough draft.

3. I use these terms as synonyms, in order to provide a flexible set of nouns for Leonardo's shifting terminology.

4. For this argument, see Kemp, "Crisis of Received Wisdom."

5. See Fehrenbach, *Licht und Wasser*, 229–56; Frosini, "Leonardo da Vinci e il 'nulla,'" 232 ("radicalizzazione dell'attitudine osservativa e—per usare un anacronismo—fenomenologica dinnanzi ad essa").

6. See Pedretti, *On Painting*, 177.

7. I have used Claire Farago's translation, with amendments. See Farago, *Leonardo da Vinci's "Paragone,"* 177–78.

8. "E questo si prova col zero over nulla, cioè la decima figura de la arismetrica, per la quale si figura un o per esso nullo, il quale, posto dopo la unità, il fa dire dieci . . . e così *infinitamente* crescerà." *Libro di pittura*, par. 1 (emphasis added). The implication of the dynamic qualities of zero in a positional numerical system is reflected in a passage in Giovanni da Sacrobosco's widely diffused *Algorismus* (ca. 1240—after zero's distant origins in Babylonian calculations, blurry development in Greek thought, elaboration in Indian-Arabian mathematics, and introduction in the West by the *Liber algorismi*, ca. 1143): "Sciendum quod iuxta 9 limites 9 inveniuntur figure significative 9 digitos representantes qui tales sunt—0 9 8 7 6 5 4 3 2 1—decima dicitur theca vel circulus vel cifra vel figura nihili quoniam nihil significant. Ipsa tamen locum tenens dat aliis significare. Nam sine cifra vel cifris purus non potest scribi articulus." See Menninger, *Number Words and Number Symbols*, 401–3, 410–12, 422–24. For the literature on zero and nothing surrounding the turning of 1999 to the year 2000 (and fueled by the fears of a "Y2K computer bug"), see Kahl-Furthmann, *Problem des Nicht*; Seife, *Zero*; Barrow, *Book of Nothing*; and, especially, Kaplan's most elegantly written *Nothing That Is*. Rotman's *Signifying Nothing* provides a fascinating deconstructivist analysis of the ambiguous character of zero, describing it as "between an empty character . . . and a character for emptiness" (13), a sign for nothing and a sign for the absence of signs. On the history and philosophy of the point, see Federici-Vescovini, *Studi sulla prospettiva medievale*, 213–37; Hagengruber, "Punkt und Mathematik"; and Wohlfart, *Punkt*. For an overview of the mathematics of Leonardo, see Bagni and d'Amore, *Leonardo e la matematica*.

9. *Corpus of the Anatomical Studies . . . at Windsor Castle*, fol. 191511r (Keele and Pedretti 118rB, ca. 1508); cf. *Codice Arundel 263 nella British Library*, fol. 131v (ca. 1505). Marinoni, in "Essere del nulla," underlines the paradoxical properties that connect these geometrical elements, the optical pyramid, nature's imponderable forces, and the soul: "'cose spirituali,' incorporee" (23). Marinoni's reading of Leonardo's oppositions in a Neoplatonic perspective has been convincingly challenged by Frosini, "Leonardo da Vinci e il 'nulla,'" esp. 213 and 231.

10. *Libro di pittura*, par. 31c.

11. See Summers, *Judgment of Sense*, passim; Fehrenbach, *Licht und Wasser*, 181–92 ("Moti mentali").

12. This refers to Ibn-al-Haytham/Alhazen's insistence on the physical nature of light rays, as echoed, for instance, in John Pecham's *Tractatus de perspectiva*, chap. 1, 26–27. Cf. Filarete, *Trattato d'Architettura* (Cod. Magliabecchianus), fol. 175v (see also fol. 173v); and Piero della Francesca, *De prospectiva pingendi*, bk. 1, preface. See Field, *Invention of Infinity*, 80–81.

13. "Quae vero intuitum non recipiunt, ea nemo ad pictorem nihil pertinere negabit." Alberti *De pictura* 1.2. Notice the hyperbolic triple negation!

14. Cf., as *pars pro toto*, Nicole Oresme: "linee, puncta, etc. nihil sunt sed solum ymaginantur esse." *Questiones de spera*, qu. 3, quoted in Frosini, "Leonardo da Vinci e il 'nulla,'" 217, with reference to Clagett, "Use of Points in Medieval Natural Philosophy." For Scholastic discussions of *continua*, infinity, and *minima*, and for precursors of Leonardo's immanence of the infinite in the fourteenth century, see Maier, *Vorläufer Galileis*.

15. Euclid, *Thirteen Books of Euclid's Elements*, def. 1.

16. "Ultimi principii, de'quali *in natura* null'altra cosa si puó trovare che sia parte d'essa scientia." *Libro di pittura*, par. 1 (emphasis added). Cf. *Codice Atlantico*, fol. 784ar: The point does not occupy any space, and it exists in nature (si dà in natura); it is mobile and generates the line. See also the *Codices Madrid*, vol. 1, fols. 60v, 109v.

17. "In tali discorsi mentali non accade esperienza, sanza la quale nulla dà di sé certezza." *Libro di pittura*, par. 1.

18. On the early modern history of infinity, see Field, *Invention of Infinity*.

19. Pedretti, "Saggio di una cronologia."

20. *Codice Arundel*, fol. 131r.

21. "Punto non è parte di linia. / L'acqua che tocchi de' fiumi è l'ultima di quella che andò, e la prima di quella che viene; così il tempo presente."

22. "Ogni quantità continua *intellettualmente* è divisibile in infinito." *Codice Arundel*, fol. 131r (emphasis added). This nominalist argument has been elaborated especially by William Ockham and Gregorio da Rimini; see Federici-Vescovini, *Studi sulla prospettiva medievale*, 219–21.

23. "Infra le magnitudine delle cose che sono *infra noi*, l'esse del nulla tiene il principato, e 'l suo ofitio s'astende infra le cose che non hanno l'essere." *Codice Arundel*, fol. 131r (emphasis added).

24. Ibid., fol. 159v.

25. Frosini, "Leonardo da Vinci e il 'nulla,'" 226. The definite article aims at a dynamic inclusion of "nothing" in the realm of an enhanced, more complex "being." The question of whether the *proxima nihilo* of the *prima materia* (a victory of Aristotle over the Bible's *creatio ex nihilo*) should be given the attribute of "unity" (oneness, identity) was answered affirmatively in Ficino *De amore* 6.xv and, quite significantly, denied in Pico della Mirandola *De ente et uno* 3; cf. 7. On the related notion of "chaos" in Leonardo, see Toussaint, "Leonardo filosofo dei contrari." For the complex history of nothingness in religion, see Nishitani, *Religion and Nothingness*. For its history in nineteenth-century science, see Adams, *Nil* (I would like to thank Paul Barolsky for this reference). On the return of the *proxima nihilo* in the modern theory of cosmic vacuum energy, see Barrow, *Book of Nothing*, 8–11. For a modern "nihilist's" critique of the reification of naught, see Lütkehaus, *Nichts*.

26. *Codice Arundel*, fol. 159v. A close parallel to this idea can be found in Jacques Gaffarel's ingenuous *NIHIL, fere NIHIL, minus NIHILO: Seu De Ente, non Ente, et Medio inter Ens, et non Ens POSITIONES XXVI* (Venice, 1634): "[XXXIII] Punctum similiter extremus magnitudinum terminus, ac meta, fere Nihil est, quia magnitudinum licet aliquid sit, ut *eorum initium, et terminus*, non tamen realiter est magnitudo, cum omni careat dimentione; inter ergo magnitudinem, et non magnitudinem situm est, seu inter Ens, et Nihil" (emphasis added). Quoted in Ossola, *Antiche memorie del nulla*, 160.

27. A close parallel to this argument is provided by Martianus Capella's translation of Euclid's definition 1: "Punctum est cuius pars nihil est." See Thomas L. Heath's commentary in Euclid, *Thirteen Books of Euclid's Elements*, 1:155.

28. "Adunque il fine del nulla e 'l principio della linia son in contatto infra loro, ma non congiunti; e in tal contatto è il punto. Del qual punto el nulla è fratello." *Codice Arundel*, fol. 204r. On the genealogical relationship of the "four powers," cf., for instance, MS A, fol. 35v. On music as *sorella* of painting, see *Libro di pittura*, par. 29.

29. "I' modo che si pò dire quantità continua per essere apicate insieme, e discontinue per essere di 2 nature." *Codice Arundel*, fol. 130r.

30. "Tutte le cose che niente ocupano, sono equali infra loro . . . e ciascuna di quelle equale a tutte. Onde in questo caso seguita che la parte sarà equale al tutto e 'l tutto alla parte, el divisibile allo indivisibile, el finito allo infinito. Adunque per quel ch'è detto, la superfizie, la linia, el punto nulla è, perché niente occupa, e tutti e'nulli sono equali a tutti, e tutti a uno, come si prova in aritmetrica. . . . El corpo è vestito di più superfizie, e le superfizie son circundate di linie, e le linie son terminate da punti." *Codice Arundel*, fol. 132r. Cf. a related passage in an anonymous late fourteenth-century commentary on Euclid: "Nec potuit crescere nec decrescere punctus. . . . Omnes igitur puncti visi videntur aequales." Quoted in Federici-Vescovini, *Studi sulla prospettiva medievale*, 227; on apparent echoes of this manuscript in Alberti's and Leonardo's writings, see 224, and for late medieval discussions on the physical or abstract character of point, line, and angle, see 213–37.

31. Frosini, "Leonardo da Vinci e il 'nulla,'" 225–32.

32. Ficino, *Platonic Theology*, 2:6; cf. Plotinus, *Ennéades*, 3:9.4, 5:2.2, 6:8.16, 5:5.9. See Beierwaltes, *Denken des Einen*, 47, 220–22. However, Neoplatonic philosophy emphasized that nature provides an analogy for the triad of the One, multitude, and nothing; on Proclus, for instance, see Beierwaltes, *Denken des Einen*, 234. On the use of analogy in Leonardo's thought, see Economides, "Everything Comes from Everything." On Porphyry of Tyre's theology of God as both "preexistent" (*prousion*) and "nonexistent" (*anusion*), but also as the pure *activity*, efficacy of being (in his commentary on Parmenides), see Beierwaltes, *Denken des Einen*, 198.

33. See Fehrenbach, *Licht und Wasser*, 205–15, 229–56.

34. See Barrow, *Book of Nothing*, 54–64. Aristotle's critique (with reference to continuous movement in fluids) can be found in *Physics* 4.214a31–32.

35. *Codice Arundel*, fol. 173v; cf. fol. 205r (in the context of geological arguments): "Dice l'aversario che il punto è o e' non è, e s'egli è, o egli si pò movere o e' non si pò movere, e se sarà mosso, e' descrive la linia."

36. Augustine *Confessiones* 11; see Flasch, *Was ist Zeit?* On the point of presence as *a-topon* ("nothing," not positively given) and as a "transitional" moving principle in Plotinus, see Beierwaltes, *Denken des Einen*, 196.

37. *Codice Arundel*, fol. 159r. The authoritative discussion of point and line, instant and time, with a focus on Zeno's paradoxes, is in the sixth book of Aristotle's *Physics*: "impossibile est ut aliquod continuum sit compositum ex indivisibilis: et linea sit composita ex punctis" (231a; cf. 235b, 237b); for the analogy in time, see 234a. On the continuum in Aristotle, see Wieland, *Die aristotelische Physik*, 283–85; Böhme, *Zeit und Zahl*, 99–158; and Inwood, "Aristotle on the Reality of Time"; in early modern science, see Mainzer, *Begruendungsproblem des mathematischen Kontinuums*, 125–37. Leonardo, however, seems more closely to follow Euclid, who states in his *Elements*, def. 3, "The extremities of a line are points." For Simon Stevin's later insistence on

"the true and natural beginning" of numbers (and counting) in zero, the *poinct de nombre* (in analogy to the point as origin of the line), see Rotman, *Signifying Nothing*, 28–32. On the line generated by the point in motion, see Aristotle *De anima* 1.4.409a4. A parallel is provided by Proclus, who refers to line as "flux of the point"; see Beierwaltes, *Proklos*, 173. Simplicius follows the same argument; see Heath's commentary in Euclid, *Thirteen Books of Euclid's Elements*, 1:157.

38. "La conversa. Il punto si gienera dove manca la lunghezza della linia; la linia nasce dove finisce la largheza o lungheza della superfizie, e la superfizie è creata nel termine della largheza, lungheza e profondità del corpo." *Codice Arundel*, fol. 159r.

39. Ibid.

40. Ossola, *Antiche memorie del nulla*, 26. Cf. Ficino *Theologia Platonica* 10.2, cited in Marinoni, "Essere del nulla," 25.

41. "Perché il moto è di natura di linia e la linia comincia in punto. Adunque il moto principia ancora lui in punto." *Codices Madrid*, vol. 1, fol. 109v.

42. "Colpo è termine di moto creato in tempo indivisibile, perché è causato nel punto, termine della linia del moto." *Codici Forster*, vol. 3, fol. 32r.

43. See Rotman, *Signifying Nothing*, 57–78.

44. See Beierwaltes, *Denken des Einen*, 343–44.

45. See Kaplan, *Nothing That Is*, 64.

46. This is explained by Petrus of Dacia in 1291; see ibid., 66.

47. Rotman, *Signifying Nothing*, 57.

48. Ibid., 60 (with reference to Colie, *Paradoxia epidemica*).

49. Barrow, *Book of Nothing*, 36–38.

50. Most important on Neoplatonic philosophy of the "One," see Mahnke, *Unendliche Sphäre und Allmittelpunkt*; Beierwaltes, *Denken des Einen*.

51. See Babb, *King Lear*, 235–49; Rotman, *Signifying Nothing*, 78–86.

52. "Est enim illud, quicquid est a se, indivisum et ab aliis divisum quae non sunt ipsum." Pico della Mirandola, *De ente et uno*, chap. 8 (cf. chap. 5).

53. See Kaplan, *Nothing That Is*, 68, 110.

54. See Frosini, "Leonardo da Vinci e il 'nulla,'" 222.

55. It would be tempting to relate Leonardo's paradox to the different Greek terms for the point—*stigme*/puncture (Aristotle) and *semeion*/mark (Euclid, Archimedes; see Heath's commentary in Euclid, *Thirteen Books of Euclid's Elements*, 1:156)—and to read the point, as *semeion*/semen, with Derrida, as *différance*. See Derrida, *Positions*, 44–46.

56. Kemp, "Leonardo's Visual Pyramid"; Ackerman, "Leonardo da Vinci's Eye"; Strong, *Leonardo on the Eye*; Veltman, *Linear Perspective and the Visual Dimensions*; Fehrenbach, *Licht und Wasser*, 115–41, 157–92.

57. See Lindberg, *Roger Bacon's Philosophy of Nature*; Koelsch Loose, "Roger Bacon on Perception."

58. Lindberg, *Theories of Vision from al-Kindi to Kepler*, 58–86; on Alhazen, see Sabra, *Optics of Ibn al-Haytham*.

59. The liminal quality of rays/images is emphasized, for instance, in MS A, fol. 2v: "L'aria è piena d'infinite linie rette e radiose insieme intersegate e intessute sanza occupazione l'una dell'altra; rapresentano a qualunche obbietto la vera forma della lor cagione."

60. See Alberti *De pictura* 1.5.

61. "L'occhio non vede se non per piramide. La prospettiva de'pittori sanza piramide non ha loco." *Codice Arundel*, fol. 232r, ca. 1483–99.

62. See Crombie, *Robert Grosseteste and the Origins of Experimental Science*; Federici-Vescovini, *Studi sulla prospettiva medievale*, 219 ("Punctus est substantia posita"); Lindberg, *Roger Bacon's Philosophy of Nature*, 94–102; Agnoli, *Roberto Grossatesta*.

63. See Frosini, "Pittura come filosofia."

64. "Tutte le potenzie spirituale, quanto piú s'allontanano dalla prima o seconda cagione, piú occupano di sito e piú diminuiscano di lor valitudine." *Codice di Leonardo da Vinci nel Castello Sforzesco*, fol. 11v.

65. On the semiosis of organisms, see Jonas, *Phenomenon of Life*; Maturana and Varela, *Autopoiesis and Cognition*; Weber, *Natur als Bedeutung*.

66. "L'aria pura è capacie di ricievere in sé sanza intervallo di tenpo ogni similitudine di corporea qualità che sia dai sola razi percossa o per la cagione aluminata. . . . Ogni parte d'aria ricieve in sé tutte le spezie de' corpi che la vedano e son veduti da lei 'n un medesimo tenpo." *Codice Arundel*, fol. 186v (1483–99).

67. Plotinus, *Ennéades*, 4:7.6; cf. Summers, *Judgment of Sense*, 93. Augustine *De genesi ad litteram* 4.34.54: "Omnis illa tam ampla immensaque spatia simul uno ictu transiri manifestum est"; Pecham, *Tractatus de perspectiva*, chap. 2; *Codice Atlantico*, fol. 949r: "Chi crederrebbe che sì brevissimo spazio fussi capace delle spezie di tutto l'universo? O magna azione, quale ingegno potrà penetrare tale natura? Qual lingua fia quella che esplicare possa tal maraviglia? Certo nessuna. Questo dirizza l'umano discorso alla contemplazione divina, eccetera."

68. "La virtù visiva è solo un puncto." Piero della Francesca, *De prospectiva pingendi*, bk. 1, chap. 1. "Ogni cosa tira a quel punto; perchè, come ai inteso, quello è il punto centrico, el tuo occhio, col quale ti bisognia fermare ogni cosa, a similitudine come colui, che balestra, che sempre tiene la sua mira a uno dato e fermo punto." Filarete, *Trattato d'Architettura* (Cod. Magliabecchianus), chap. 23, fol. 178v (p. 163 in Oettingen's edition). Leonardo's position can be compared to that of Roger Bacon, who blames the *auctores perspectivae* of his time for neglecting the functions and anatomy of the eye (*Opus Majus*, part 5, bk. 1, distinction 2.1). For a thorough discussion of the relevance of the optical tradition to Quattrocento painting, with an emphasis on the extended area of perception on the surface of the eye or on one of the eye's humors (as a *speculum animatum*), apparently in contrast to Leonardo's arguments, see Summers, *Vision, Reflection, and Desire*, 43–77.

69. Cf. MS C, fol. 19v; MS A, fols. 3r, 10r, 40v, 41r; MS H, fol. 131v; MS I, fol. 97v, all in Leonardo, *Manoscritti dell'Institut de France*; *Codici*

Forster, vol. 3, fol. 36r; *Codice Atlantico*, fols. 85va, 232r, 955r, 1101ar; *Corpus of the Anatomical Studies . . . at Windsor Castle*, fol. 19152r (Keele and Pedretti 118rB). See also Kemp, "Leonardo's Visual Pyramid," 133.

70. See Galluzzi, *Leonardo e i proporzionanti*.

71. Cf. MS D, fol. 4v: "Occhio dell'omo. Che sia vero che ogni parte della popilla abbia virtù visiva e che tal virtù non sia ridotta in punto, come vogliano li prespettivi."

72. Aristotle *De sensu et sensibilibus* 438a.

73. *Codice Arundel*, fol. 71v (ca. 1508); *Codice Atlantico*, fol. 543r.

74. Alhazen *De aspectibus* 2.2.23; Bacon, *Opus Majus*, part 5, bk. 1, distinction 3.1.

75. Cf. MS D, fols. 1v, 2r, 9v (all at the end of the manuscript).

76. "Tucte le parte minime delle spetie penetra l'una l'altra sanza occupatione l'una dell'altre. . . . Come concludiamo noi la superfitie riddursi in punto . . . per essere incorporee." *Corpus of the Anatomical Studies . . . at Windsor Castle*, fols. 19149–19152v (Keele and Pedretti, fol. 118v). Cf. Kemp, "Leonardo's Visual Pyramid," 144. On the difference between mathematical and natural points, see Zubov, "Jean Buridan et les concepts du point"; Federici-Vescovini, *Studi sulla prospettiva medievale*, 213–37; Leinkauf, *Mundus combinatus*, 58–59.

77. "Guarda il lume e considera la sua bellezza. Batti l'occhio e riguardalo. Ciò che di lui tu vedi, prima non era, e ciò che di lui era, più non è. Chi è quel che lo rifà, se 'l fattore al continuo more?" MS F, fol. 49v. Cf. Lucretius *De rerum natura* 5.290–93: "ut noscas splendore novo res semper egere / et primum iactum fulgoris quemque perire / nec ratione alia res posse in sole videri, / perpetuo ni suppeditet lucis caput ipsum."

78. Baratta, *Leonardo ed i problemi della terra*; Kemp, *Leonardo da Vinci*, 114ff.; Fehrenbach, *Licht und Wasser*, 193–215.

79. For the Christian perspective relevant to these pursuits, see Augustine *De civitate Dei* 12.11; Fehrenbach, *Licht und Wasser*, 215–29.

80. Codex Leicester, 1B:36r (1).

81. Cf. ibid., 2A:35v.

82. Cf. MS A, fol. 58v; *Codici Forster*, vol. 3, fol. 7r; *Codices Madrid*, vol. 1, fols. 6r, 114r. See Moody, *John Buridan on the Habitability*; Zubov, *Leonardo da Vinci*, 249ff.

83. "Del mondo. Ogni grave attende al basso e le cose alte non resteran in loro altezza, ma col tempo tutte discenderanno; e così col tempo il mondo resterà sperico e per conseguenza fia tutto coperto dell'acqua." MS F, fol. 84r. For the reference to Albert of Saxony's *Questiones subtilissime in libros Aristotelis*, II, qu. 28, see Solmi, *Fonti di Leonardo*, 55–56.

84. MS F, fol. 52v.

85. Kemp, *Leonardo da Vinci*, 254–55.

86. Cf. Codex Leicester, 2A:35v (3).

87. Kircher's colossal effort to localize God in the *punctum* of the earth's center is both a bold twist in the history of the famous Neoplatonic formula "Deus est sphaera infinita, cuius centrum est ubique, circumferentia nusquam" (*Liber XXIV philosophorum*, propositio 2) *and* a confutation of the traditional rejection of the earth's center as the most material, dark, and shameful place, *fex foeculentissima* (Francesco Patrizi, *Nova de universis philosophia*); see Leinkauf, "'Centrosophia' des Athanasius Kircher," 221, 224–25.

88. "Muovesi il centro dell'acqua e terra insieme g[i]unti quando si move il peso del mare portato da venti."

89. Cf. *Codice Atlantico*, fol. 412v.

90. Codex Leicester, 15A:22r (8).

91. MS F, fol. 70v.

92. See Duhem, *Études sur Léonard de Vinci*, vol. 3, *Les précurseurs parisiens de Galilée*. On Leonardo's dynamics, see Moody's introduction in *John Buridan on the Habitability*, xx; Fehrenbach, *Licht und Wasser*, 239–45. On impetus physics, see Maier, *Zwei Grundprobleme*; Maier, *Metaphysische Hintergründe*; Drake, "Impetus Theory Reappraised"; Wolff, *Geschichte der Impetustheorie*; Wolff, "Mehrwert und Impetus"; Sorabji, *Philoponus and the Rejection of Aristotelian Science*; and (with reservations) Grün, *Vom Unbewegten Beweger*. For a general survey, see Jammer, *Concepts of Force*.

93. See Schneider, *Kosmologie des Franciscus de Marchia*, chap. 3.

94. For the Aristotelian tradition, see Seeck, "Theorie des Wurfs."

95. Quoted in Jammer, *Concepts of Force*, 71. This example is depicted in one of Leonardo's latest manuscripts, MS E, fol. 50v (ca. 1513–14); in the context of his studies of the flight of birds, cf. fol. 50r: "Difinizion dell'impeto. L'impeto è una virtù creata dal moto e trasmutata dal motore al mobile. Il qual mobile ha tanto di moto, quanto l'impeto ha di vita."

96. Plato *Laws* 10.895c–899c.

97. On the tradition of self-motion after Plato, see Gill and Lennox, *Self-Motion*.

98. "Che cosa è forza? Forza dico essere una potenzia spirituale incorporea e invisibile, la quale con breve vita si causa in quelli corpi che per accidentale violenza stanno fori di lor naturale essere e riposo. Spirituale dissi, perché in essa forza è vita attiva; incorporea e invisibile dico, perché il corpo, dove nascie, non crescie in peso ne in forma; di poca vita perché sempre desidera vinciere la sua cagion, e, quella vinta, sé occide." MS B, fol. 63r.

99. "Esso impeto fugatore del corpo dov'è creato si consuma e more insieme col moto d'esso corpo." *Codice Arundel*, fol. 2r (ca. 1508–9).

100. "Forza non è altro che una virtù spirituale, una potenza invisibile, la quale è creata e infusa per accidental violenza, da corpi sensibili nelli insensibili, dando a essi corpi *similitudine di vita . . . corre con furia a sua disfazione. . . .* Tardità la fa grande, e prestezza la fa debole. *Vive per violenza, e more per libertà . . . volentieri consuma se stessa . . .* [ne]ssuna cosa sanza lei si move." *Codice Atlantico*, fol. 826 (ca. 1492), emphasis added.

101. MS C, fol. 6v (ca. 1490).

102. *Codice Atlantico*, fol. 340r (ca. 1497–1500).

103. Aristotle *Physics* 1.185a.

104. *Codice Arundel*, fol. 159r.

105. For a more extended discussion of this argument, see Fehrenbach, "Oszillierende Blick." For different views on *sfumato*, cf. Nagel, "Leonardo and 'sfumato'"; Prater, "Sehnsucht nach dem Chaos"; Bell, "Sfumato, Linien, und Natur"; Wellmann, *Entdeckung der Unschärfe*.

106. "È la maestra dell'altre linie, dalle quali sempre essa è mossa diterminando quel che l'altre vedano e non cognoscano." MS D, fol. 8v.

107. Cf. Plotinus's formula of the indivisible soul, "tota in toto et tota in qualibet parte," a topos echoed in Augustine, Cusanus, and Ficino. Leinkauf, *Mundus combinatus*, 58–60. On Luca Pacioli's use of the formula to mark the ubiquity of a *proportion*, the Golden Section, in any quantity, see Veltman, *Linear Perspective and the Visual Dimensions*, 83; and Frosini, "Leonardo da Vinci e il 'nulla,'" 231.

108. "Opinio autem inordinata et mobilis imaginum multitudo sed substantia puntisque unita, cum anima ipsa in qua est opinio una substantia sit, nullum occupans locum." Ficino *De amore* 7.13. On Ficino's and Pico's notion of the soul as *vinculum naturae totius* and *mundi copula*, see Beierwaltes, *Denken des Einen*, 282ff.

109. Cf. Pascal, *Pensées*: "Car enfin qu'est-ce que l'homme dans la nature? Un néant a l'égard de l'infini, un tout a l'égard du néant, un milieu entre rien et tout" (84).

110. Rotman, *Signifying Nothing*, 14–22. Cf. Luigi Manzini, *Il niente* (Venice, 1634): "La prospettiva ove riguarderebbe, quando non ricorresse al Niente? S'ella non s'industriasse di guidarti con piacevole tradimento de gli occhi alla meta d'un punto, d'un indivisibile imaginato, ch'è pure un niente, come la conteresti tu fra le pompe che, illustrando le maraviglie dell'arte, felicitano il lusso degli occhi? La pittura poi, vana creatrice d'imagini, altro non intende gia' che, fingendoti una figura, dissimularti un niente." Quoted in Ossola, *Antiche memorie del nulla*, 103. See also the objection by Raymond Vidal, *Il niente annientato*, of the same year (1634): "La prospettiva, la pittura, la scultura e somiglievoli arti, non ponno altrimenti consistere nel Niente, perché di loro ragion formale non hanno altro scopo che d'andar pascendo con i lor effetti apparenti e reali la curiosità di quell'occhio che per oggetto ha l'Ente, non il Niente." Quoted in Ossola, *Antiche memorie del nulla*, 144. On the spectator in perspective as "non-empirical punctum," see Bryson, *Vision and Painting*, 110, and the recent critique of the argument in Summers, *Vision, Reflection, and Desire*, 155–65.

111. See the discussion of this aspect of the point in Boehm, "Topos des Anfangs."

112. On transitional objects in painting and their relationship to Leonardo's notion of the point, cf. Pedretti, "Poem to Sculpture."

113. *Libro di pittura*, par. 1.

114. "Fa, che quando ritrai e che tu movi alcun principio di linia . . ." MS A, fol. 109r.

115. *Libro di pittura*, par. 13. Compare this to Aristotle's acceptance of a point in time as marking the *end* of movement, but his categorical denial of an ultimate point at the *beginning* of a process (*Physics* 6.236a). The relationship between Leonardo's theory of the point and artistic creation is considered in Batkin, *Leonardo da Vinci*, 167–82.

116. According to the main line of argument in Summers, *Vision, Reflection, and Desire*, the disembodied *punctum* of perception remains therefore a moment of transition giving way necessarily to an insurmountable corporeality, one that, however, keeps oscillating between being and nonbeing.

117. Cf. *Libro di pittura*, par. 58a.

118. Cf. Kemp, "Crisis of Received Wisdom"; Zöllner, "'Ogni pittore dipinge sé'"; Laurenza, *Leonardo nella Roma di Leone X*.

119. "Hinc inter Ens, et Nihil, Medium datur, scilicet Possibilitas ad Ens." Quoted in Ossola, *Antiche memorie del nulla*, 152. On the realtionship between the philosophy of "nothing" and painting in the seventeeth century, see Stoichita, *Self-Aware Image*, chap. 9.

120. *Libro di pittura*, par. 13.

121. "Necessità costringe la mente del pittore a trasmutarsi nella propria mente di natura e che sia interprete infra essa natura e l'arte, comentando con quella le cause delle sue dimostrationi costrette dalla sua legge, *et in che modo le similitudini delli obietti circostanti all' occhi concorrino colli veri simulacri alla popilla dell'occhio*." Ibid., chap. 40 (emphasis added). Farago's translation— "Praising the causes of nature's demonstrations in this, the painter is compelled by the laws of nature in the way that the similitudes of objects which surround the eye act together with the real simulacri on the pupil of the eye" (*Leonardo da Vinci's "Paragone,"* 273)—misses Leonardo's point.

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