Preface

The aim of this book is to elucidate the question of the interrelationship between optics, vision and perspective before the Classical Age. In the Middle Ages and the Renaissance, the concept of *Perspectiva*—the Latin word for optics—encompassed many areas of enquiry that had been viewed since antiquity as interconnected, but which afterwards were separated: optics was incorporated into the field of physics (i.e., physical and geometrical optics), vision came to be regarded as the sum of various psycho-physiological mechanisms involved in the way the eye operates (i.e., physiological optics and psychology of vision) and the word 'perspective' was reserved for the mathematical representation of the external world (i.e., linear perspective).

However, this division, which emerged as a result of the spread of the sciences in classical Europe, turns out to be an anachronism if we confront certain facts from the immediately preceding periods. It is thus essential to take into account the way medieval scholars posed the problem—which included all facets of the Latin word *perspectiva*—when exploring the events of this period. What we now recognize as a 'nexus' between optics and perspective was at the time in fact seen as a single science. I submit that the earliest developments in linear perspective cannot be elucidated without reinserting them into the web of ideas that originally constituted *perspectiva*.

The central focus of this book is the theory of binocular vision, which has been virtually ignored in the field of perspective studies. This theory generated one of the most puzzling alternatives to linear perspective in the history of representation—two-point perspective which could be regarded as a 'heterodox system' inasmuch as linear perspective is taken to be the norm. However, linear perspective was not at all the standard until the late sixteenth century (Cinquecento). Before then many other systems were used, such that one would be justified in asking whether it would not be better to admit that different, parallel systems of perspective existed as late as the Renaissance. Since the norm was still to come, it was common to find painters and architects testing new methods that lay at the margins of linear perspective. As a result, there is no way to demonstrate that painters and architects as a whole were applying the rules of perspective from Brunelleschi's time onward. Up until the end of the Cinquecento the word 'perspective' referred to a series of free and

uncoordinated systems, with debates being conducted in scholarly and artistic circles on the merits of each.[1]

In Chap. 1 we will seek to define more clearly the similarities and differences between perspective and *perspectiva*, i.e., medieval optics. One of the main differences was the gradual trend to decouple linear perspective from medieval optics, the course of which included an entire chapter on the formation of binocular images.

Errors—Chap. 2 investigates the emergence of perspective as a geometric science and seeks to separate what is fact from what is fiction regarding the birth of perspective in Quattrocento Italy. Events that were codified into what may be regarded as the mythology of perspective are discussed, including Brunelleschi's untraceable *tavoletta*, Alberti's *costruzione legittima*, and the perspective in Masaccio's fresco of the *Holy Trinity* in the Church of Santa Maria Novella in Florence. This chapter will show how access to knowledge could change practices; it establishes, for instance, that the solutions found by draftsmen to the problem of how to draw the perspective view of a circle varied, depending on their degree of familiarity with optics and geometry. Chapter 3 provides a classification of the types of errors that may arise in perspective constructions, deepening our understanding of the problem by presenting several examples of works that depart from the rules of perspective. Chapter 4 scrutinizes a blatant example of mistaken judgment regarding the correctness of one specific case of perspective—the interpretation by Erwin Panofsky of Masaccio's *Trinity*. Although celebrated as a milestone in the history of perspective, this fresco is not a correct example of central perspective due to the many errors—both random and systematic—that can be found in its geometric construction. These results undermine the commonly held idea that linear perspective became the unspoken rule in Brunelleschi's time, with all other alternatives being gradually abandoned. Linear perspective was neither clearly defined nor followed as a general rule in these early stages, and there was not yet a sufficient consensus to limit alternative representational systems.

Theory—Chap. 5 outlines the theory of binocular vision presented by Ibn al-Haytham in *Kitāb al-manāẓir* and discusses the innovations and limitations of this medieval Arab scholar's work in the light of modern physiological optics. Chapter 6 seeks to retrace the impact of Ibn al-Haytham's theory on Latin medieval optics. There is evidence that the study of key sections of *Kitāb al-manāẓir* and the commentaries written by European scholars ensured the wide dissemination of his theory of binocular vision. Chapter 7 focuses on certain contemporary documents

[1]The present book includes revised content from several papers, mostly in French, published in academic journals. Chap. 1: *Nel Segno di Masaccio*, ed. F. Camerota, Firenze, 2001, pp. 11–13. Chap. 2: *Les Espaces de l'homme*, eds. A. Berthoz and R. Recht, Paris, 2005, pp. 333–354. Chap. 3: *L'Hypothèse d'Oxford*, Paris, pp. 62–85. Chap. 4: *Nuncius* 17 (2003): 331–344. Chap. 5: *Arabic Sciences and Philosophy* 13 (2003): 79–99. Chap. 8: *Oriens/Occidens* 5 (2004): 93–131. Chap. 9: *Sciences et Techniques en Perspective* 2-1 (1998): 3–23. Chap. 10: *Zeitschrift für Kunstgeschichte* 67/4 (2004): 449–460. Chap. 11: *Physis* 45 (2008): 29–55. Appendix A: *L'Œuvre et l'artiste à l'épreuve de la perspective*, eds. M. Dalai Emiliani et al., Rome, 2006, pp. 411–430. The other parts of the book are new.

that explicitly condemned the practice of 'two-point perspective.' These texts, which were written by members of the earliest Italian academies and of the *Académie Royale de Peinture* in France, inform us that the theory and practice of monocularity continued to encounter strong resistance during the Renaissance and well into the classical period.

Sifting the Hypotheses—Applying standard techniques of error analysis, Chap. 8 and Appendix 1 address the methodological issue of how to eliminate or reduce the errors that may be introduced during the *ex post* reconstruction of a perspective view. An in-depth analysis is presented of *The Saint Enthroned*, a fresco by Giusto de' Menabuoi that illustrates the use of two-point perspective. The same methodology is then applied to 30 works produced in Italy between the Duecento and the Cinquecento in which the use of two-point perspective has been identified. The error analysis is supplemented by a reconstruction of the geometric plans and elevations in these paintings, working backward from the perspective views. This analysis based on a large number of works allows us to eliminate a series of alternative forms of representation, and the sifting of the different representational systems proves that binocular vision might have provided the foundations for the construction of these medieval and Renaissance perspectives.

However, the hypothesis that early works of perspective were constructed on the basis of binocular vision can be accepted only if all the competing assumptions are successfully rebutted. We therefore carried out an evaluation, one by one, of the various theses that currently dominate discussions of the history of perspective. In Chap. 9 we demonstrate the inconsistency on both logical and empirical grounds of the Hauck–Panofsky conjecture regarding 'curvilinear perspective.' Similarly in Chap. 10 we disprove the White–Carter conjecture regarding 'synthetic perspective' by pointing out a mathematical property that renders this system unlikely. Chapter 11 examines Andrés de Mesa Gisbert's conjecture that medieval perspective was the result of an arithmetic method of construction, a solution that, while elegant, poses some serious difficulties.

All the competing assumptions having been disproved, I conclude that binocular vision and two-point perspective constituted a genuine alternative to linear perspective from the late Duecento onward. In this way a strong interdependence between optics and perspective is established that accords with the original meaning of the word *perspectiva* and opens up the possibility for a better understanding of how perspectives were constructed in the early modern period. I submit that binocularity represents a key juncture point between the history of art and the history of science.[2]

[2]From this perspective, the binocular system makes a genuine difference with the foreshortening rule, which could have been derived from Euclid's Optica, postulate 5, as well as from practical geometry, in particular the "Turris altitudinem metiri" section included in many treatises. See for instance Stephen K. Victor, *Practical Geometry in the High Middle Ages*, Philadelphia, 1979; Hubert L.L. Busard, "The 'Practica geometriae' of Dominicus de Clavasio," *Archive for the History of Exact Sciences* 2 (1965): 520–575; and Cosimo Bartoli's *Del modo di misurare*, Venezia, 1564.

The intent of this book is to explore the various explanations and past modes of rationalizing the phenomenon of vision that can be derived from the matrix of *Perspectiva*, thus contributing to the rewriting of an important chapter in the history of optics and perspective from an angle that takes into account the criticisms that have been brought to bear on linear perspective in the past, and that is more sensitive to the precarious balance that characterizes the early stages in any process of innovation.

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Saint-Martin Dominique Raynaud
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