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Hindsight: Journal of Optometry History publishes material on the history of optometry and related topics. As the official publication of the Optometric Historical Society, Hindsight: Journal of Optometry History supports the purposes and functions of the Optometric Historical Society.

The purposes of the Optometric Historical Society, according to its by-laws, are:
- to encourage the collection and preservation of materials relating to the history of optometry,
- to assist in securing and documenting the recollections of those who participated in the development of optometry,
- to encourage and assist in the care of archives of optometric interest,
- to identify and mark sites, landmarks, monuments, and structures of significance in optometric development, and
- to shed honor and recognition on persons, groups, and agencies making notable contributions toward the goals of the society.

The official publication of the Optometric Historical Society was previously titled: Newsletter of the Optometric Historical Society, 1970-1991 (volumes 1-22), and Hindsight: Newsletter of the Optometric Historical Society, 1992-2006 (volumes 23-37). Hindsight: Journal of Optometry History began in 2007 with volume 38, number 1.

On the cover: The drawing represents OHS for Optometric Historical Society: the O an elementary schematic of an eye, the H three intersecting pairs of spectacles, and the S a representation of a light wave with the Greek letter lambda indicating one wavelength. The drawing artist was Diane Goss.

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Section in a single author book:
Hofstetter HW. Optometry: Professional, Economic, and Legal Aspects. St. Louis: Mosby, 1948:17-35.

Chapter in a multi-author volume:
Penisten DK. Eyes and vision in North American Indiana cultures: An historical perspective on traditional medicine and mythology. In: Goss DA, Edmondson LL, eds. Eye and Vision Conditions in the American Indian. Yukon, OK; Pueblo Publishing, 1990:186-190.

Citations to articles in *Hindsight: Journal of Optometry History* should be given as follows:
Bennett I. The story behind Optometric Management magazine. Hindsight: J Optom Hist 2007;38:17-22.

Addendum to: The "Burnt City": The First Known Artificial Eye – A New and Related Development, Middle Asia Takes Center Stage

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The New Development

Andrew Lawler recently reported a major-reassessment of the early history of civilizing influences presented at a key meeting which had taken place in Ravenna, Italy.[1] A number of early interacting and widely separated "Middle Asian" emerging-cities had developed during the third millennium Before the Current Era (B.C.E. or B.C.). These cities served critical roles, and had profound and lasting effects on the future organization of cities and their societies. These major advances were, in a way, similar to, and of comparable influence to those occurring in cities in Northern Italy during the (much later) early Renaissance. Shari-i Sohkta or "The Burnt City", was one of them. So-saying, unlike the cities of the Renaissance, these particular cities were mostly deserted at a later time.

"Long dismissed as a backwater, the vast area between Mesopotamia [i.e., roughly modern Iraq] and the Indus Valley, [including Harappa and Mohenjo-Daro, and, separately, Hili, etc., in Oman on the Arabian Peninsula], is now revealing a tapestry of wealthy urban centers that shaped humanity's first concerted attempt at city life".[1] This led to a civilizing "awakening" which occurred roughly 5000 years ago in these widely dispersed but communicating urban centers (Fig. 1). We will surely hear more about these developments in the future.

"At Shahr-I Sokhta ['The Burnt City'], archaeologists have uncovered what was a bustling metropolis between 2550-2400 B.C.E. [It was] as large as 150 hectares with at least 380 smaller [associated] sites in the surrounding region."[1] [At almost at the same time as the reported meeting, estimated total sites associated with The Burnt City were increased meaningfully.]

"Artifacts from that era include lapis from Afghanistan, shells from the Pakistan coast, vessels from the Indus [Valley], and game boards in the style of those found in Ur. Long distance trade appears to have extended backwards to at least 3000 B.C.E."[1]

Reference

1. Andrew Lawler: Middle Asia takes Center Stage. Science 2007; 317(5838): 586-590. (A report of the meeting of the "International Association for the Study of Early Civilizations in the Middle Asian Intercultural Space". Ravenna, Italy, July 7,8, 2007)

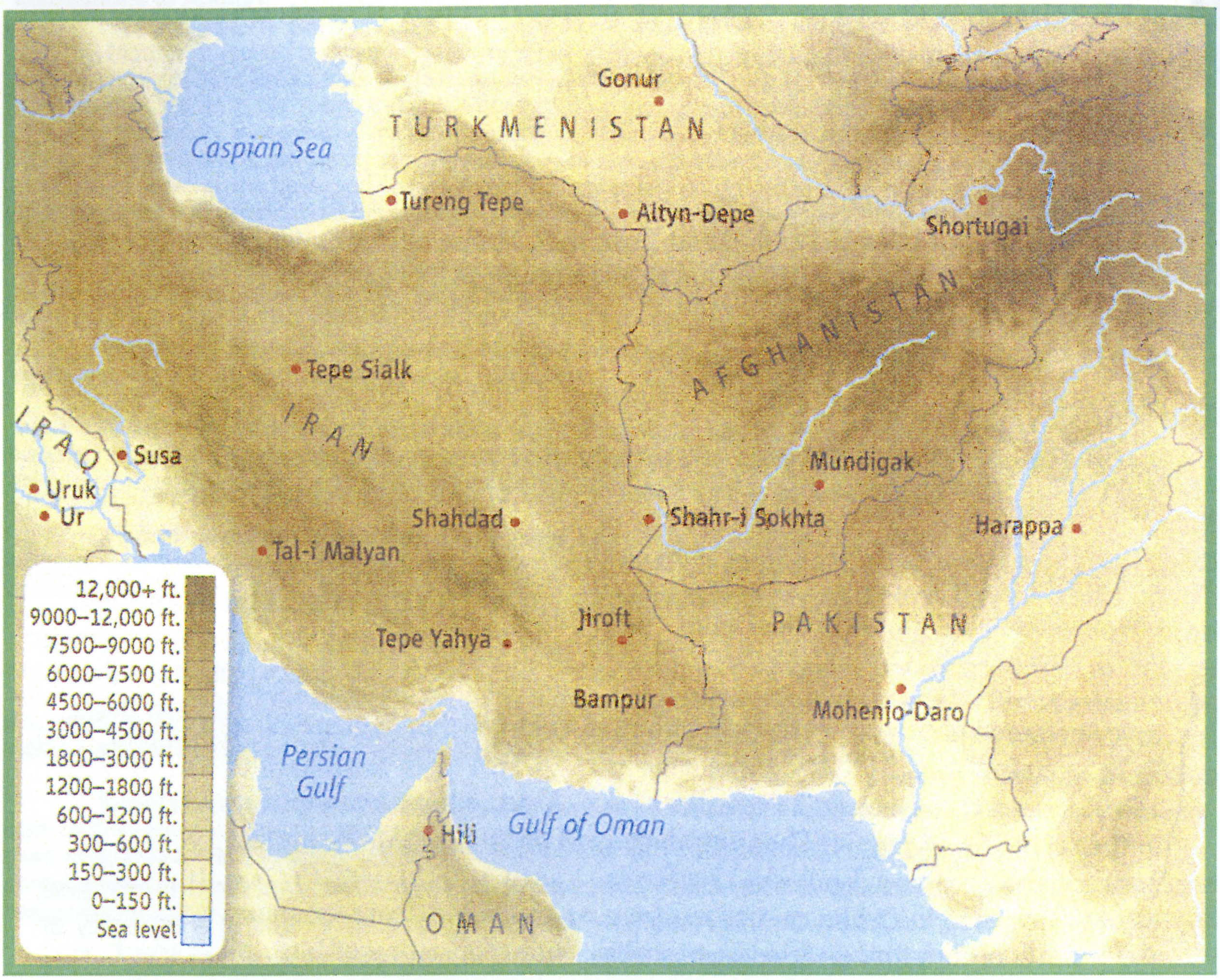

Fig. 1. Middle Asian cities considered in this discussion. This figure is reproduced with the kind permission of Science magazine and the author, Andrew Lawler.

Thirteenth Century European Authors and Manuscripts on the Eye and Vision

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Abstract

This paper discusses books on the eye and vision by six thirteenth century authors. Some information about the lives of these authors is also included. The six authors are Benvenutus Grassus, Peter of Spain, Robert Grosseteste, Roger Bacon, John Pecham, and Witelo.

Key words: *book history, history of vision science, medieval manuscripts.*

The history of books on the eye and vision is an area worthy of greater study than has so far been undertaken. One era that could be examined is the Middle Ages. Looking into the available literature on the nature of books on the eye and vision in Europe during the Middle Ages, it becomes apparent that the most notable medieval authors were composing their works in the 13th century. The purposes of this paper are to examine the primary authors on the eye and vision in 13th century Europe and to present some notes on the surviving manuscripts of their works.

The authors to be examined are Peter of Spain, Benevenutus Grassus, Robert Grosseteste, Roger Bacon, John Pecham, and Witelo. While most of these authors considered a broad range of topics within optical, medical, and vision science fields, two areas of particular interest were the treatment of eye diseases and how the process of vision worked. Knowledge of treatment of eye diseases obviously was a matter of practicality. Writings about the visual process often included examination of the nature of light as well as how the sensation of vision occurred, and thus vision was generally considered within a broader discussion of light and optics. An important motivation to understanding vision was that it would provide insight into God's creation and thus insight into God. As stated by medieval science historian David Lindberg, "To many of its early practitioners [the science of optics]...appeared...to be the most fundamental of the natural sciences, the key that would unlock nature's door and reveal her innermost secrets."[1] To place the work of these authors into context, we will first very briefly look at the nature of the book in the 13th century, the influence of authorities from antiquity, and how information from ancient authorities was transmitted to 13th century Europe.

Books produced at this time are known as manuscripts, because they were literally "written by hand." Persons who wrote the text were scribes, and persons who applied the accompanying colored illustrations and decorations were illuminators.[2] The pages were vellum or parchment, specially prepared animal skins. Prior to the 13th century, most manuscripts were produced in monasteries. In the 13th century, a vigorous book trade arose, along with the rise of universities.[3,4] Book buyers commissioned works with stationers who contracted out work to professional scribes and illuminators or did parts of the work themselves. Stationers' shops were often located near universities. Stationers often owned exemplars of various common works from which copies of books were written.

Books in the Middle Ages did not have titles and title pages as we know them today. The titles by which medieval books are now known are often popular appellations applied to books when subsequent authors referred to them. Thus book titles were a matter of tradition, not author's choice. The lack of a title page also makes the dating of books uncertain at times. One of the devices used to identify a given text is examination of the incipit, the opening words of a manuscript.[5] A colophon, remarks generally at the end of a book, can be useful in determining authorship or circumstances concerning the production of a book.[5]

Medieval scholars were often also churchmen. Some university physicians were scholars and clerics as well as physicians. Today we may perceive clear boundaries between the study of theology and the study of mathematics and science, but the boundaries were not so obvious to medieval scholars. Roger Bacon thought that mathematics was important because it was essential for understanding philosophy, which in turn was essential for understanding theology.[6] Grosseteste and Bacon saw the study of optics as valuable for understanding and illustrating religious truths.

Medieval European viewpoints were largely based on authority – the authority of God and the Church and of ancient authorities such as Aristotle and Galen. In the first few centuries of the Middle Ages, only fragments of works by Aristotle, Galen, and other authors from antiquity were available in Europe. Knowledge of ancient authorities later came by way of translations from Arabic into Latin. Many of these translations were performed by Constantine the African (c.1015-1087) in the eleventh century and Gerard of Cremona in the twelfth century.[3] The rediscovery of more complete versions of ancient Greek works represented new knowledge.

Works by Galen, Hippocrates, Dioscorides, Aristotle, and others had been translated from Greek into Syriac or Arabic by the physician Hunain ibn Ishaaq (known in the West as Johannitius), who lived from about 808 or 809 to about 873 or 877. Johannitius also wrote a number of books used by medieval European physicians, including *Ars Parva Galeni* or *Isagoge Johannitii.* MacCallan[7] expressed the opinion that Hunain's most famous book was *The Ten Treatises on the Eye,* which covered ocular anatomy, a Galenic description of the brain, the visual process, and eye disease.

Arabic authors commented on and built on the writings of ancient Greek authors. Important Arabic physicians and scholars who wrote about the eye and vision included Alhazen (965-1038 or 1039), *Optics*; Hunain or Johannitius, *The Ten Treatises on the Eye* and *Book of the Questions on the Eye*; Abu Ali al-Hussein ibn Abdallah ibn Sina (Avicenna, 980-1037), *Book of Healing*, which included a section on vision; Rhazes (865-925); Ali ibn Abbas (?-994); and Alkindi (d.c.870), *De Aspectibus* or *On Optics.*[8,9] Alhazen wrote important books on optics and championed an intromission theory of vision (light entering the eye) over an extramission theory (visual ray leaving the eye). The *Isagoge* of Johannitius was one of the components of the articella, a reference book used by medieval European physicians.[10] The *Canon* of Avicenna was another influential book. Lindberg[11] was able to document the existence of twenty Latin language manuscripts of Alhazen's *De aspectibus (Perspectiva* or *Optics)* and fourteen Latin language manuscripts of Alkindi's *De aspectibus* in European libraries.

The last background topic we will look into before getting to the six authors of interest is a brief overview of Galenic medicine. In Galenism, the body was thought to be healthy when there was a harmony of its four qualities, hot, cold, dry, and moist.[10] Food and drink, like all substances, consisted of fire, air, earth, and water, and after digestion, they were converted into humours or bodily juices. The four humours were blood, phlegm, yellow bile, and black bile. An imbalance of these led to disease.[10] The nature of the imbalance was diagnosed by an exploration of symptoms and an examination of urine. Treatments included blood letting, cautery, surgery, and medicines. Blood letting served to relieve the body of the humour that was present in excess, with the vein from which blood was taken being dependent on the disease. The timing of surgery was sometimes decided based on astrological signs.[12]

Benvenutus Grassus

Benvenutus Grassus is known only by his book, *The Wonderful Art of the Eye*. Various other spellings of his name exist, such as Grapheus or Graffeus. It is thought that he was Italian and that he traveled throughout Italy and perhaps other countries, working as an itinerant eye physician. It is unknown exactly when Benvenutus lived, but Eldredge[13] suggests that it was in the late thirteenth century. Benvenutus cites the work of Johannitius. The primary diagnostic method used by Benvenutus was observation. The book by Benvenutus consists of introductory material, a brief discussion of the anatomy of the eye, diseases of the eye, eye injuries, and miscellaneous other material. The diseases of the eye were divided into types of cataracts and diseases dues to imbalances of the humours. What Benvenutus referred to as cataracts included what we know to be cataracts today. But it also included incurable cataracts, which were other diseases which could not be observed at that time because there was no instrumentation to view the inside of the eye. Eldredge[13] suggests that Benvenutus had some university education based on the introductory material that Benvenutus included in his book.

The treatments recommended by Benvenutus could be put into four categories: cautery, blood letting, surgery, and pharmacology. Surgery for cataracts was probably somewhat successful, even though it was certainly quite painful. Without anesthetic, a needle was inserted into the eye and the cataract was pushed out of the way of the light entering the eye. Pharmacological formulations in pills were usually herbal elements with honey or sugar. Some of the recognizable plant materials were rhubarb, celery, and parsley. Powders applied to the eye included ground mineral material or finely ground sugar. Most ointments contained egg white. Eldredge[13] discusses four manuscripts based on two independent translations from the original Latin into Middle English. Some of them had other items bound in with the Benvenutus manuscript.

Based on the form of individual letters, Eldredge[13] believed that two of them were written all by one scribe each, one of them was written by three scribes, and the fourth was written in four different hands. The number of surviving manuscripts of Benvenutus's book is second only to Peter of Spain's *Eye Book* among medieval books on eye disease (see Appendix).

Peter of Spain (Petrus Hispanus)

Peter was born in Lisbon some time between 1205 and 1220. His given name was Petrus Julianus Lusitanus. He received university education in Paris. It is unclear whether he received his medical education in Paris, Montpelier, or Salerno.[14] He was a physician, scholar, and priest. He was employed by the University of Siena to teach medicine in 1847. He wrote about 20 medical books, several of which dealt with diet, hygiene, and living conditions.[15] He also wrote a book on logic and grammar. He served various roles in the Catholic Church, becoming physician to Pope Gregory X in 1272 and a Cardinal in about 1273. He was elected Pope in 1276. In 1277, an addition being constructed at the papal palace fell on him, and he died six days later as a result of his injuries.[15]

In the *Dietary of Isaac*, Peter of Spain presented a set of rules for assessing the effectiveness of medicines: "1. The medicine to be tested should be pure…. 2. The patient should have the disease for which the medicinal is intended…. 3. The medicine should be given alone…. 4. The medicine should be the opposite of the disease…. 5. It should be tested many times…. 6. It should be tested on the right body – i.e., the body of a man, not the body of an ass."[16,17] Peter's six rules for testing the effectiveness of medicines show solid logic and appear to be similar to rules applied to medical research today. However, Peter did not make the next step of performing research with control groups. He relied on personal experience. Daly[18] suggested that the reasons that medieval medical science did not advance may include: a) medieval scholars were "overwhelmed by the force of authority, whether Galen, Aristotle, Hippocrates, the Church or the King"; b) knowledge of anatomy was inadequate because microscopes had not yet been invented and human dissection had been disallowed; c) the basic "science" informing medical practice at the time was astrology, whereas today important information is gained through biochemistry, molecular biology, and other sciences; and d) diagnoses were made through signs and symptoms without the benefit of laboratory tests, thus making it impossible to distinguish between different diseases with similar symptoms or to recognize the unity of a single disease that may have different symptoms.

Peter of Spain wrote both handbooks for practicing physicians and more scholarly works on medical and philosophical issues. Examples of the latter are *De Anima* and *Regimen Sanitas*, the last being commentaries on Hippocrates, Galen, Aristotle, Hunain, and other authorities.[14] *The Eye Book* is an example of his writings for practicing physicians. It must have been a popular book, judging by the fact that there are more surviving manuscripts of it than any book on eye disease. In the introductory paragraphs of the book, Peter says that he "assembled this book from many books, from reason, and from experience."[14] There are a few sentences devoted to ocular anatomy, and then the remainder of the book gives descriptions of various eye diseases, followed by the corresponding preparation and application of medicinal treatments.

Robert Grosseteste

Grosseteste was born into a poor family in about 1168 or 1170 and died in 1253.[19] He was a lecturer at Oxford when he entered the priesthood in 1225. He wrote extensively on theological topics. Most of Grosseteste's work in science was done from about 1220 to 1235. In 1235 he became Bishop of Lincoln. It is likely that his work in optics was done from about 1230 to 1235.[20]

Significant works by Grosseteste included *On Lines, Angles, and Figures (De lineis, angulis et figures)*, which included some optics, and *On Light (De luce).* Among the optical topics he wrote about in those and other books were the laws of reflection and refraction, the nature of color, the process of vision, and the optics of natural phenomena. Grosseteste used facts based on experience to argue for particular principles. For example, he used a flask of water to explain refraction of light. Grosseteste's writings on refraction suggest a knowledge of lenses or a prediction of their refractive effects.[19] He thought that mathematics was important for an understanding of the natural world, and he applied mathematics to his optical studies. Grosseteste's use of personal experiences and elementary experiments has been viewed as a step toward the development of the scientific method.[20] In the *Opus tertium,* Roger Bacon had the following to say about Grosseteste: "No one really knew the sciences, except the Lord Robert, Bishop of Lincoln, by reason of his length of life and experience, as well as of his studiousness and zeal. He knew mathematics and perspective, and there was nothing which he was unable to know, and at the same time he was sufficiently acquainted with languages to be able to understand the saints and the philosophers and the wise men of antiquity."[21]

Roger Bacon

Estimates of the year of Bacon's birth are 1210, 1214, and 1220. Bacon was born in England to a family thought to have been prosperous. Bacon's university studies were at Oxford and Paris. In the early and mid 1240s Bacon taught in Paris. Where he was in the late 1240s and in the 1250s is not known for certain. Bacon started studying science and mathematics in the late 1240s, perhaps inspired by the works of Robert Grosseteste.[22] Vision and optics were among the subjects that Bacon studied at that time. In the late 1250s he joined the Franciscan Order, probably due to their reputation for learning and piety. However, Bacon was censured by his superiors in the Franciscan Order, perhaps for seeking patronage outside the Order or for composing books without permission.[22] In late 1267 or early 1268, Bacon delivered his *Opus maius* to Pope Clement IV, formerly Cardinal Guy de Foulques, from whom Bacon had sought patronage. Little is known of the last decades of Bacon's life, other than that he continued to write. He died in 1292 or 1294.

Lindberg[23] rates Bacon's *Perspectiva* and *De multiplicatone specierum* as his most important existing optical works. *Perspectiva* was published in Part V of Bacon's

Opus maius. Other publications by Bacon which considered optical matters were Parts IV and VI of *Opus maius, Opus tertium,* Part I of *Communia naturalium,* and *De speculis comburentibus.* Bacon's optical writings were influenced by Alhazen, Alkindi, and Grosseteste.[19]

It was in *Perspectiva* that Bacon wrote about the use of a plano-convex lens placed on written material to magnify it.[24] Bacon wrote that lenses "will prove to be a most useful instrument for old persons and all those having weak eyes, as they can see in this manner the small letters."[25] This statement has led some authors to erroneously attribute the invention of spectacles to Bacon. While his statement was clearly a very significant one, he was talking about lenses, not spectacles. Extensive investigation of the origins of spectacles suggest that their invention occurred in about 1286 in Italy.[25-27] The inventor of spectacles was likely a layman from Pisa who did not publicize the manufacturing methods for his invention because he wanted to protect the profits he made from potential competitors.[25-27]

John Pecham

John Pecham's name appeared in various forms in the Middle Ages, most commonly Pecham and including Pechanus, Pescham, and Pecheam, but not Peckham. The year of Pecham's birth is unknown, but is thought to have been in the early or mid 1230s. He was born in England, studied at the Universities of Paris and Oxford, entered the Franciscan order in the late 1250s, and in 1269 received a doctorate in theology in Paris. He served on theology faculties in Paris and Oxford.[6] He became the Archbishop of Canterbury in 1279. He died on December 8, 1292. Pecham wrote on a number of topics in theology, psychology, natural philosophy (science), and mathematics. Pecham's optical writings were influenced by Robert Grosseteste and Roger Bacon, and Alhazen. Lindberg[28] notes that Pecham and Roger Bacon must have known each other because they were Franciscan residents in Paris at the same time.

Among Pecham's optical works were *Tractatus de Perspectiva* and *Perspectiva communis*, the latter probably being composed between 1277 and 1279 and being the better known. Pecham's *Perspectiva communis* first came to be known by that name in the 14th century. Its contents included the nature of light and color; anatomy and physiology of the eye; visual perception; and reflection and refraction and their consequences for vision. Pecham's prefatory comments and the contents and format of the book suggest that it was a textbook for students.[6]

Pecham's *Tractatus de Perspectiva* was probably composed between 1269 and 1275. Of the five manuscripts used by Lindberg[28] to make an English translation, four gave no author and one gave Pecham as the author. Lindberg[28] strongly feels that Pecham was the author because of great likenesses in style, vocabulary, and theoretical constructs between it and *Perspectiva communis.* There are also comments of an autobiographical nature in *Tractatus de Perspectiva* that would tie it to Pecham. In *Tractatus de Perspectiva*, Pecham discusses the nature of light, the lines of support for extramission and intromission theories of sight, anatomy and physiology of the eye, the process of vision, reflection, and refraction.

Witelo

Witelo, who was also known as Vitello or Vitelionis, was born in 1227 in Poland and lived to 1290. He was a priest and studied mathematics and philosophy in Paris and Padua, Italy. In approximately 1268 to 1270, he wrote a ten book optics encyclopedia, *Perspectiva.* Fryczkowski et al.[29] stated that twenty-nine Witelo manuscripts have survived. Lindberg[11] gives a count of 25 surviving *Perspectiva* manuscripts by Witelo. Witelo's *Perspectiva* opened with a 57-page introduction with the mathematics necessary for consideration of optical principles, and it included theory of refraction and reflection, visual perception, and anatomy of the eye.[19] In *Perspectiva*, Witelo summarized the writings of classical authorities, ninth to eleventh century Arabic writers, such as Alkindi and Alhazen, and authors who were his contemporaries, such as Roger Bacon. He also included his own interpretations and observations. He realized that vision occurred by light entering the eye (an intromission theory of vision) rather than the eye sending out a visual ray (extramission theory of vision). One particularly significant departure from classical thought was that he noted that light rays continue past the crystalline lens as opposed to the commonly held belief that the crystalline lens was the end organ for vision, an idea coming from Euclid.[29] One indication of the importance of Witelo's work is that Johannes Kepler, sometimes hailed as the father of modern optics, published a book on optics in 1604 that he presented as an addendum to Witelo, *Ad Vitellionem Paralipomena.*

Witelo and Pecham were both younger than Bacon. Like Pecham, Witelo was influenced by Bacon's works. Lindberg[23] argues that the paths of Witelo and Bacon did not cross, but that Witelo knew Bacon's written works. Based on parallel passages in some parts of Pecham's and Witelo's works and the likelihood that Pecham wrote *Perspectiva communis* later than Witelo wrote *Perspectiva*, Lindberg[23] suggests that Pecham was familiar with Witelo's *Perspectiva* when he wrote his *Perspectiva communis.*

Interesting possibilities for future research

As this paper was being written, some random questions and thoughts for possible future research in book history arose: 1) Lindberg noted in his catalog of medieval and Renaissance optical manuscripts that other manuscripts may not have been discovered by him. It would be interesting to have a comprehensive search follow up Lindberg's work. 2) There seems to be an extensive literature on the work done by manuscript illuminators. Many of the optical works discussed here include optical ray-tracing diagrams. One could wonder how much information is available about the persons who constructed those diagrams in the various manuscripts – were those persons "regular" illuminators or had they received scientific training in order to accurately duplicate the diagrams? 3) One could also wonder about medieval scribes and illuminators before the invention of spectacles. Were their careers effectively over when they reached presbyopia if they were not nearsighted? Their work was clearly visually quite demanding, and Bacon's idea of putting a lens on the page would not have been helpful to them. Are there any documents or memoirs discussing the life of scribes and how visual problems affected their ability to work?

Numbers of Surviving Manuscripts

Listing of surviving manuscripts which include scientific writings on the eye and vision by the six authors considered in this paper. This listing is based on Lindberg's catalogue.[11] The number of manuscripts documented by Lindberg is given in parentheses. At the time of Lindberg's writing in 1975, almost all of the manuscripts were located in various libraries in Europe.

Roger Bacon
- De multiplicatione specierum (26)
- De scientia experimentali (Opus maius, Part VI) (6)
- De speculis comburentibus (3)
- Perspectiva (Opus maius, Part V) (39)

Robert Grosseteste
- De colore (De coloribus) (10)
- De iride (12)
- De lineis, angulis et figuris (14)
- De luce (13)
- De natura locorum (9)

John Pecham
- Perspectiva communis (64)
- Tractatus de perspective (8)

Witelo
- Perspectiva (25)

Benvenutus Grassus
- De egritudinibus oculorum (18)

Peter of Spain (Petrus Hispanus)
- De morbis oculorum (34)
- Libro degli occhi (2)

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Book Review: Renaissance Vision from Spectacles to Telescopes

Renaissance Vision from Spectacles to Telescopes. Vincent Ilardi, Ph.D., 1925- , Professor of History Emeritus at the University of Massachusetts at Amherst. Vol. 259 of the *Memoirs of the American Philosophical Society,* Philadelphia, 2007. xv + 378 pages, including appendices, list (and presentation) of illustrations, references and index. ISBN-10: 0-87169-259-7. ISBN-13: 978-0-87169-259-7. Hardcover, $85.

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Earlier, with permission of the publishers, I wrote a review for Hindsight in anticipation of publication of a major new work by Prof. Vincent Ilardi on the early history of spectacles, optics, vision science, and broadly associated topics. That review was based upon a draft of the first four chapters of the book then assessed in behalf of the editors of the book. Now, this elegant work has appeared. The four chapters have since been broadened and well integrated into a larger and the much more complete whole volume. The delay in publication was no doubt, in part, due to events associated with the demise of Prof. Ilardi's very lovely wife and long-time companion, Mrs. Nina Ficarra Ilardi.

In recognition of this masterful, scholarly and readily readable work, Professor Vincent Ilardi recently received the very prestigious *J. F. Lewis Award*, *2006,* from the distinguished American Philosophical Society (APS) at its meeting in San Francisco. This award recognizes the best book published that year by the APS. The writer had the pleasure to be present as a guest of his friend Vincent on the occasion of this recognition. Vincent literally beamed and giggled in his happiness (and perhaps in disbelief that this was happening to him) on that special occasion. He truly earned that fine recognition. What a book; what a unique analysis!

Ilardi writes of the history of, the discovery of, and further development of spectacles and of much which followed during succeeding centuries after the year 1306 AD when the discovery of spectacles was first announced as having occurred in or near Pisa in about 1286 AD. This development/discovery, made by an individual or individuals unknown, was first stated during a Lenten sermon presented by Dominican Friar Giordano da Pisa *or* da Rivalto at the Dominican monastery of the Santa Maria Novella Church in *Firenze* (Florence, Italy).

Ilardi traces the many facets of the subsequent history of spectacles, and aspects of optics from this rather ambiguous start through to the early development of telescopes and microscopes (in his chapter titled, "From Terrestrial to Celestial

Vision"). Intertwined are developments regarding our understanding of the visual system (image formation on the retina versus within or upon the lens of the eye), and much more including discussions including major events and personalities of these times, and some contributions of Leonardo, Kepler, Galileo, Descartes, etc. He attempts to fit the whole into a larger historical fabric from antiquity to the first half of the 17^{th} century. He points out the very important roles these collective developments played in societal, economic, and cultural developments of the Renaissance.

He utilizes, in particular, a number of important and relatively recently discovered archival records found in Florence (and notes that these developments had not been previously been associated with that great renaissance center). He addresses the rapidly increasing demand for these critically needed visual aids, which occurred roughly in concert with growing availability of printed materials. He treats, at length, the early dispersal of spectacle corrections from Florence (apparently *the dominant site* for early manufacture and development of spectacle lenses and frames), and discusses the lesser role(s) played by Venice and other Italian centers. And he draws attention to contributions made by Southern Germany. He shows how the popularity of these products led to expansion of their use in other nations within Europe and, in time, to the Middle-East and beyond.

Importantly, he also addresses the early history and utilization of optics (all forms including lenses and mirrors, pinholes, etc.), and the fact that visual corrections and magnification aids of various sorts had been used for a millennium or more predating the development of spectacles. As noted, he considers the quite rapid dispersal of spectacles for visual corrections (and their modest cost!) from central Italy to a broader base throughout Europe. He brings together all manner of materials and related topics to his analysis. It is a *tour de force*!

This book contributes critical new knowledge to the history of optics, to spectacle lens and frame developments, to cases for same, and to the history of provision of ophthalmic care and practice. Ilardi uses his research on commercial transactions to point out that *myopic corrections were used rather early on* for refractive purposes (well in advance of current knowledge from other sources!) [see Chapter 3] – this is deduced from the fact that there were *two strengths of concave lenses* provided for use "by the young" early-on, e.g., see letter by Duke Francesco Sforza of Milan addressed to a Florentine source, dated October, 21, 1462 [p. 82]. No doubt further gradations developed in time to cover the extended range of corrections required. And there was rather early recognition of a need for grading of lens powers (a pre-form of grading of lenses by dioptric power). For presbyopia (and hyperopia), convex/plus lenses were graded *by age* in 5 year steps, namely, 30, 35, 40, 45, 50, 55, 60, 65, and 70 years.

Importantly, he points out that frames used with early spectacle lenses were attached together by a hinge for folding the lenses together when they were not in use. The hinge allowed support of the appliance on the nose. In a number of illustrations presented, spectacles were shown folded together. When the two lens holders were folded together in the closed configuration, double lens power could be appreciated and utilized! Another interesting citation, dated 1459, is a first description of colored/tinted spectacle lenses for use in spectacles (in this instance, for "riding horseback in the snow" [p. 127]).

There were apparently different capabilities encountered in the shaping/grinding and polishing of early lenses. This led to individuals favoring different sources of lenses as selected by experience, by word-of mouth, as well as by cost. Crystal lenses, e.g., rock crystal, and beryl, tended to be finer and were more expensive than the cheaper glass ones. There was also trade in lens blanks used for manufacture of spectacle lenses.

With two lenses used, Ilardi points out that it was apparently inevitable that individuals would place two lenses into a tube; thus, he argues the apparent progression from simple microscopes (or magnifiers) to compound microscopes and separately to the development of telescopes.

There is some discussion of anisometropia, but this problem apparently was not addressed for quite a long period of time. Not addressed in the text, but possible, when a number of such items were ordered (commonly requested by individuals), it was possible to select the best lens for each eye out of the number of samples purchased, and to have an artisan replace the hinge and to obtain improved resolution in each of the two eyes.

Ilardi does make some modest mistakes. One cannot be too critical here given the extraordinary breadth and depth of the coverage of topics considered. For example, he does not quite understand specification of magnification. He does not distinguish between angular, lateral, and longitudinal magnification, nor does he quite understand the consideration of the often-termed "distance of clear vision" and relative magnification. In the one instance where spectacle magnification is discussed he uses the classical 25 cm "distance of clear(est) vision" (+4.00 Diopters Spherical = DS or about 10 inches) which is found in a number of optics texts. The late Prof. Louise Sloan of Johns Hopkins argued that this is neither the position in space used by most individuals for such purposes, nor a distance where many individuals can sustain comfortable clear vision for extended periods of time. She proposed a distance of 40 cm (+2.50 DS or a little less than 16 inches) as a reasonable alternative to the "classical" distance of distinct vision. Today, this new distance is often used for magnification analyses in refractive and low vision work. Another matter is Ilardi's definition of myopia as an eye being too long for the power of the optical system of that eye [p. 78]. That is indeed correct. But as the late Prof. Arnold Sorsby of the Royal College of Surgeons, in London, drove home to many of us, we must consider two forms of myopia, the case just mentioned, and the more normal length eye with too strong an optical system. Clearly issues such as these were not considered during the renaissance years and for some time thereafter, but today this distinction is well recognized, that is, there is a refractive form of myopia, and a form of overgrowth of particularly the posterior portion of the eye in a globe having more normal front-of-the-eye optics.

It is easy to criticize, but I wonder if I could do as well in diplomatic studies of the renaissance as Ilardi did in optics. Diplomatic studies of the renaissance is Vincent Ilardi's chosen field of study! Given the elegance of the associated discussions, I had thought he was, by training, a historian specializing in economic matters.

Ilardi mentions astigmatism only one or two times in this book, and does not consider other aberrations except to comment on poor image qualities encountered (no doubt a common problem in the early days of spectacle lens provision). Early-on, this may have been the reason that a number of pairs of spectacles were often ordered by individuals (other than considerations of breakage of early glass lenses, or a lack of local providers of quality lenses). Thus, given some variance in power/quality of lenses, one or the other of the corrections might have proved to be superior to the others provided. This situation no doubt improved with time, and with development of standards by the guilds of artisans. Apparently, there was relatively rapid dispersal of trained artisans/providers to make lenses, repair them and to replace lens and frame parts. The rapid fall in prices of spectacles, so eloquently detailed by Ilardi, probably often resulted in replacement of entire spectacle lenses and frame sets rather than repair of them, particularly among the wealthy.

Ilardi eloquently points out that the several developments reported here, were in reality the result of "many fathers", some known and recognized, others not known or little recognized.

He ends the book with a fine quote from Rene Descartes' *Dioptrics,*1637*, "The whole conduct of our life depends on our senses, among which vision being the noblest and most universal, there can be no doubt that inventions serving to increase its power are the most useful there can be."* He closes with the statement that *ours* is a *"divine" calling!*" Stated another way, provision of enhanced visual quality of life to individuals is no small thing!

Finally, Vincent Ilardi does us yet another favor. He directs us to a fine resource for accessing many critical original documents cited and discussed in this book. The citation is as follows: "Ilardi Microfilm Collection of Renaissance Diplomatic Documents ca. 1450 – ca. 1500." It is located at the Sterling Memorial Library, Yale University, New Haven, CT. This major resource has an index.

This book should be read by all those with an interest in the history of the renaissance, the history of optics and spectacle optics, optometry, ophthalmology, vision science or physiological optics, and those interested in the development of science, in general, during that intriguing age. It is a truly brilliant scholarly work!

Book Review: Purkinje's Vision: The Dawning of Neuroscience

Purkinje's Vision: The Dawning of Neuroscience. Nicholas J. Wade and Josef Brožek. Mahwah, NJ: Lawrence Erlbaum, 2001. xiv + 159 pages. ISBN-10: 0-8058-3642-X. ISBN-13: 978-0805836424. Hardcover, $49.95.

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Jan Evangelista Purkinje (1787-1869) has had his name immortalized in connection with several phenomena of vision: Purkinje shift, the change in spectral sensitivity from scotopic to photopic conditions; Purkinje images, the reflections from the refracting surfaces of the eye; and Purkinje tree, the appearance of the shadow of the retinal vasculature on the photoreceptors. He is also known for Purkinje cells in the cerebellum and Purkinje fibers in the heart. This book deals primarily with some of Purkinje's work on subjective visual phenomena. The authors suggest that Purkinje "shifted the way in which we think about vision itself and of the links with our underlying biology. His vision was that all subjective experiences have objective correlates. This was the dawn of neuroscience." (p. 1)

The first chapter is an introduction which provides a historical context for some of Purkinje's studies on vision. Purkinje's experimentation on vision was done without elaborate instrumentation. He did not have access to much equipment as a medical student when he conducted his experiments, nut he thought that the description of subjective visual phenomena was important for the insights it could provide into visual physiology. In the mid 19th century, after the work by Purkinje described in this book, the use of more involved instrumentation in a laboratory setting became more commonplace.

The second chapter, "Biographical and Bibliographical Notes," is the shortest chapter. Purkinje undertook medical studies at the University of Prague. Purkinje defended his doctoral dissertation, *Contribution to the Knowledge of Vision in its Subjective Aspects*, in 1818 and it was published in Prague in 1819. It appeared in book form in 1823, a translation of which is included in this book. From 1823 to 1850, Purkinje taught at the University of Breslau. In 1825, he published another book, *New Contributions to the Knowledge of Vision in its Subjective Aspects*. At Breslau, Purkinje lectured on "empirical" and physiological psychology, and did studies on microscopic anatomy, physiology, and psychology. Purkinje returned to Prague in 1850, and he died there in 1869. A collection of Purkinje's works, *Opera Omnia*, was published in 13 volumes.

Chapters 3 and 4 concern Purkinje's 1823 book. Chapter 3 discusses Purkinje's observations and similar observations made by other authors. Chapter 4 is a translation of Purkinje's book into English from the German. Purkinje reported what he saw under various conditions and with various manipulations of his eye. He undoubtedly experienced some pain in the name of science. Among the phenomena he described were pressure phosphenes, phosphenes from electrical stimulation, intrinsic light, haloes, vascular patterns of the eye, the blind spot, afterimages, diplopia, floaters, and various entoptic images.

The fifth and final chapter discusses the importance of some of Purkinje's studies in vision and other areas. The authors noted that "the scope of Purkinje's interests was broad, and he made important contributions to many areas that have hardly been touched on. For example...Purkinje [in 1823] described the principles on which an ophthalmoscope could operate, and he outlined how fingerprints could be used as a means of identifying individuals." (p. 111) Purkinje used the study of image reflections from the ocular surfaces to support Thomas Young's theory of accommodation. The authors suggested that Purkinje contributed to the beginning of neuroscience through his microscopic studies of neural tissue and because his interpretation of perceptual phenomena in terms of their underlying physiology represented a novel departure." (p. 115) Purkinje also attempted to link pharmacology and physiology, in part through experiments in which he self-administered drugs. The authors quote Helmholtz as saying, "It might seem that nothing could be easier than to be conscious of one's own sensations; and yet experience shows that for the discovery of subjective sensations some special talent is needed, such as Purkinje manifested in the highest degree." (p. 126)

Book Review: The Moving Tablet of the Eye: The Origins of Modern Eye Movement Research

The Moving Tablet of the Eye: The Origins of Modern Eye Movement Research. Nicholas J. Wade and Benjamin W. Tatler. Oxford, UK: Oxford University Press, 2005. xiii + 312 pages. ISBN-10: 0-19-856616-6. ISBN-13: 978-0-19-856616-8. Hardcover, $79.50 (also available in paperback).

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The title of the book was taken from the poem *The Temple of Nature* by Erasmus Darwin (1731-1802), who was grandfather of Charles Darwin and who wrote about visual vertigo and eye movements in 1794 in the first volume of his physiology book *Zoonomia*. A portion of the excerpt of the poem in the book reads as follows:

Yon waving woods, green lawns, and sparkling streams,
In one bright point by rays converging lie
Plann'd on the moving tablet of the eye.

The stated aim of the authors in this book is to "draw attention to the experimental studies of eye movements that were conducted before systemic equipment was available, and to integrate this with contemporary research." (p. 30) Coverage in the book extends from the earliest observations of eye movements, including those of Aristotle and Euclid, on into the late twentieth century and early twenty-first century. The book contains seven chapters: (1) Informing contemporary research, (2) Origins of eye movement research, (3) Nystagmus, (4) Saccades and fixations, (5) Visual motion illusions and eye movements, (6) Perceptual stability and eye movements, and (7) Summary and conclusions.

The first chapter provides an introduction to the study of eye movements and its history and it traces the development of methods of measuring eye movements. The authors identify six types of techniques for eye movement measurement: (a) afterimages, (b) attachment devices, (c) optical devices, (d) remote devices, (e) electro-oculographic devices, and (f) portable tracking techniques.

Among the topics in the second chapter are discussions of some topics in binocular vision and the anatomy of the oculomotor system. They note that William Porterfield in 1737 and 1738 distinguished between internal movements of the eyes (accommodation and movements of the iris) and external movements of the eyes. The authors make a case for William Charles Wells "being one of the founders of research on eye movments." (p. 71), despite his work often being overlooked. Wells' 1792 book *An Essay Upon Single Vision with Two Eyes* and papers published in 1794 contained a number of experiments on eye movements.

In the chapter on nystagmus, the contributions of Wells, Darwin, Purkinje, Fluorens, Mach, Brewer, Crum Brown, Bárány, and others are discussed. The authors note that Purkinje (1787-1869) is often credited with the discovery of various aspects of nystagmus, but that much of that work was predated by Wells.

The main topic of the fourth chapter is saccades, but it also deals with subjects such as ocular torsion, Donders' and Listing's laws, and studies of ocular orientation during fixation by Helmholtz, Hering, and others. The origin of the word saccade is from 19th century French, meaning "jerk." Emil Javal (1839-1909) is often credited with the first description of saccades, but the authors state that Javal, in an 1879 article and in his 1904 book, "did not himself attempt to take credit for the work describing saccadic eye movements and was explicit in attributing this work to Lamare." (p. 149) Among the work on saccades highlighted by the authors was that of Raymond Dodge (1871-1942), who designed photographic eye movement recording devices which made possible his own studies on eye movements during reading, as well as studies by other investigators.

Chapter 5 discusses various visual motion illusions, how various investigators tried to connect them to eye movements, and how others showed them to be independent of eye movements. Chapter 6 discusses writings concerning perceptual stability during eye movements.

The authors are located in the Department of Psychology at the University of Dundee in Scotland. The first author, Nicholas Wade, is noted for his books and papers on the history of vision science, and is a Fellow of the Royal Society of Edinburgh. The second author is an active eye movement researcher and has published in journals such as *Perception* and *Vision Research*. Like many of Wade's other publications, this book contains portraits of most of the persons being discussed and has quotations from their original publications.

One of my teaching assignments during the first twelve years of my career as an optometry faculty member was teaching a required course in ocular motility. I developed some acquaintance with aspects of the history of eye movement research, but this book contains several times more information on the topic than I had read previously. The emphases in the book are on version eye movements, as opposed to vergence, and on the relationship between eye movements and perception. It is recommended to anyone interested in the history of the investigation of those areas of visual function.

Recent Articles of Historical Interest

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This article will briefly review two recently published articles that contain information of historical interest. One article, from the *Canadian Journal of Ophthalmology*, deals with the eyeglasses worn by rock and roll star Buddy Holly. The other article, which appeared in *Archives of Ophthalmology*, presents a possible explanation for Abraham Lincoln's intermittent hypertropia.

Buddy Holly's Glasses[1]

The author of this article, Gerald Goldlist, noted that rock and roll star Buddy Holly had "distinctive heavy-rimmed black glasses [that] became part of his performing identity and his wearing glasses while performing may have inspired other musicians to do the same." Buddy Holly was born in Lubbock, Texas, in 1936 and died in 1959 in an airplane crash in Iowa. Holly recorded fifty songs he wrote himself and influenced numerous musicians who followed him.

Goldlist, a big fan of Holly, met Holly's optometrist, Dr. J. Davis Armistead of Lubbock during a visit to Holly's hometown. Armistead graduated from Southern College of Optometry and was influential in the development of the College of Optometry at the University of Houston. This article includes a biographical sketch of Holly's life and career by Goldlist and a reproduction of an eleven paragraph letter from Armistead to Goldlist concerning Buddy Holly's glasses.

Armistead noted that Holly had been his patient for three or four years. The last lenses he prescribed for Holly were:

OD -3.50 -0.25 X 60
OS -3.75 -0.75 X 10

Holly had been an unsuccessful contact lens wearer with Butterfield scleral lenses before corneal contact lenses were widely available. Armistead related this story concerning the spectacle frame that came to be associated with Holly: "...Buddy was trying to wear the least conspicuous frames he could find. He wore plastics for a while that were non descript and then he wore the B&L Citation.

"Personally, I was not happy with the frame styles we had been using. I did not think that they contributed anything to a distinct personality that a performer needs....

"...I told him I was leaving for a trip to Mexico City and would try to find some frames for him that would be different. I brought back a black and a demi amber...

Those heavy black frames achieved exactly what we wanted – they became a distinct part of him...."

Possible Cause of Lincoln's Hypertropia[2]

Some photographs of Abraham Lincoln show a left hypertropia and it was reported on occasion by some of his contemporaries. Fishman and Da Silveira present a theory for the cause of that intermittent hypertropia. They performed a laser scanning of two plaster casts of Lincoln's face, one made in 1860 and one made in 1865, two months before his assassination. Computer three-dimensional analysis of the laser scans showed a greater than normal facial asymmetry.

The left half of the face on the plaster casts is smaller than the right side. However, the left anterior orbital aperture is larger than that on the right side, largely due to asymmetry in the superior rims of the orbits, with the left being more rounded and thinner. Lincoln was usually photographed from the right side, due to the awareness on the part of the photographers of his facial asymmetry.

One theory for the origin of Lincoln's intermittent hypertropia is a slight paresis of the left superior oblique from a kick in the head from a horse when Lincoln was ten years old. A familial occurrence of hypertropia has also been noted in photographs.

The authors suggest another possible cause of Lincoln's intermittent left hypertropia. If the left superior orbital rim was smaller than the right and if the left trochlea was placed farther back in the orbit compared to the right one, there may have been a resultant underaction of the left superior oblique. They explain the mechanism as follows: "When the superior orbital rim is displaced backward compared with the other side, the trochlea is also relatively retroplaced. This has 2 effects: it decreases the effective length and tone of the superior oblique muscle and it changes the angle at which the reflected tendon inserts on the sclera. Both mechanisms weaken the capacity of the superior oblique muscle to depress and intort the eye."

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