

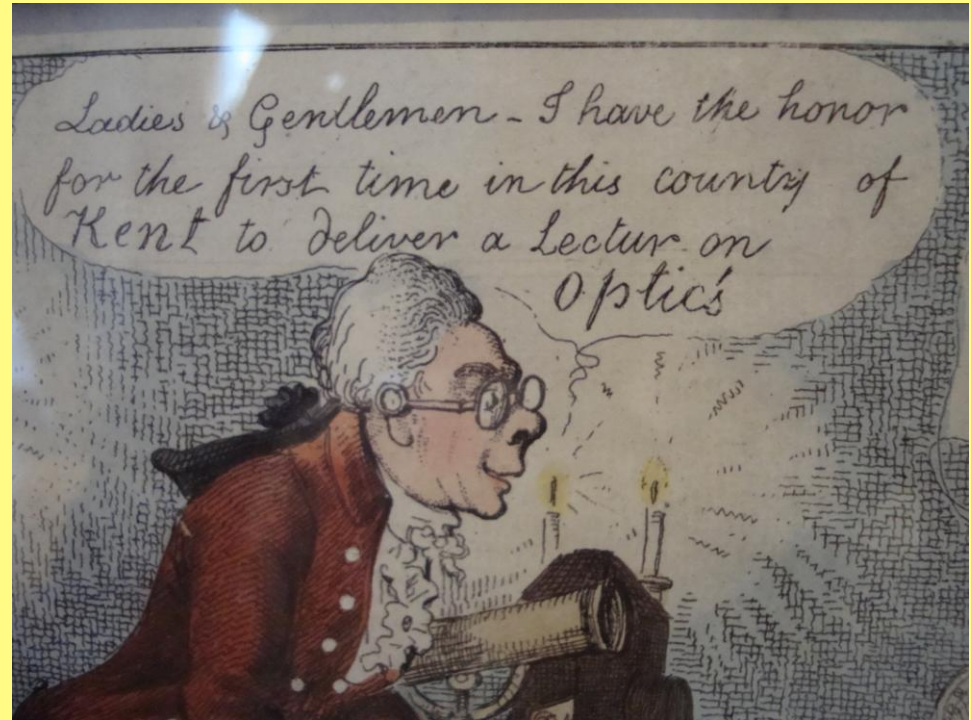
The correction of Optical Defects From Spectacles to Laser

Prof Will Ayliffe

Gresham College 2010

Sources and further information

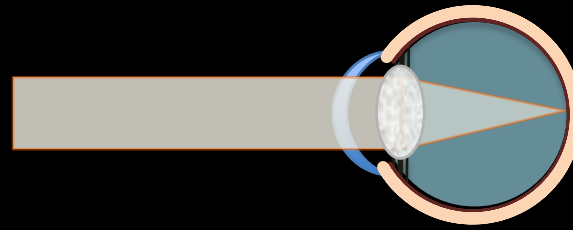
- The College of Optometrists craven street
- Neil Handley MA: AMA
- Cult Eyewear: Merrell 2011.
- American Academy of Ophthalmology
- Royal College of Ophthalmologists
- Vincent Ilardi: Renaissance vision
- Edward Rosen The invention of Eyeglasses J Hist Med 1956
- antiquespectacles.com curator Dr. Fleishman
- Eyegasses warehouse: fabulous site.
- information@eyeglasseswarehouse.com
- J. William Rosenthal: Spectacles and other vision aids: a history and guide to collecting
- Colleagues and friends.
- Andrew Gasson: Best website on contact lens history. Wilkie Collins expert.
- Christopher Kerr President of BCLA



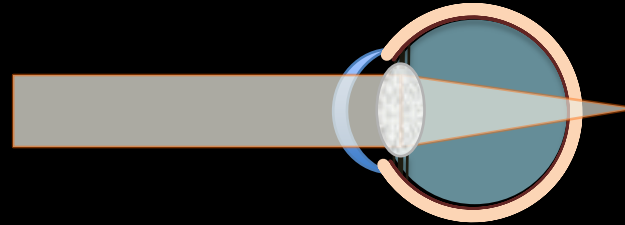
What are the optical defects of the eye
Correction with lenses
5,000 years of lenses
Invention of eyeglasses
Contact lenses
Laser taster.

Focused image

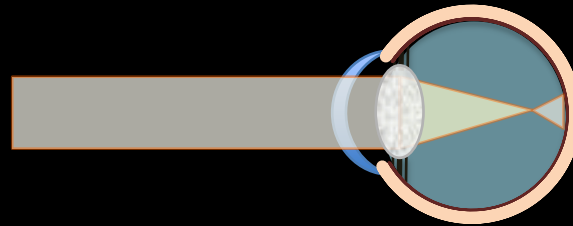
Normal sight: Emmetropia



Long sight: Hypermetropia



Short sight: Myopia



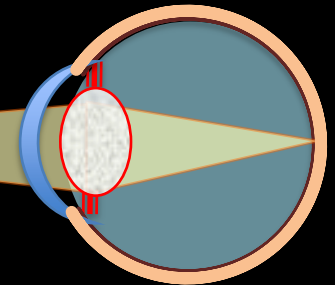
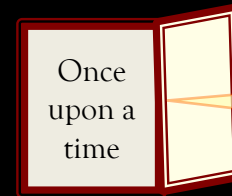
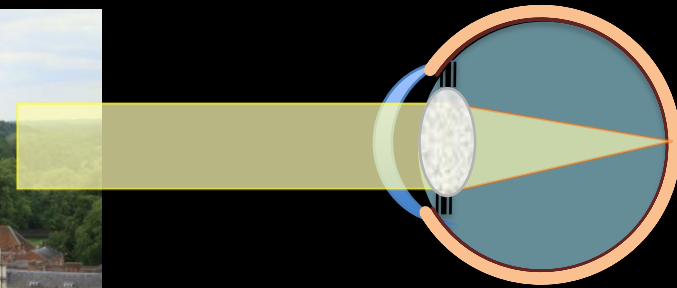
Normal sight (Emmetropia)

The focusing system of the eye (the cornea and crystalline lens) forms an image by converging the rays of light.

For a near object more power is needed. In humans this is achieved by increasing the power of the crystalline lens.

This mechanism (accommodation) requires effort by the ciliary muscles.

H
AL
TNC
OLHA
ECTNO



Long-sight Hypermetropia

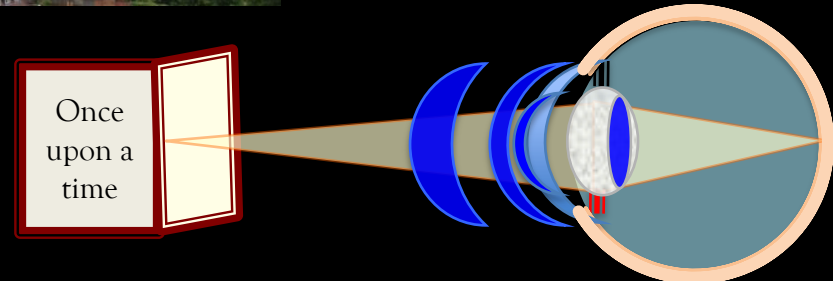
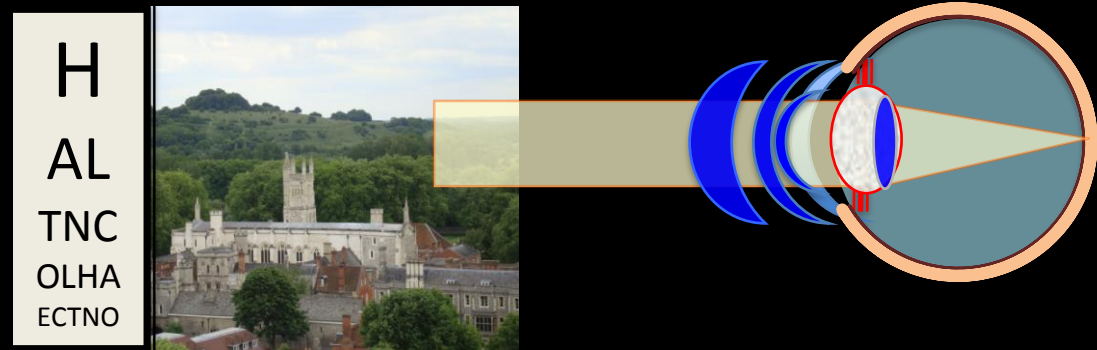
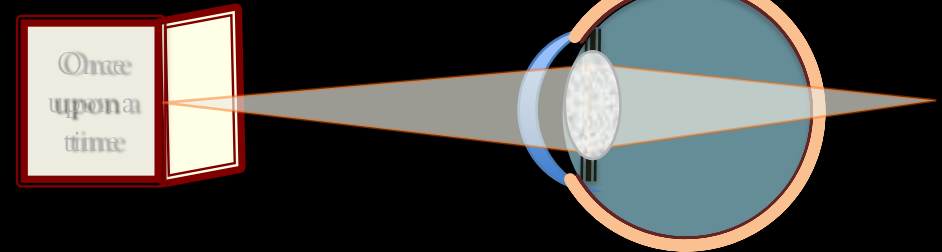
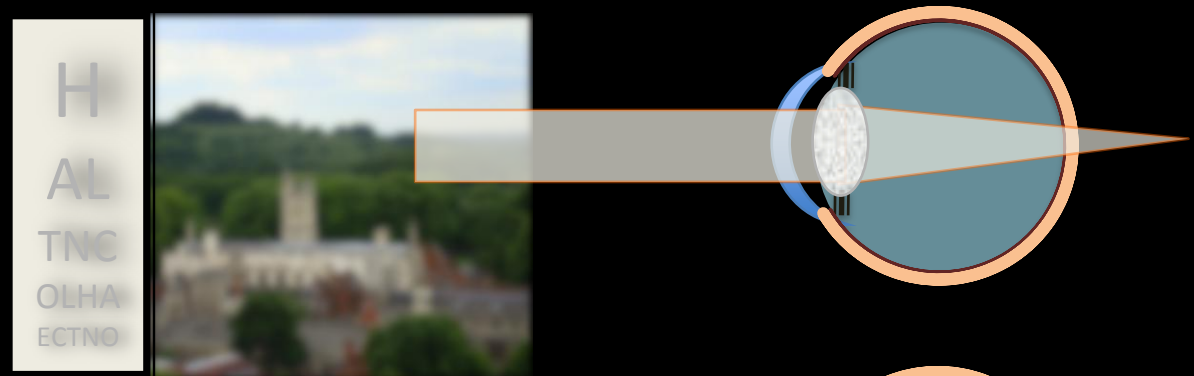
Blurring for distance and near

Focus power insufficient

Eye “too short” for the system

Increase refracting power of eye

- Accommodation in young
- Glasses (plus convex lenses)
- Contact lenses
- Laser to steepen cornea
- Intraocular lens high power



Short-sight Myopia

Problem:

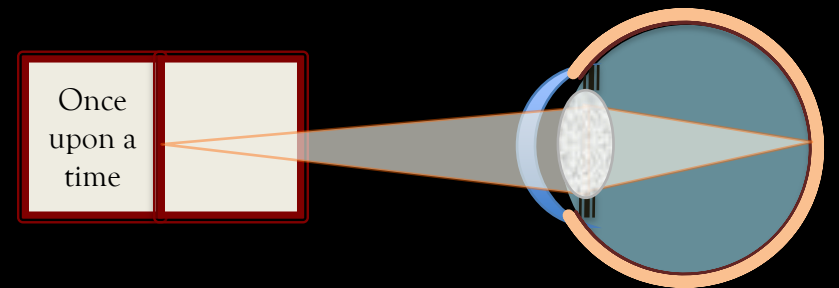
Blurring for distance
Can read unaided

Focus power too high for eye
Eye “too long” for the system

Solution:

Decrease refracting power of eye

- Glasses (minus concave lenses)
- Contact lenses
- Laser to flatten cornea
- Intraocular lens low power



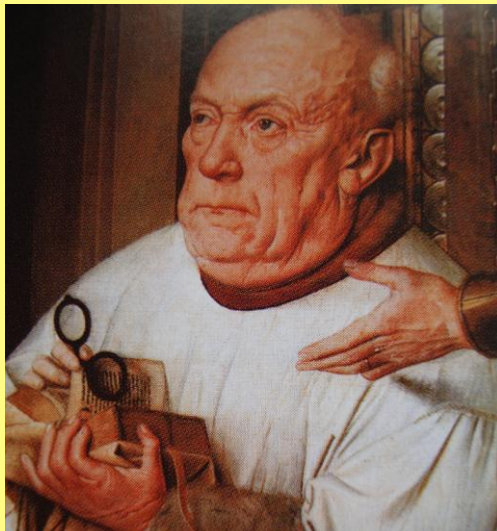
Presbyopia

With age crystalline lens less elastic
Ciliary muscles unable to accommodate

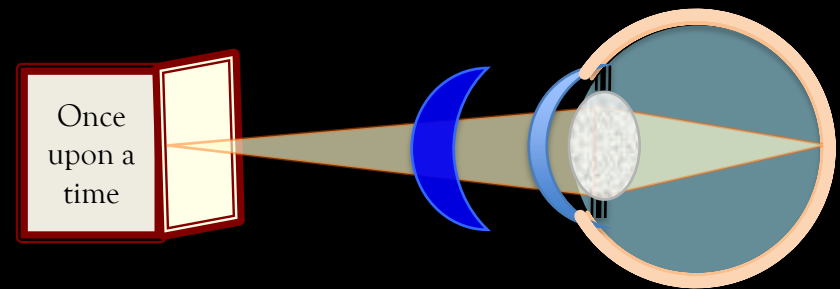
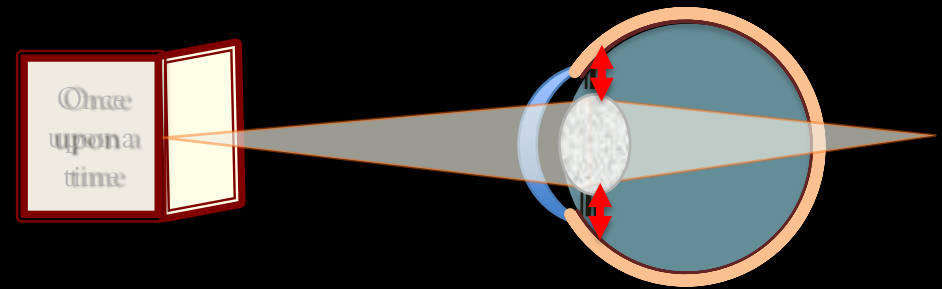
*Many when they wish to read hold
the writing at a distance from their
eyes so the image may enter they
more easily and more sharply:*

Dante Alighieri in Convivio BIII Ch9

Need extra + lens to focus image



Jan van Eyck 1436
Madonna met Kanunnik Joris
Van der Paele



Properties of lenses

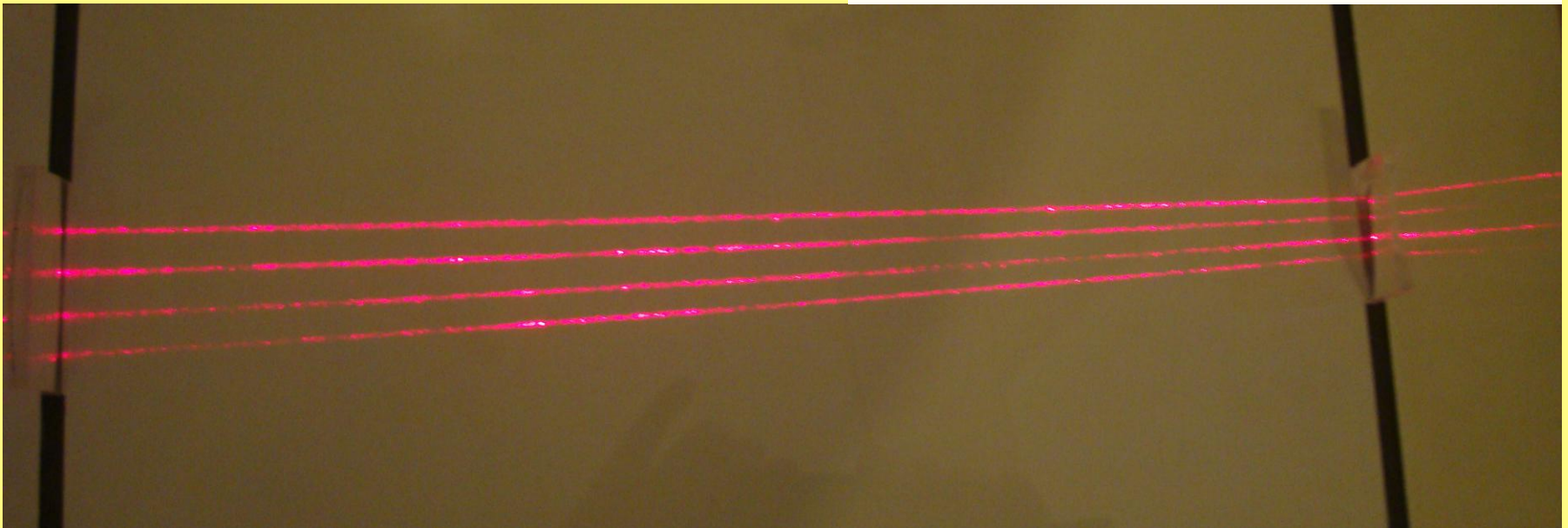
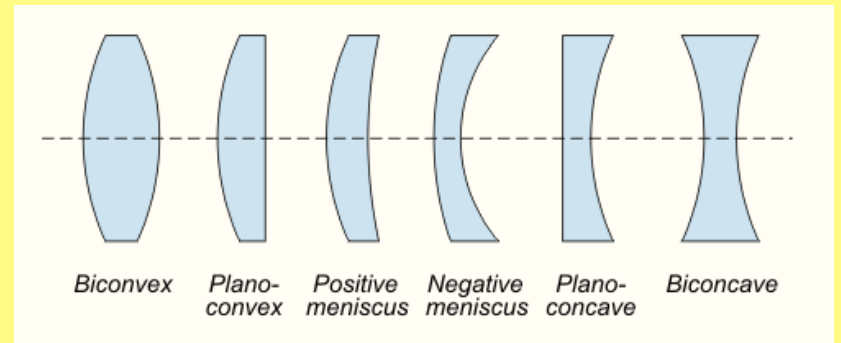
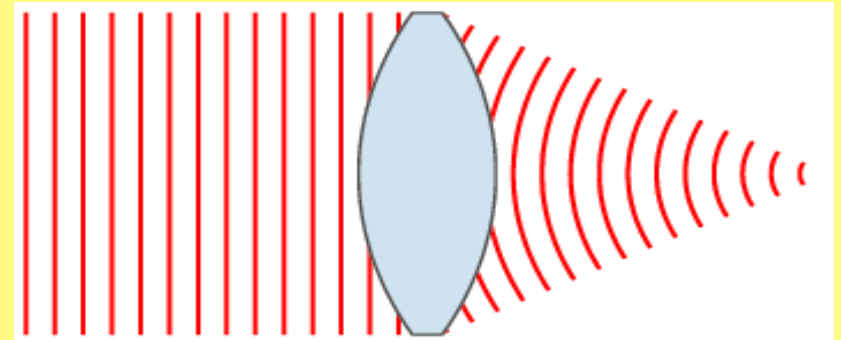
Transparent material with curved surface(s)

- Beryl.
- Quartz.
- Glass.
- Plastic

These materials slow down light waves so they bend

A converging lens (+)

A diverging lens (-)



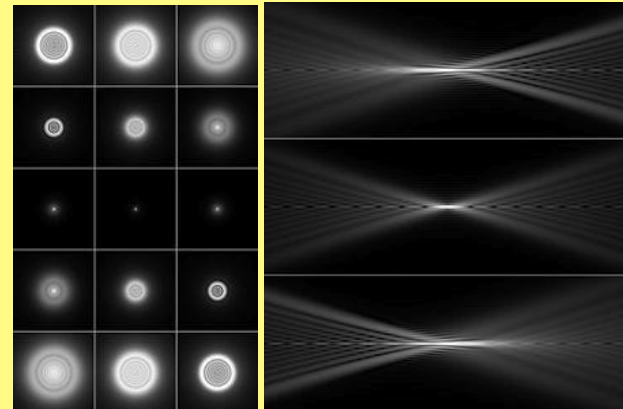
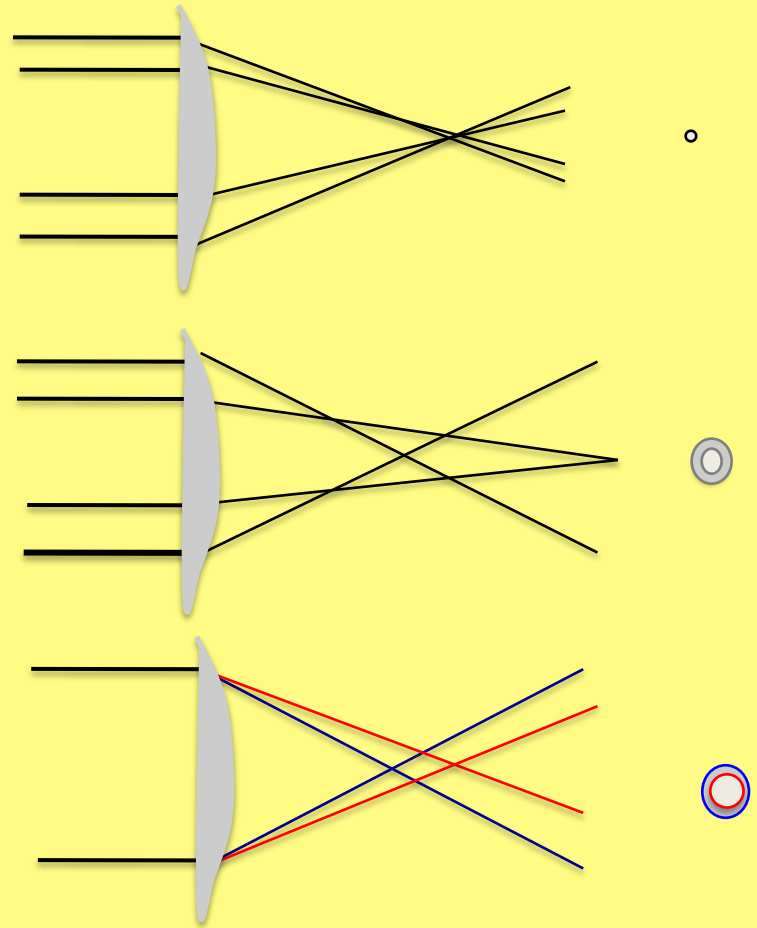
Lenses cause aberrations

Don't get a point image

Spherical

Chromatic

Higher order



Ancient lenses

The early history of lenses is controversial.

Objects that function as lenses occur frequently in the archeological record. Difficult to distinguish from jewelry.

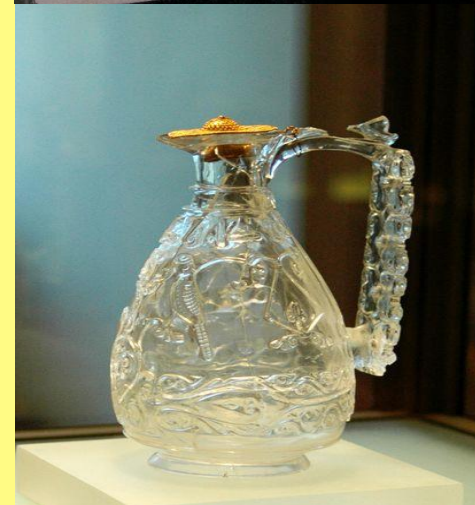
Many artifacts that could be lenses are classified as decorative.

Manufacture of transparent glass difficult until Middle Ages.

Made of quartz (rock crystal), beryl or glass.

Quartz: Abundant mineral SiO_2

Beryl mineral is a beryllium aluminium cyclosilicate: $\text{Be}_3\text{Al}_2(\text{SiO}_3)_6$. Hexagonal crystals, Pure colorless, impurities cause colour: green (Emerald), blue, (aquamarine). Beryl is common and occurs usually in granite rocks, mica schists and with tin ores.



Rock crystal flask (Fatimid, late 10th early 11thC). From the Treasure of Saint-Denis.

Water Globes

Lucius Annaeus Seneca 4BC-65AD:

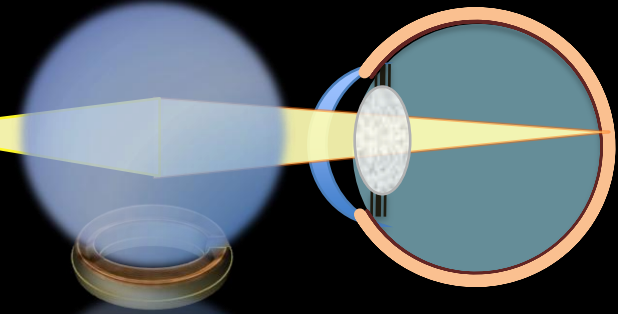
Roman philosopher and politician

”There are mirrors which increase objects they reflect..Letters, however small and dim, are comparatively large and distinct when seen through a glass globe filled with water.

Quaestiones Naturales, I, vi 5

Linen and lace making globes were filled with water and a candle was placed next to it.

Oplomachus
nunc es,
fueras
opthalmicus
ante. Fecisti
medicus quod
fanis
oplomachus.



C1850: lenses ground near the centre.

Ancient Optical theory

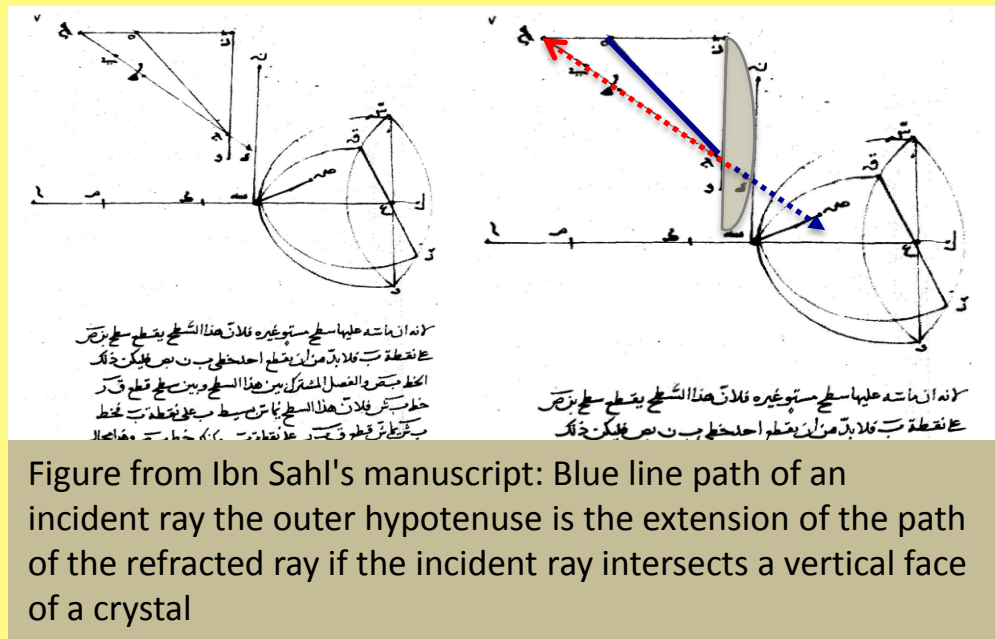
Euclid Optics, first studies of the geometry of optical systems in mathematical detail.

Ptolemy, 1st-2nd BC most important writings on optics before Newton, survive only as translations into Arabic - the originals having been lost. Discusses optics: light, refraction, reflection and colour

Ibn Sahl (c940-1000) mathematician with Abbasid court Baghdad. Burning mirrors
Discovered law of refraction rediscovered by Harriot 1602 in correspondence with Kepler. Snell's law.

the ratio of the length of the smaller hypotenuse to the larger = 1/refractive index of the crystal

Ibn Al-Haytham (Alhacen 965-1040) b. Basra, spent much of his life in Egypt. Kitab al Manazir c1023 transl into Latin as De Aspectibus c1230. Influences Franciscans and Witelo. Describes principles of magnification.

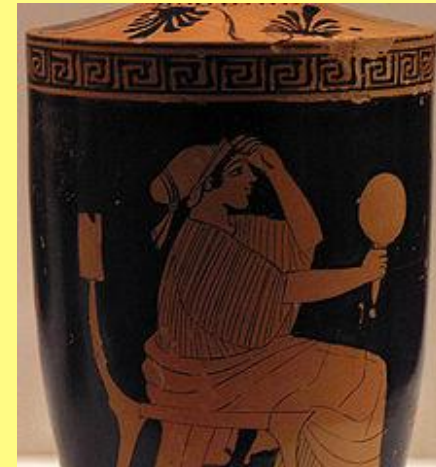


Ancient Optical Practise

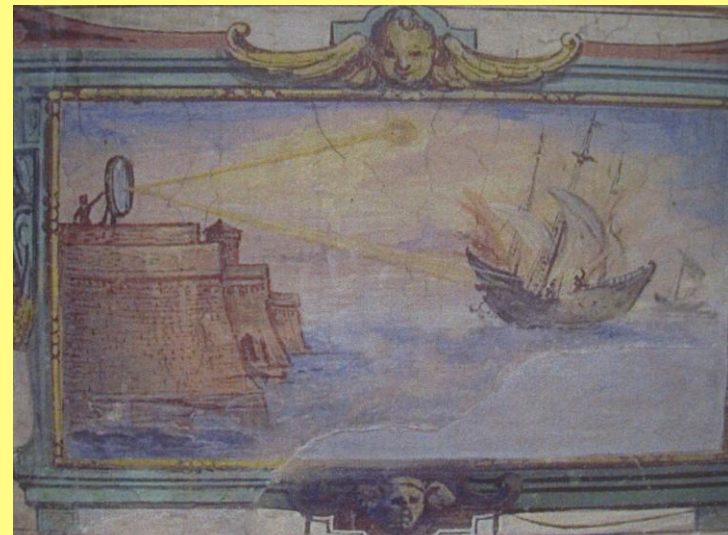
Aristophanes: The clouds: Staged in Athens 423BC

Strepsiades: Have you ever seen a beautiful, transparent stone at the druggists', with which you may kindle fire? **Socrates:** You mean a crystal lens. **Strepsiades:** That's right. Well, now if I placed myself with this stone in the sun and a long way off from the clerk, while he was writing out the conviction, I could make all the wax, upon which the words were written, melt. (thus freeing him from debt)

Archimedes 287-212BC: May have used burning mirror to defend Syracuse against the Romans



Ancient Greek Attic red-figure lekythos, ca. 470-460



G Parigi: Archimedes burning mirror C17th salle del matematiche Uffizi

Nero's Emerald

Pliny the Elder: 23-79 AD. Due to die in Herculaneum;
Lenses for cauterizing wounds

“Emeralds are concave in shape so that they concentrate the vision. When laid flat they reflect objects like mirrors. Emeralds are used to refresh tired eyes.”

'Nero princeps gladiatorum pugnas spectabat smaragdo'

Nero watching gladiatorial contests with an emerald (mirror):
Has also been suggested that he used glasses.

Perhaps Nero was myopic; *nisi cum conniveret ad prope admota hebetes* Pliny; means either he could only see near objects, or that his vision for near was defective.

He certainly had remarkable eyes *oculis ceasiis et hebetioribus* Suetonius: Meaning he either had grey eyes or defective vision (or both if it means the cornea was opaque).

However Nero was a successful competitor himself and probably didn't have myopia. Also emerald had other uses, as a gem, as the sporting green colour of the Emperor, or as a charm.

The whole story may be based on Pliny misreading an earlier txt (Woods; Arctos 2006). Nero spied *κατοπτρη* on the games thru a hole in a screen designed to cover his absences. Mistranslated as using a mirror *κατοπτρον*.



Pliny's *Natural History*, mid-12th century
manuscript
Abbey of Saint-Vincent, Le Mans



Did the ancients use lenses for optical purposes?

George Sines, "Precision in Engraving of Etruscan and Archaic Greek Gems", detailed statistical analysis of nine engraved Etruscan gems. spacings of hatchmarks:

Modern skilled machinist can achieve a precision ~0.2 mm unaided eye; with a simple magnifying glass ~0.08 mm.

The median spacing on the ancient gems was half this size 0.048mm.

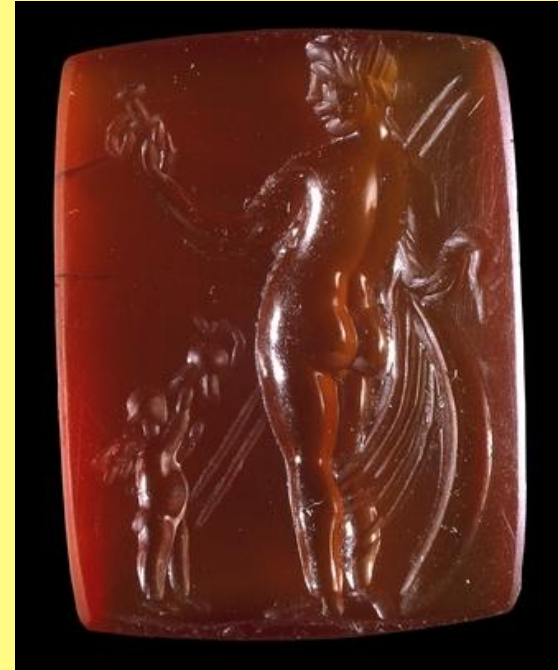
1854: Significant discovery of Roman period magnifying lens in the "House of the Engraver" on the Stabian Way Pompeii. It is plano-convex with a corroded, opaque surface in the gem collection at the National Museum in Naples.

Sines and Sakellarakis, *Lens in Antiquity*, *American Journal of Archaeology* 91 (1987).

G. Sines, *Archeomaterials*, Vol. 6, No, 1 (Winter 1992).

Demetrios Plantzos *American Journal of Archaeology*, Vol. 101, No. 3 (Jul., 1997), pp. 451-464

Argues that skill and experience were enough.
Perhaps myopia.



Roman Britain, 4thC AD Venus with Cupid (love) and the armour of Mars, common Roman iconography; Thetford hoard of late-Roman gold jewels 1979. Large carnelian removed from older jewelry & cut down for re-setting.

Ancient lenses

Lenses are older than their literary references.

Lens-like objects scattered in the archeological record around the globe;

Found in the Middle East, France, Rome, in Americas and Scandinavia.

Technique of polishing stones

4,500 yrs ago: Earliest lenses IV/V Dynasties of Egypt. Decorative eyes.

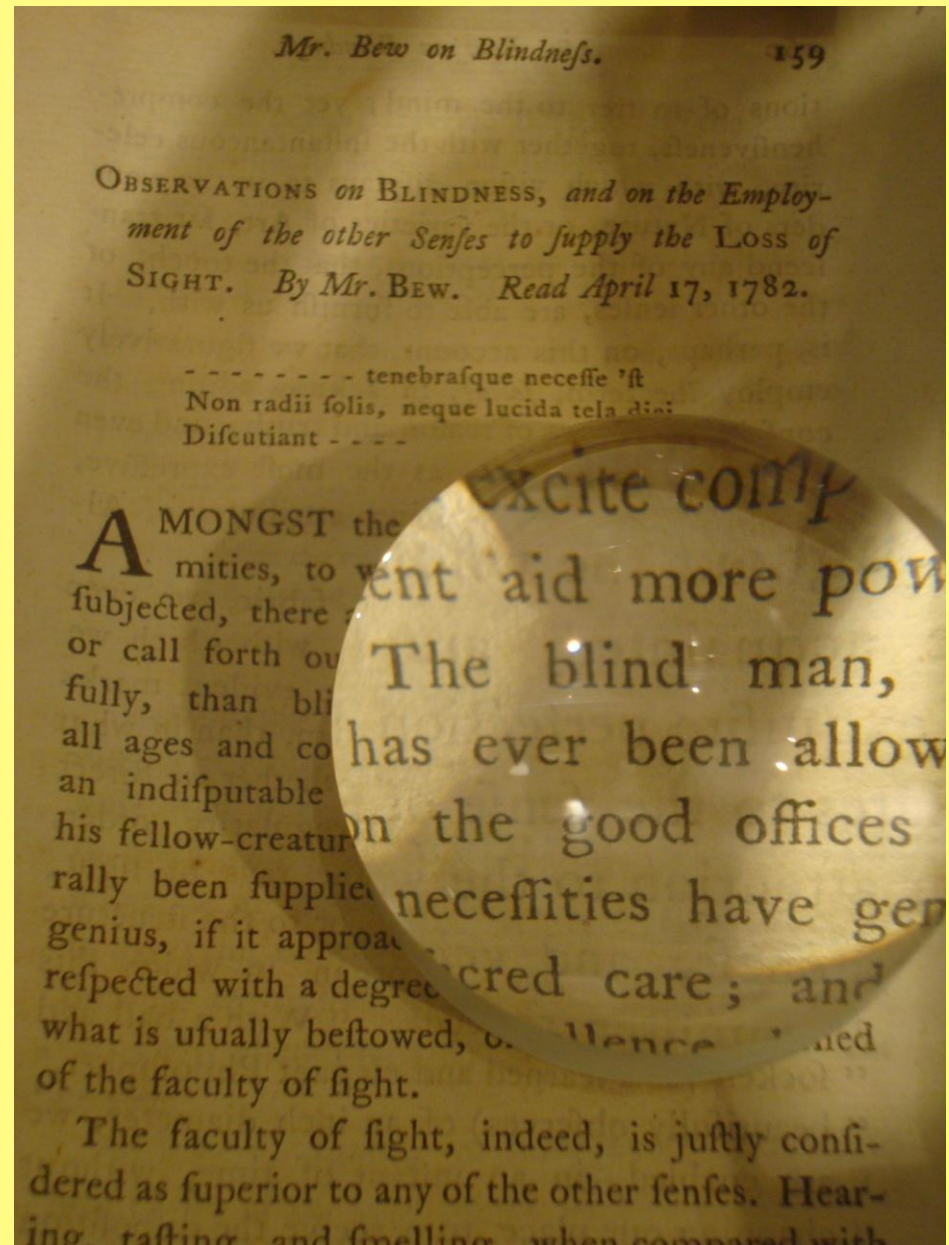
Troy: Crystals shaped as lenses were discovered by Heinrich Schliemann, one was 2" diameter. Most were perforated in the centre.

3,500 yrs ago: Later examples from Minoan culture found in Knossos by Arthur Evans (Herakleion Museum)

3,000 yrs ago: Assyria Nimrud.

2,000 yrs ago: Mayan Mexico

1,000 yrs ago: Viking reading stones



The earliest lenses: Decorative eyes

Djoser 2630-2611: 3rd dynasty pharaoh builds step pyramid at Saqqara; the necropolis of Memphis.

Imhotep his grand vizier

Sneferu 2613-2589 4th dynasty ushers in golden age; his son **Khufu** builds great pyramid at Giza.

During early dynasties, craftsmen learned to polish hard stones including crystalline quartz. Lenses manufactured as components for eyes of funerary statues

Thick lenses: front ground, polished convex surface, flat rear surface, into which a high power concave surface ground. A realistic image of the pupil in the iris plane as seen in the living eye.

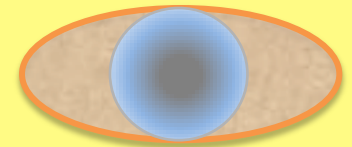
Results in an optical illusion the eye appears to follow the observer of the statues.

These “eyes” appear to follow the observer as he/she rotated in any direction about these statues

Made only for 200 yrs (2620–2400 BC)

Technique reused briefly 700 years later, 1750–1700 BC.

After this the skill was lost forever!



"Le scribe accroupi"

Auguste Mariette; founder of the Cairo Museum, discovered the statue at Saqqara, 1850 north of the avenue of sphinxes.

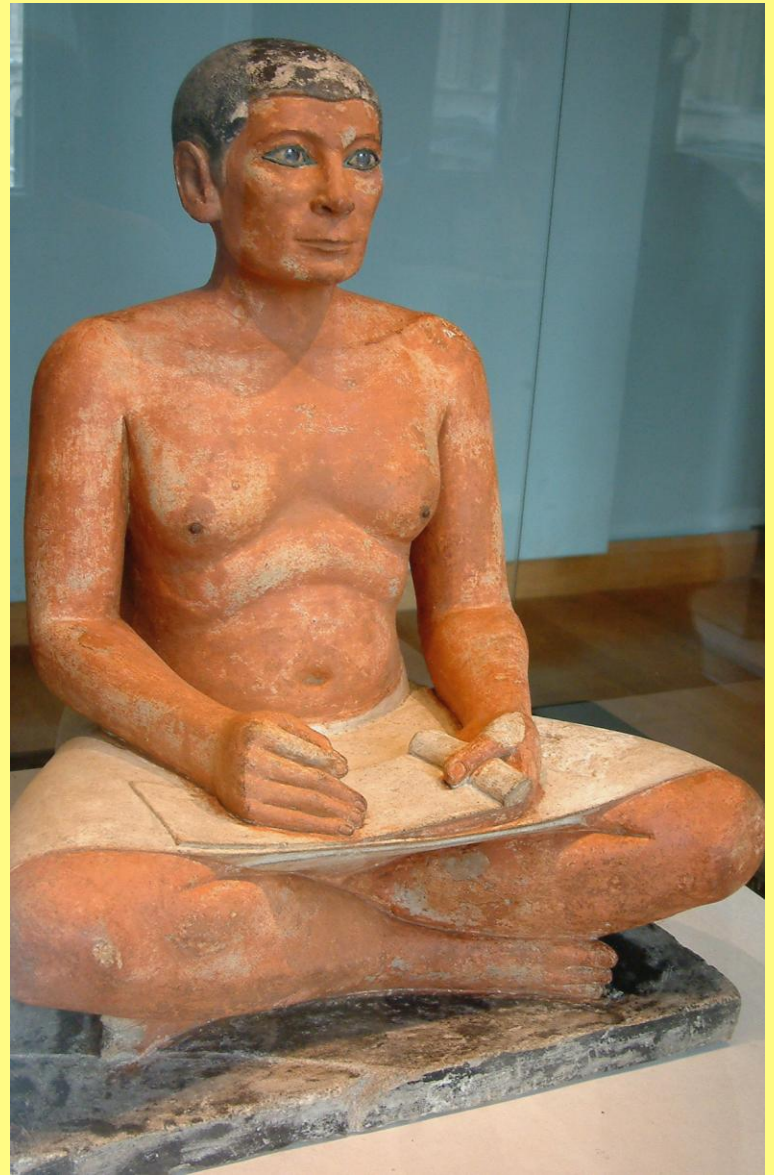
Dating is difficult. Similarities to statue of Péhernefer 4th dynasty, when scribes reading are a more common style.

"Seated Scribe" sits with crossed legs over which a white kilt supports a papyrus roll. The right hand would have held a brush.

Eyes: a block of red-veined white magnesite (magnesium carbonate)

Embedded rock crystal lens, with polished front surface. The back is painted, both an adhesive and colouring the iris.

set into the orbit with a welded copper mounting.



Seated Scribe Old Kingdom, Dynasty IV.
Painted limestone statue, Louvre



Rahotep and Nofret

Painted limestone,
beginning of Dynasty IV, c. 2620
BCE

These two separate statues of the
prince, probably a son of King
Sneferu, and his wife.

The convention was to paint a
man's body darker than woman's
skin.

Both figures have inlaid eyes.

Nofret wears a long sheath dress
with a mantle, a wide necklace
with concentric rings, and a wig
with a headband of rosette design



The Statue of Kai with his Children

Old Kingdom official late Fourth Dynasty. ca. 2575-2150 BCE

Kai: Old Kingdom official late Fourth Dynasty. The priestly titles and secular duties are listed. Behind his legs are two of his many children: a son, who is shown as a child but is old enough to have been awarded the title of scribe, stands by his right leg in the traditional pose of youth; and a daughter, Nefret, kneels and embraces her father's left leg. Made of painted limestone with copper inlays and calcite crystal eyes
55.9 cm ht width of the base is 25 cm.

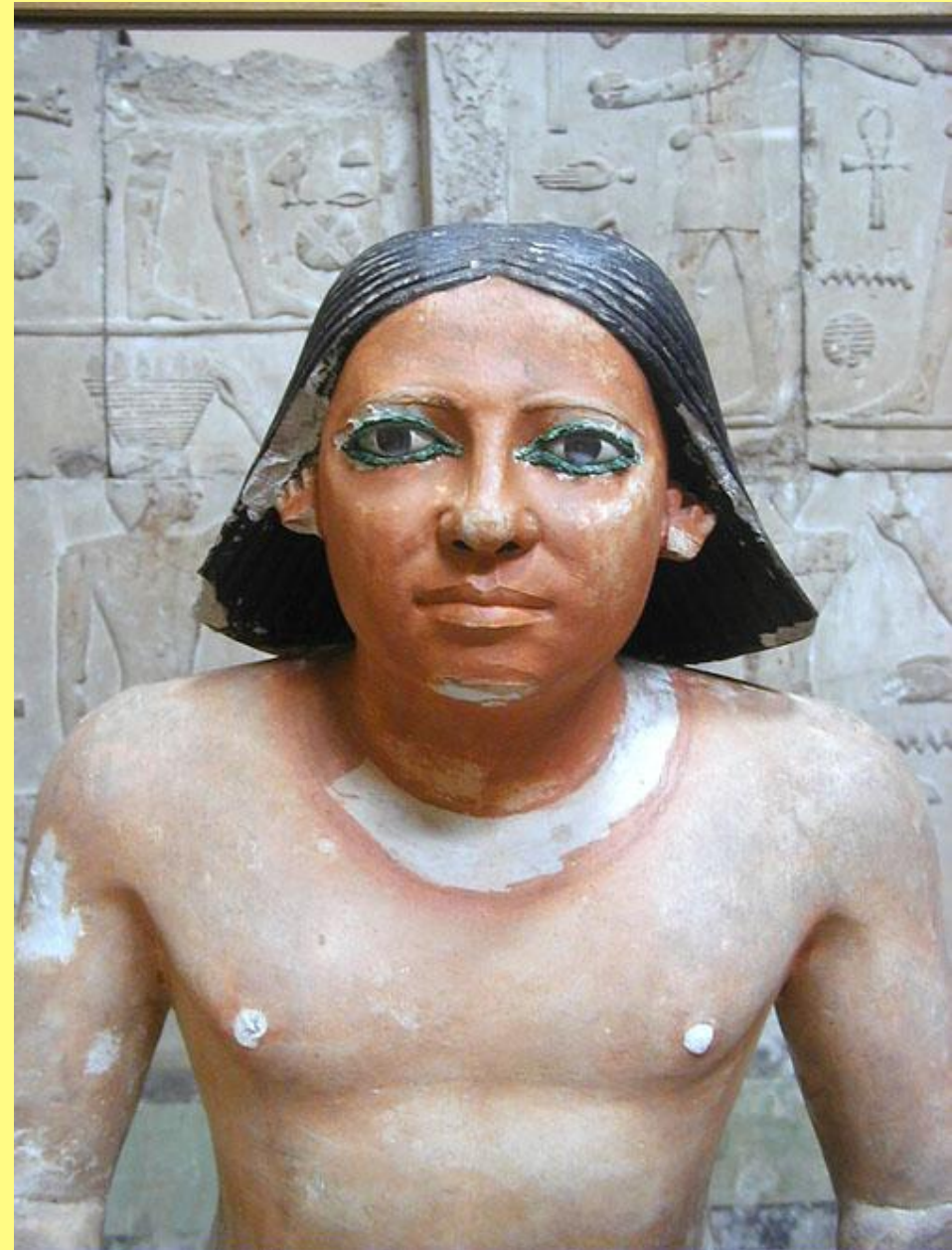
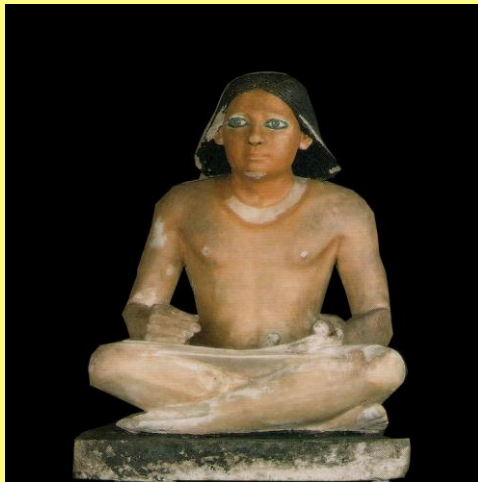


**Statue of Kai ca. 2575-2150 BCE
painted limestone with inlaid crystal eyes.**

Seated Scribe

C24th BCE Egypt Cairo.

Found in a tomb at Sakkara
painted limestone, 5th Dynasty,
20 inches high. A black sculpted wig
stands out from the head and shoulders.
A white kilt stretches tight used as a table
for the scroll, held by the left hand.
Right hand has detailed fingernails. It used
to hold a reed, chewed to make a brush.
A paint pallet with red and black ink,
illustrated in the hieroglyph above.



Seated Scribe: painted limestone, 5th Dynasty,

The administrator Kai -

Statue of Vizier Kai

Le haut fonctionnaire Kai: Louvre
2600-2350BC Old kingdom 5th
Dynasty

Statue of Ka-aper:

5th dynasty Cairo 2450 Sycamore
wood & plaster

Chief priest, in charge of reciting
prayers for the deceased in temples
and funerary chapels.

Masterpiece of the private statuary
of the Old Kingdom.

When excavated was nicknamed by
the workers The Sheikh El-Beled:
after the headman of the village

The eyes are inlaid; the rim is made
out of copper and the white is of
opaque quartz, the cornea is rock
crystal.



Stone and faience eyes

New materials include ivory, glass and semiprecious stones.

Face on a coffin: 18th Dynasty, c. 1400 BC

Wood, eyes of obsidian (naturally occurring volcanic glass) and ivory set in bronze sockets.

A wedjat (Eye of Horus) 3rd Intermediate Period, 1069-945 BC. 8.9 cm long, 1cm thick

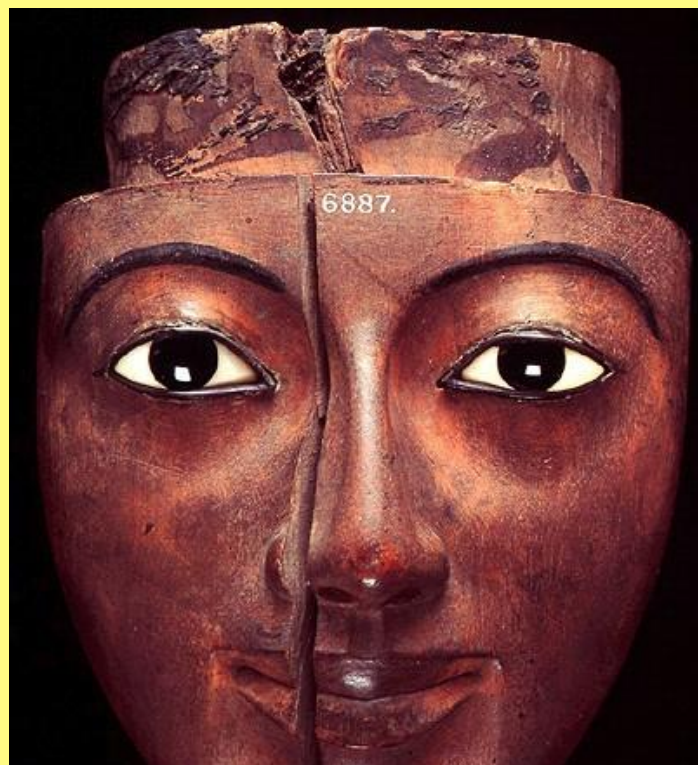
The first use of a wedjat eye as an amulet was by Horus falcon-headed god of the sky, to bring Osiris back to life.

In a battle with Seth, the god of chaos and confusion, Horus lost his left eye. The wound was healed by the goddess Hathor. The left eye of Horus represents moon, waxing and waning ie. Horus losing and regaining his sight.

Egyptian faience ceramic: crushed quartz or sand, (not clay) with small amounts of calcite lime and a mixture of alkalis; surface vitrification due to the soda lime silica glaze. Colours; copper pigments bright blue-green: iron oxide ochre for red.

Eye and stylized eyebrow with 3 rows of cats; blue faience, area around eye red cornea and iris are white and black faience.

in great numbers because of regenerative power.



Wedjat eye amulets were placed in mummy wrappings Symbolise the process of regeneration

Trojan lenses

Hisarlik: Turkey. First occupied during the Early Bronze Age, 3000 BC, Site of Late Bronze Age Trojan War, Troy level VI (1800-1275 BC) or Troy VII (1275-1100 BC).

1850: Test excavations; railroad engineer **John Brunton** and archaeologist/diplomat **Frank Calvert** in the 1860s, whose brother owned the site. No money to continue.

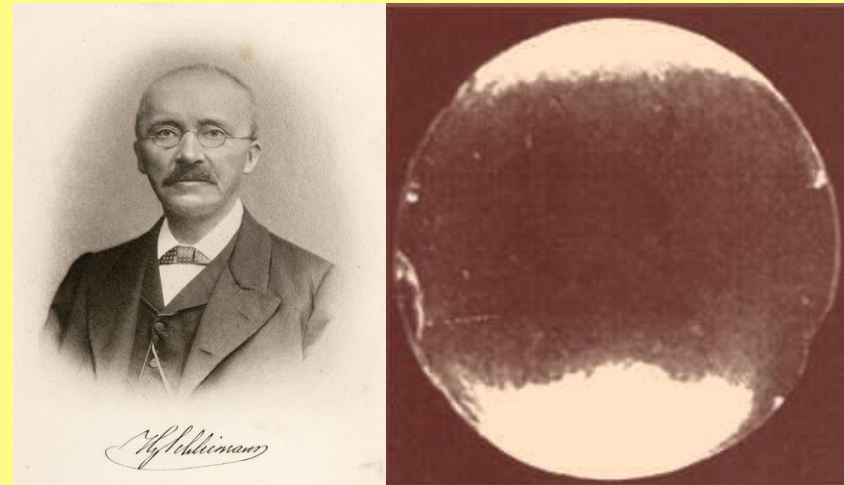
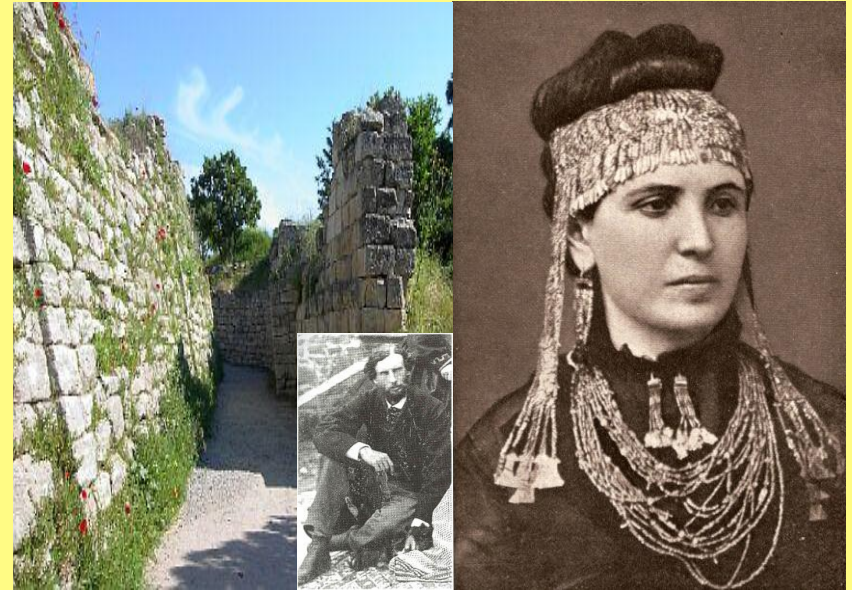
Heinrich Schliemann: (1822-1890), wealth, Amsterdam, St. Petersburg and Sacramento. Guided by The Iliad to a site in northern Turkey that he "knew" was ancient Troy. Excavated treasures and crystal lens-like objects; photographed his 2nd wife, Sophie in the diadem he claimed was worn by Helen. Not Homeric King Priam's Troy, c1400 to 1200 B.C; older, c2500 to 2400 B.C. He dug right through it without noticing.

Lenses not mentioned in his reports, looted WWII, only photos, 1921 survived (King: Optician 1958)

Eventually Pushkin Museum Moscow allows access.

Treasure A, 101 objects, inc famous diadem. **Treasure L** 4 axes of polished stone, 1 in lapis lazuli.

The collection includes lenses of rock crystal polished well enough to be used as magnifying glasses. 24mm x2, 50mm 55mm, and one 54mm with a 9mm central perforation interpreted as jewelry. Could also have been used to put an engraving tool through.



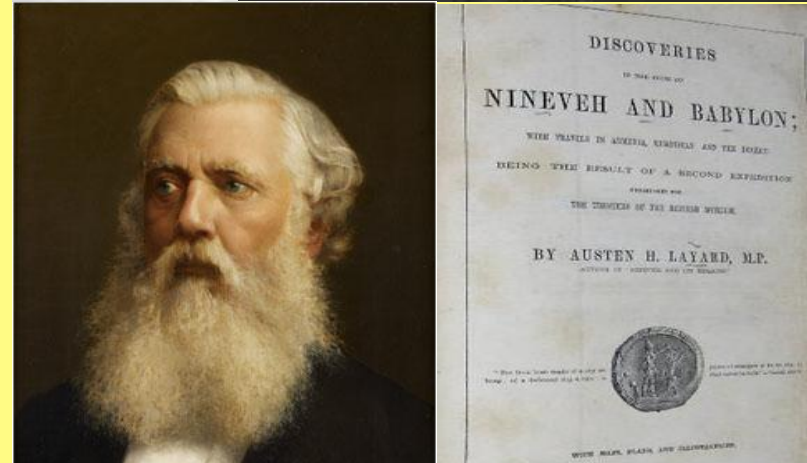
The Nimrud lens

Austen Henry Layard (1855-7) ruins of King Sargon II Assyrian palace of Nimrud (Iraq): 3000 year old rock crystal among a collection of glassware C9th to 7th B.C.

Sir David Brewster (1781-1868) British Association for the Advancement of Science. 1.63 by 1.32” thickness of 0.24”, magnification power of 1.25X to 2X, one flat surface and one convex, focuses at 4.5” “It is obvious from the shape and cutting of the lens, that it could not have been intended as an ornament. We are entitled, therefore, to consider it as intended to be used as a lens, either for magnifying, or for concentrating the rays of the sun”.

Giovanni Pettinato University of Rome: part of a telescope, explains their knowledge of astronomy, eg rings of Saturn. Assyrians regarded Saturn as a god surrounded by a ring of serpents, which occur frequently in Assyrian mythology. The right size and shape to have been used as a reading aid for tiny cuneiform; by King Sargon himself?

Interpretation of a ground oval crystal with a biconvex cross-section as an optical lens is not necessarily a guide to its original function.



Ancient Cretan lenses

~ C5th BC Lens-like artifact found in disturbed stratum with other archaic Greek items 1983 a cave on Mount Ida Crete. c1800BCE

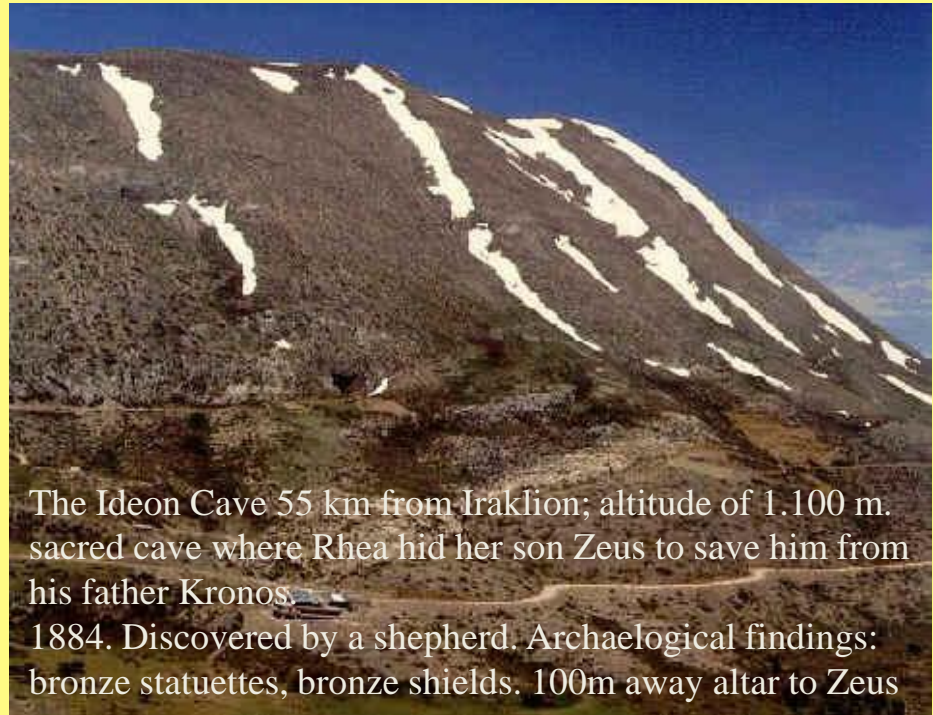
It is more powerful and of better quality than the Nimrud lens.

1. Rock crystal. Plano-convex 8mm diam, 4mm thick focal length 12mm 20X magnification. Limited by distortions to 7X.

Rock crystal, circumferential polish marks seen under mag.

2. 15mm diam 6mm thick. Focal length 25mm giving magnification of 10X useful 2.5X. Edge has marks consistent with shaping tools of hard stone using a template.

(Sines & Sakellarakis Am J Arch 1987)



The Ideon Cave 55 km from Iraklion; altitude of 1.100 m. sacred cave where Rhea hid her son Zeus to save him from his father Kronos.

1884. Discovered by a shepherd. Archaeological findings: bronze statuettes, bronze shields. 100m away altar to Zeus



Rhea riding a lion, Pergamon Altar

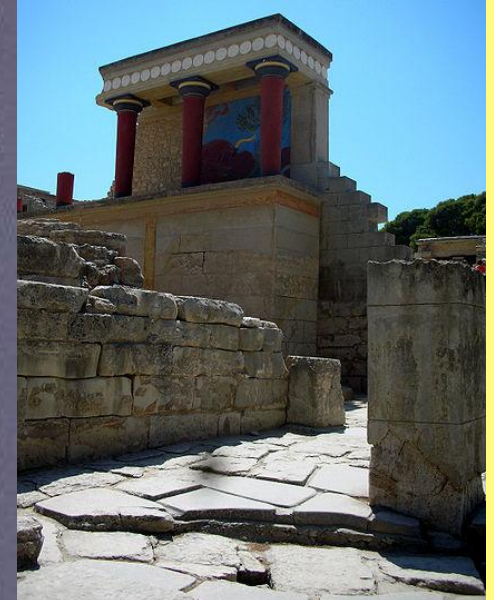
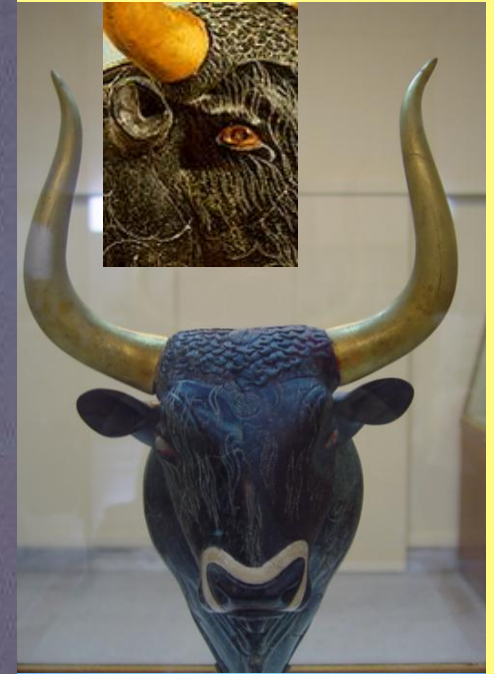
Cretan Bronze age lenses

Sir Arthur Evans: Bronze age lenses
1400BC found 1928 in Palace of
Knossos and Mavro Spelio Cemetary.

Rock-crystal rhyton. libation vessel
used in sacred rituals: carved from a
large block of rock-crystal; handle is
made of crystal beads threaded on a
bronze wire. MM III-LM IB period
(17th-15th centuries B.C.)

Bull's head rhyton; Little Palace of
Knossos. steatite. Gilded horns, rock
crystal eyes. MM III-LM IB period
(1500-1550BC).

The art of stone carving, declined in
Old Palace Period, revived and
perfected in New Palace times.



Tanis: New Kingdom lenses

Sir Flinders Petrie (1853-1942).
Self taught Egyptologist Appalled
by rate of destruction of Egyptian
Archeology (a house on fire) tries to
salvage what he can.

Organises workers so that small
finds are recorded not discarded.

Tanis; New Kingdom site northern
Egypt. Two more lenses were
discovered in the house of an artist.
destruction of the house dated AD
174.

Both lenses are plano-convex.

2.5" in diameter and have a focal
length of about 3.5"

Dies in Jerusalem 1942 donating his
head to science!

Lenses in BM



Ancient New World (Mayan)

Ability to shape and polish Quartz

Decorative

Also magnification and image
formation



Talisman of Charlemagne

800AD: Charlemagne had a sapphire talisman/amulet made for his wife by craftsmen of the court of Haroun el Raschid, Emperor of the East.

Two large cabochon sapphires. One oval the other square sandwiching a remnant of the wood from the Holy Cross and a strand of the Virgin's hair. Act as a magnifying lens.

Intended to make their love constant, it must have worked. The talisman was buried with him at Aix-la-Chapelle, in 814, and re-discovered when the tomb was opened by Otto III in 1000 and kept in Cathedral treasury.

Given, by the canons, to Empress Josephine in 1804, to wear at her coronation.



Medieval lenses

1268, Roger Bacon: Opus Majus: "If anyone examine letters or other minute objects through the medium of crystal or glass or other transparent substance, if it be shaped like the lesser segment of a sphere, with the convex side toward the eye, he will see the letters far better and they will seem larger to him. For this reason such an instrument is useful to all persons and to those with weak eyes for they can see any letter, however small, if magnified enough".

The "Admirable Doctor," b. Somerset, ~1214, educated at Oxford and Paris. joined the Franciscan Order. Imprisoned in Paris 1257 for 10yrs.

Pope Clement IV, asked him to write out and send a summary of what he knew.

His 1268 work summarises all known science; original experiments mathematics, physics, and other disciplines.



Visby lenses

Sophisticated lens-making techniques 1,000 years ago.

Lens-shaped objects made of rock crystal (quartz) found in several Viking hoards on the island of Gotland, Sweden, 11/12th C. Some in silver mounts; the lenses may be older than their mount

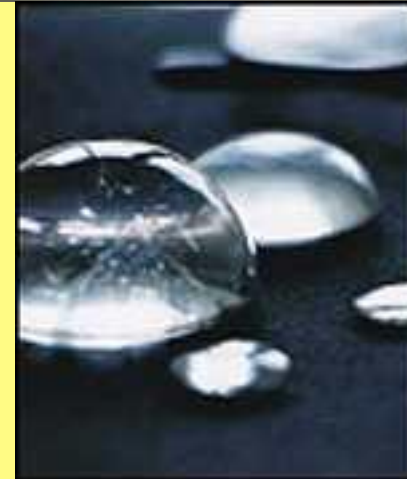
image forming qualities of 10 of these lens-shaped rock crystals

bi-aspheric; excellent imaging properties. Far surface oblate ellipse, surface nearest the eye parabolic

The combination of top and bottom surfaces of the lens causes an imaging quality comparable to the modern aspheric lenses used, e.g., in today's projectors

The craftsmen used trial and error, since the maths to calculate the best form for a lens not yet discovered. possibly only a few craftsmen, perhaps a single person, in Byzantium or Eastern Europe

Schmidt et al, (Optometry and Vision Science 1999).



Invention of spectacles

The first spectacles were made between 1268 and 1289.

On 23 Feb 1306 **Friar Giordano da Pisa**, popular Teacher, Lent sermon:

"It is not yet twenty years since there was found the art of making spectacles, (trovo l'arte di fare gli occhiali) one of the most useful arts on earth, was discovered".

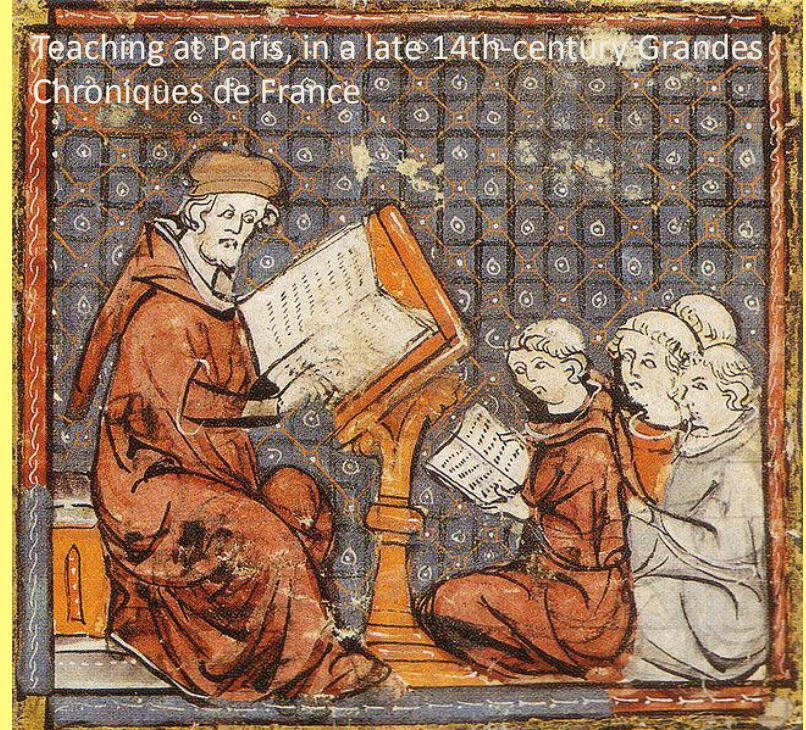
1, myself, have seen and conversed with the man who made them first".

In the vernacular, obviously aimed at general public.

Important invention for scholarly Dominicans.

He had studied at Bologna and Paris between 1284-86, and did not record the marvelous invention in either city.

Subsequently travelled widely in Italy and died 1311 at Piacenza en route to Paris.



Friar Alessandro della Spina

May also have known the inventor of spectacles.
He learned to make them and let out the secret for
the public good.

Fr Bartolomeo da San Concordio 1313 records
about della Spina in the Ancient Chronicle of the
Dominican Monastery of St. Catherine in Pisa.

“ vir modestus et bonus; Ocularia ab alio primo
facta.

*Spectacles having first been made by someone else,
who was unwilling to share them, he [Spina] made
them and shared them with everyone.*

*By his ingenuity he made himself a room in the
house of the Eternal King.*

Pisa had a small glass industry drinking glasses:
Breve dei Consoli della Corte dell Ordine de
Mercanti del Commune: 1321; lists arte dei
bichierai.

Mirrors were also made arte delli spechiari



Venetian claims

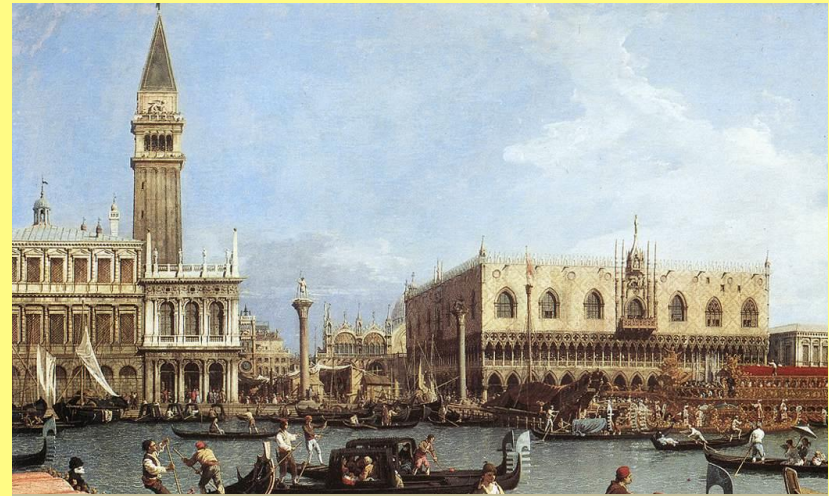
At the time of Giordano's sermon spectacle makers were already working in Venice.

Tradesmen organised into Guilds which had statutes, (*capitolare*) the first were for Tailors 1229.

1300: The guild regulations for crystal-workers **Capitolare dell'arte dei cristalleri**. Repeated prohibition of 1284 for making objects of clear glass to counterfeit rock crystal objects. These included *roidi de botacelis* (glass stoppers for vials) and **roidi da ogli** (spectacle lenses).

Distinguished from **lapides ad legendum** (stones for reading i.e magnifying lenses)

1301: Liberalisation of manufacture of *vitros ab oculis ad legendum* (glass for reading specs) as long as under oath; the seller labeled them as **spectacles with glass lenses**.



Return of the Bucintoro to the Molo on Ascension Day: Canaletto, 1732. Royal Collection, Windsor.



Luck of Edenhall: Medieval Venetian glass V&A

Venetians tax glasses

1317: Francesco, son of late surgeon Nicolas, granted permission to make and sell **oglarios de vitro** (I Capitolari p138 q.IIardi).

1321 Senate adopts Tuscan term **veri da occhiali** and imposes 5% export tax on them.

1409: spectacle maker Bartholomeo granted citizenship

The cristalleri guild were concerned that glass shouldn't be passed off as crystal, mainly for jewels and reliquaries but also for spectacles. Spectacle makers no guild of their own; so may not be found as such in the historical record. Associated with goldsmiths for tax purposes.

1446: Mercers Guild Capitolare mention mirrors, spectacles amongst other goods such as hats imported by the Fondaco dei Tedeschi, over which it had jurisdiction. "every kind of mercery...everything shall be regarded as subject to our trade.



Florentine claims

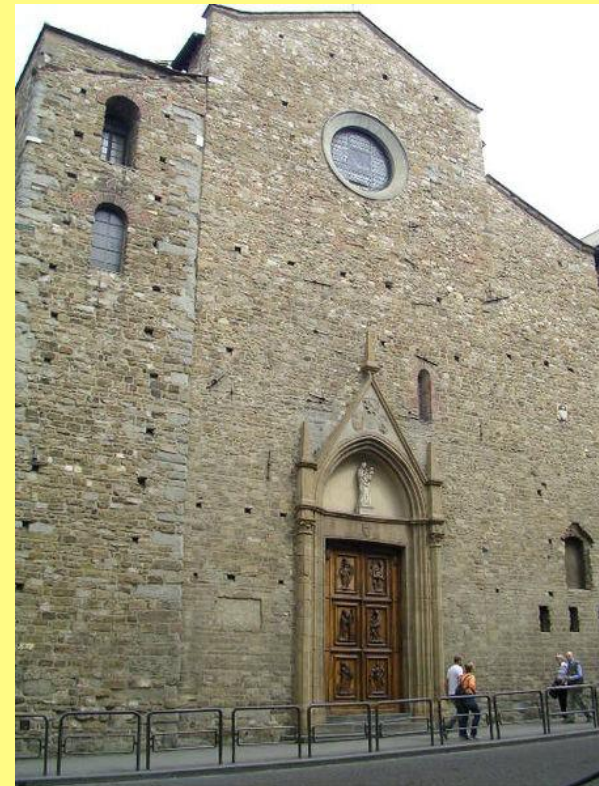
Francesco Redi 1626-97 court physician of grand Duke of Tuscany makes a fraudulent claim that in a mss; never seen by anyone else (*Traite de con uite de la famille*), that in 1299 Sandro di Pippo mentions spectacles as a new invention.

1684 larger hoax; **Ferdinando del Migloiore** Claimed unknown inventor in the Pisan document was a Florentine **Salvino degli Armati**, d.1317. burial register for Salvino d'Armato degli Armati. The family had died out and its funerary monuments, originally in Santa Maria Novella, had been destroyed for centuries.

Firenze città nobilissima illustrata: (1684) the tombstone of Salvino d'Armato; called as the "inventor of eyeglasses" had been visible in the church of Santa Maria Maggiore up to a few years earlier

Historian Pasquale Villari plaque was erected on the Armati house in 1885. A monument appeared in Santa Maria Maggiore, composed of a mismatch of statue and head on a sarcophagus of unknown family dated 1272, assembled in the C19th.

Even Umberto Eco propagated this hoax in the Name of the Rose 1980; Franciscan Friar William of Baskerville, had received a pair of spectacles as a gift from the great master Salvino degli Armati.



Drops for presbyopia

Collyria used to strengthen sight.

Ali ibn Isa 940-1010 Baghdad: (Jesu oculist)
Christian: **Tadhkirat al-kahhalin** (notebook for Ophthalmologists). Treatment of eye diseases based on Hunayn. "they who do not see in the near, a condition which mainly affects old people" should use styptic (tissue contracting) medicines; whilst those who see well near by but not in the distance, require medicines which give moist nutrition and bring the moist principle to the eye.

Bernard de Gordon, Professor of Montpellier.
Lilium medicinae (1305). recommends a collyrium of such potency people could read without an "oculo berillino". (Magnifying lens not glasses)

If we want to test some drug, we first should experiment on birds, then dumb animals, then in hospitals then on Franciscans (fratribus minoribus), lest it be poisonous and fatal.

Guy De Chauliac 1363 *Inventarium Sive Chirurgia Magna* If these things do not work resort to "ocularios vitri aut berillorum" or "spectacles of glass or beryl". Oculist to papal court Avignon.

Piero Ubertini da Brescia: 1361: Ricette per gli occhi (prescriptions for the eyes) d.ca 1395. 22 years practiced at Lucca. For weak sight in an 80 year old scholar monk who could no longer read or write without occhi di vetro; he recommended pills.



San Nicolo Treviso

Dominican church of San Nicolò, Gothic church built in brick (C13th-14th), round piers and an unusual vaulted timber roof
1352 Tomaso da Modena, son of painter, Barisino Barisini, hired by Prior of S. Nicolo, Treviso. He wanted the general chapter of the Dominicans to move to Treviso, so he could be elected superior general at his own monastery.

The failed venue of the conference, the chapter house, decorated illustrating history of the order.

40 prominent past members in upper zone, 2 popes, 18 cardinals and 17 Dominican friars. The saints, Dominic, Peter the Martyr and Thos Aquinas destroyed in WW2
37 monks at study.



First depictions of reading aids

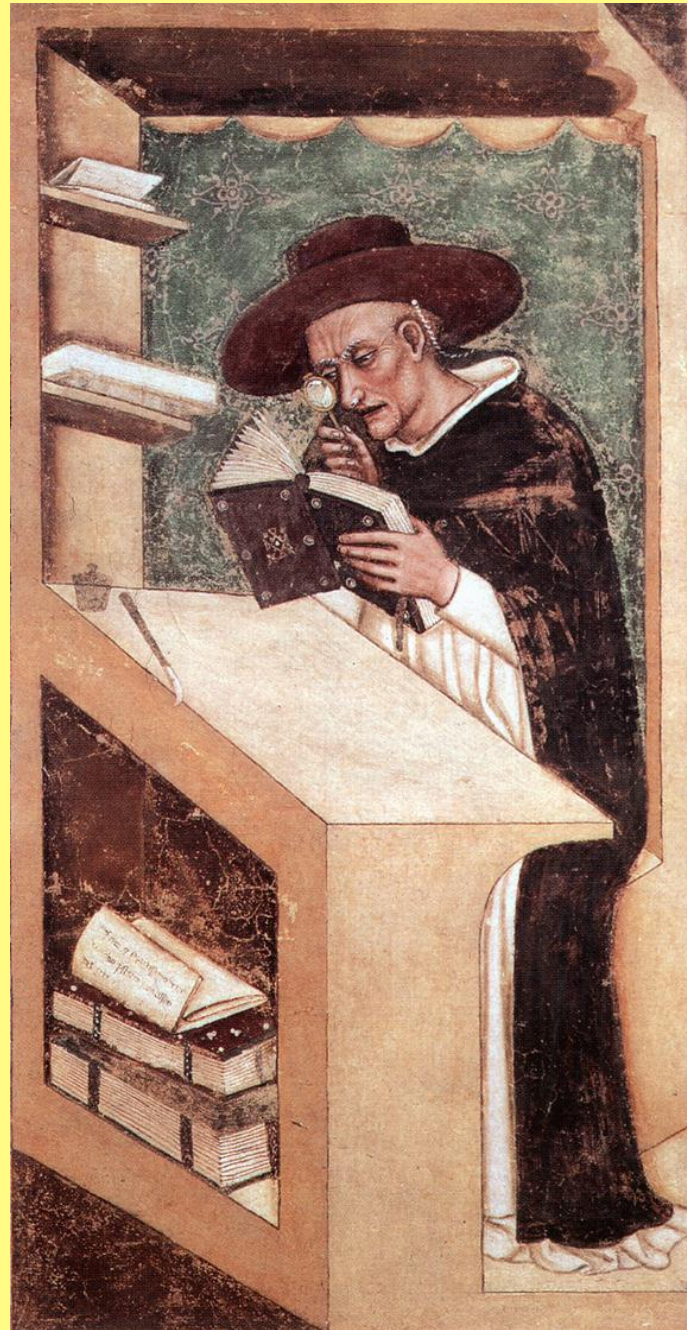
Nicholas de Freauville ca1250-1325:

First depiction of a reading glass

Professor of philosophy and theology at the Sorbonne University, Paris. Elected prior. Named Confessor of King Philip IV of France in 1295

Created cardinal priest of S. Eusebio 1305: Author of many texts on the liturgy.

Frescoed on the southern wall, he is depicted as an old man bringing the book close to his eyes so that he can read it more easily with the magnifying lens. An inkstand and an erasing knife are on the writing desk



Reading mirror

Pietro Isnardo da Chiampo (Vicenza)

Preacher d.1244.

Concave reading mirror on a metal stand.

C13th **The Romance of the Rose**

Guillaume de Lorris and Jean de Meun

Other [mirrors] make different images appear in different situations—straight, oblong, and upside down in different arrangements.... they make phantoms appear to those who look within. They even make them appear, quite alive, outside the mirror, either in water or in the air..."

Concave mirrors were being used for projecting images.

Meissner German Poet (1260-80): Small writing can made legible for the aged by the use of a mirror (spiegel)



Concave reading mirror

Another depiction of a different type of reading mirror; set in a leather horn not on a fixed metal stand

Column fresco in Nave of S. Nicolo

St Jerome often painted with reading aids

Venerated by Dominicans

The use of mirrors for reading continued into the sixteenth century,

Also used by artists (David Hockney and Charles Falco)

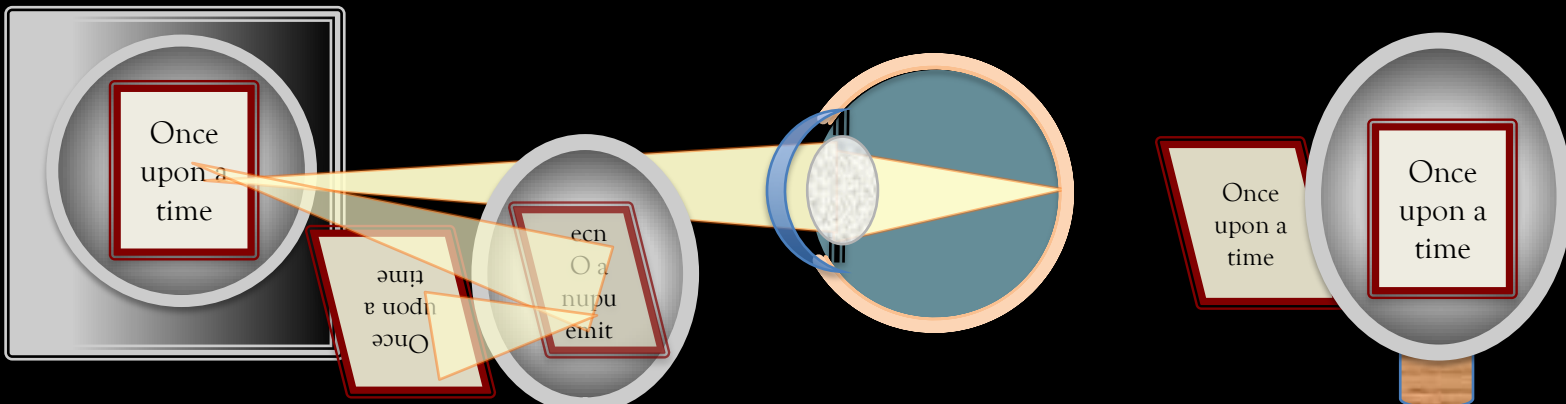
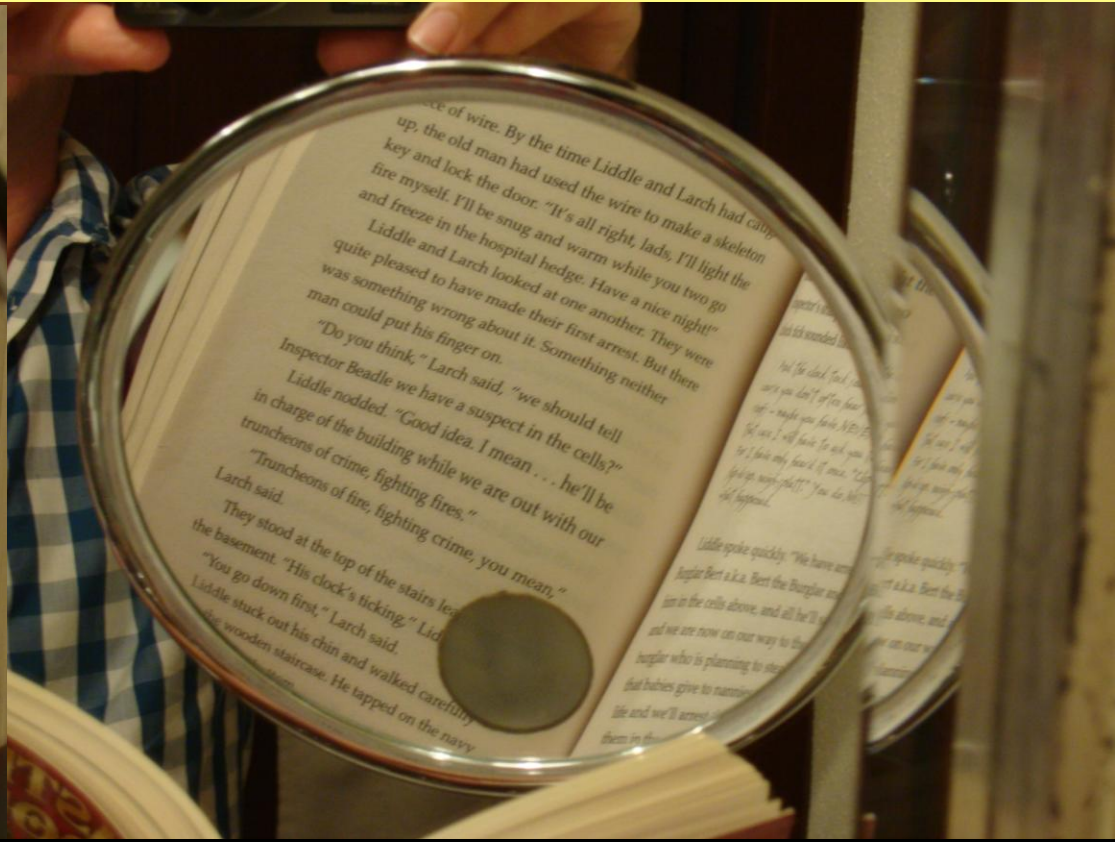
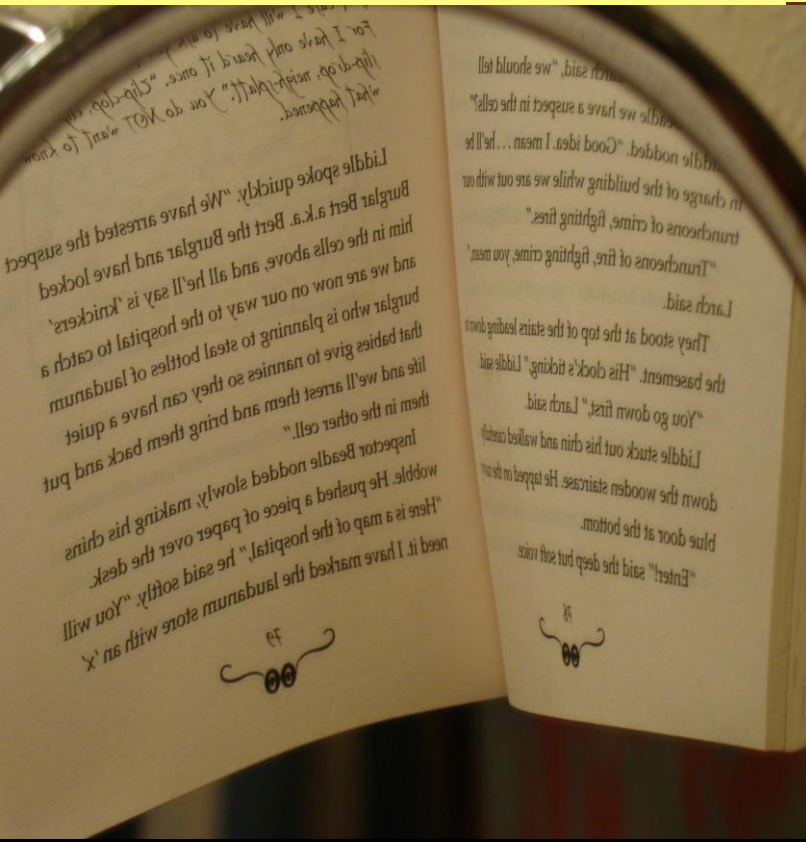
In 1549 Lorenzo Lotto paid the enormous sum of 22 Venetian lira for a 'big crystal mirror' ordered from Venice to replace a broken one while he was working in Acona

Giambattista della Porta: *Magia naturalis* 1589

Describes using a concave mirror with a plane mirror to magnify print.



Inverted image in concave mirrors



First depiction of spectacles

Friar Ugone de Provenza (Cardinal Hugh of Provence first Cardinal of the order). famous theologian, who also wrote a Commentary on the Bible

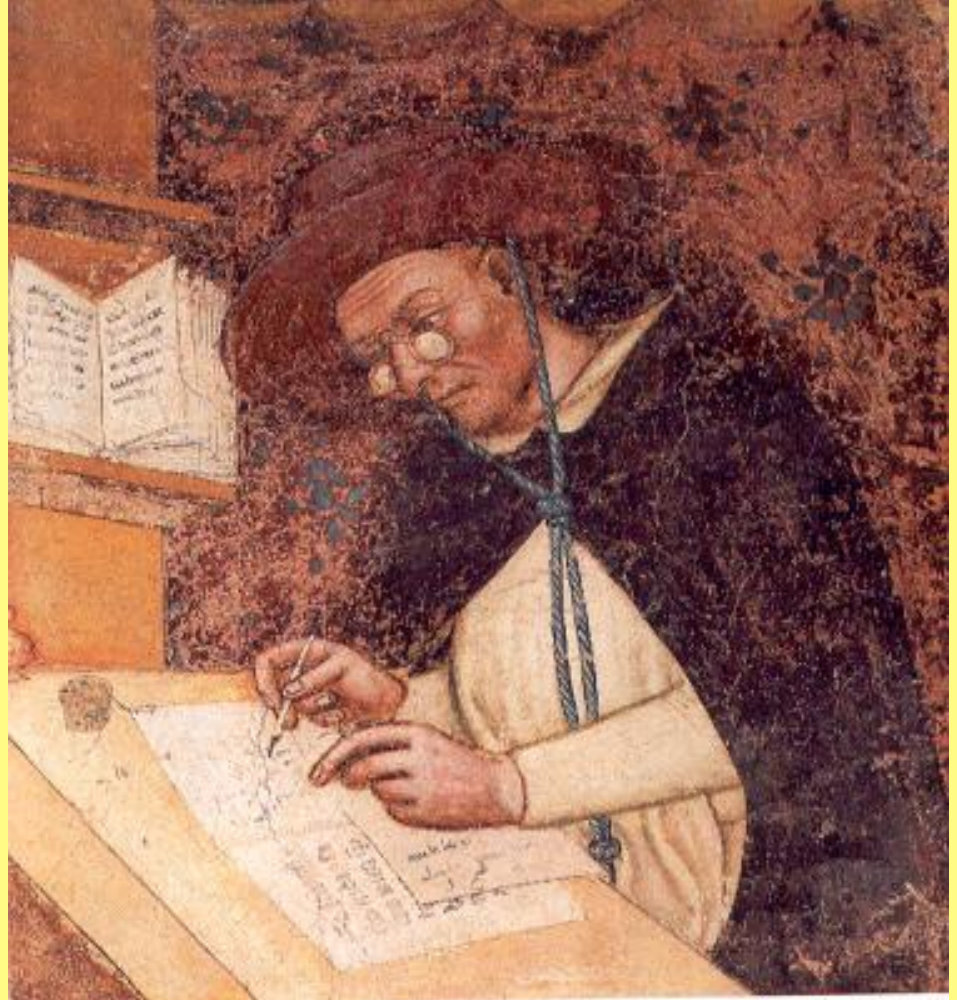
These rivet spectacles are the first pictorial representation of spectacles. Painted after 3 generations of use.

Hugh never wore specs; he died 20 years before they were invented:

Tomaso thought a man of his age would have needed them.

A possible earlier image of spectacles is a bird-dragon in the margin of a Ghent psalter dated 1240-1270, shown wearing spectacles. Not certain what date the image was inserted into the margins.

Daxecker F. Doc Ophth 9: 921-9 1999.



Type 1 rivet spectacles: 2mm thick boxwood grooved rims with slit for lens insertion, then secured with string. Straight shafts: two magnifying glasses riveted together.

Earliest depiction of glasses in Florence

The All-Saints Church (*Chiesa di Ognissanti*) Franciscan church in Florence.

1251: F. By scary fanatical lay order, the Umiliati, who had come from Lombardy in 1231; descendants of noble POW in Germany
Dedicated to all the saints and martyrs, known and unknown.

Completed 1250s, the order suppressed by Pius V, church taken over by Franciscans rebuilt in Baroque by Bartolomeo Pettirossi, 1627

C15th frescoes in nave chapels, by Ghirlandaio & Botticelli, (buried in the church)

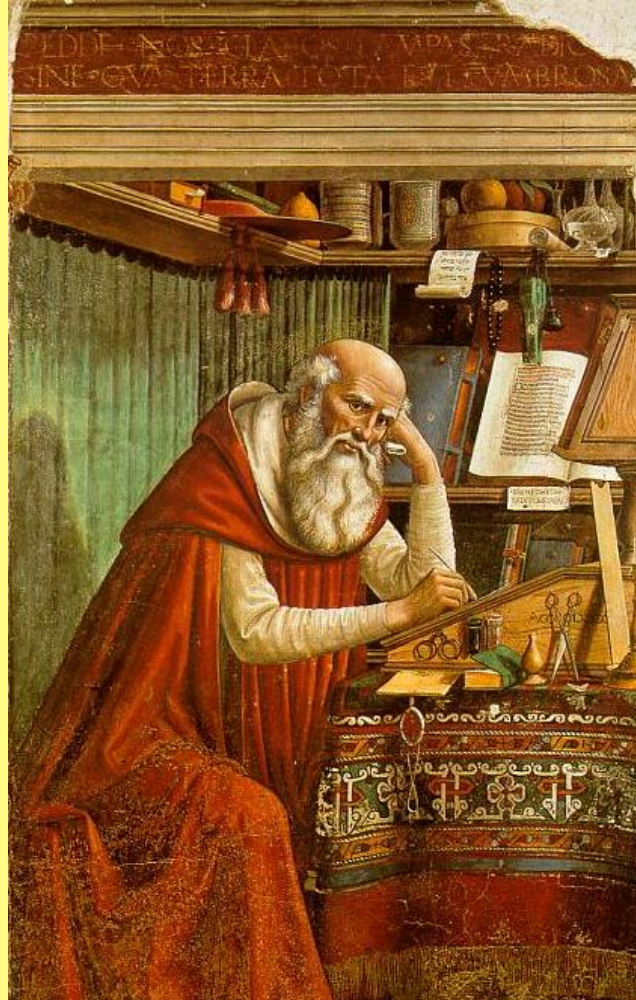
St. Jerome (340 – 420 A.D.) first person to translate the bible into Latin, detached fresco in Uffizi

1480: Specs a symbol of scholarship.

Patron saint of scholars and French spectacle-makers.

1982, in the ancient well of Via de' Castellani near Piazza della Signoria

A thin pair of bone specs c1450



Sant'Agostino Fresco by Sandro Botticelli



Type 2 rivet spectacles:
curving shaft; tighter grip on nose support from nasal bridge means less strain on the weakest part of the frame, the rivet.
Less ornamented than type 1

Der 'Brillenapostel' Conrad von Soest 1403

The 'Spectacled Apostle' in the *Day of Pentecost* altarpiece of the church of Bad Wildungen (Germany).

Oldest depiction of eyeglasses north of the Alps.

Type 3 rivet spectacles: flatter shafts that resemble a modern bridge. Lenses inserted between two bevelled layers of Limewood (the woodcarver's choice; light, little grain) glued together. This technology had only recently been introduced to the cabinet-making trade



Weinhausen spectacles

The Convent of Wienhausen f. between 1221 and 1228 by Duchess Agnes of Landsburg (d. 1248), widow of Henry (Heinrich), Count Palatine of the Rhine, and the elder son of Henry the Lion, Duke of Saxony

1310 to 1330: Rebuilt in the North German style: Red brickwork Gothic gables by the widow resident Princess Mechtild

1953 floor planks lifted from the choir stalls. Devotional images, hand held looms, thimbles, amulets, spindles, pilgrim badges, knives, brushes, slate pencils, wax boards, and 2 pairs and parts of C14th specs.

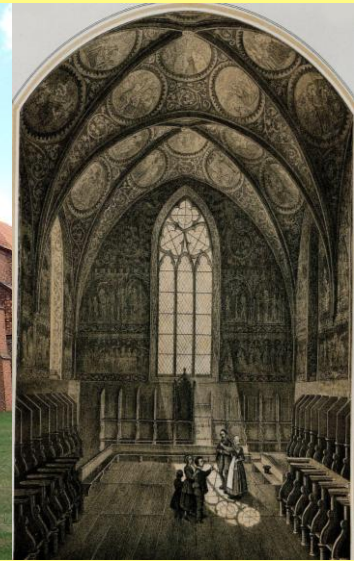
2 complete rivet spectacles of wood, and # of 9 others. The frames are Mediterranean boxwood.

Four later style leather spectacles, late 15th/early 16thC

Leather belt pouches, also discovered.

The lenses (30 – 34 mm) planoconvex +3 to 3.5D.

The institution was becoming stricter perhaps these items were being purposely hidden.



Northern European Rivet spectacles

The Luneburg city museum a dark tinted lens still in an eyeglass frame, found in the Michaeliskloster Where Bach was a choirboy). C15th

Also casket 1330 with spectacle lenses.

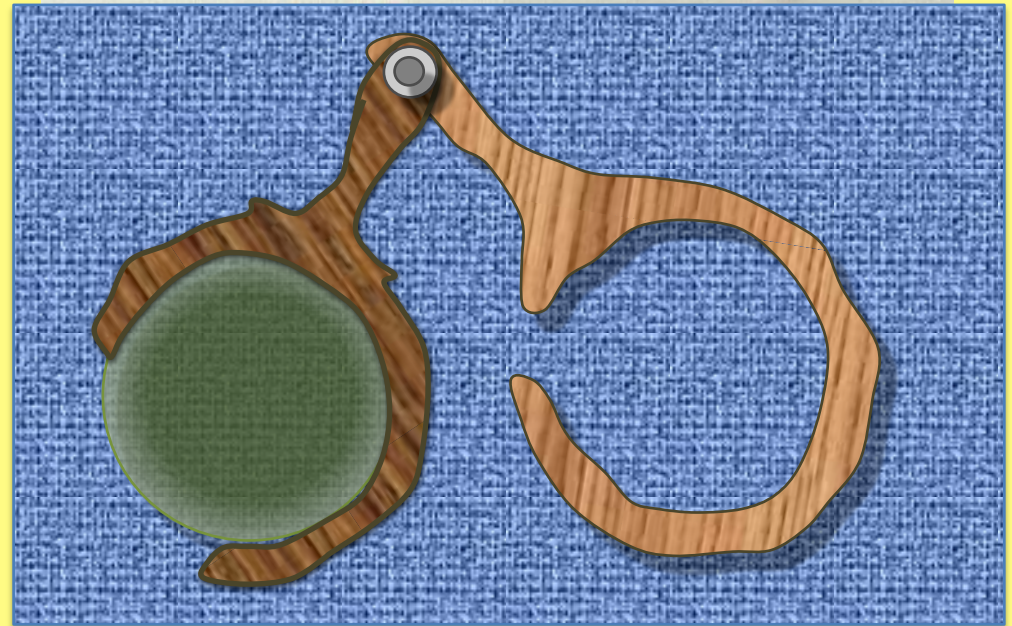
Many Dutch and German finds

Bergen Op Zoom: found 2000. mid 15thC. Bone

27 sites where examples of rivet spectacles have been found.

See David Fleishman

www.antiquespectacles.com



Oldest spectacles of known date

Trigg Lane; Blackfriars. Generations of carpenters shored up walls of river. Replacing river bank and filling in space with domestic refuse.

1440 ended with building of stone wall. Archeologists find rivet spectacles in the 300m³ of refuse. Therefore must predate 1440.

Made from Bone (Bull metacarpal). Improvement over wood frames. Stronger and light (frames 50g)

One of the copper wires securing the lens has survived.

Swan steps: ?Antler, Merton Priory, Syon Abbey (pic), Battle Abbey, Chester Friary, Hailes Abbey, Wicken Church Northants, Melrose Abbey.

Michael Rhodes: Antiquity 1980.

M Carlin Medieval Southwark 1996



Early records of English spectacles

1326: Bishop Walter de Stapeldon (cofounder of Exeter College Oxford) inventory *unum spectaculum cum duplici oculo precii ijs* (2s). Also a mirror *speculum precii jd*.

Carpenter 3s12d/day

Customs records 1384 and 1390-91 survive (Harding, MacGregor, Jenks)

1384: 8 gross 1,152 pairs imported between Jul 1 and Sept 29.

1390 May-Jun 764

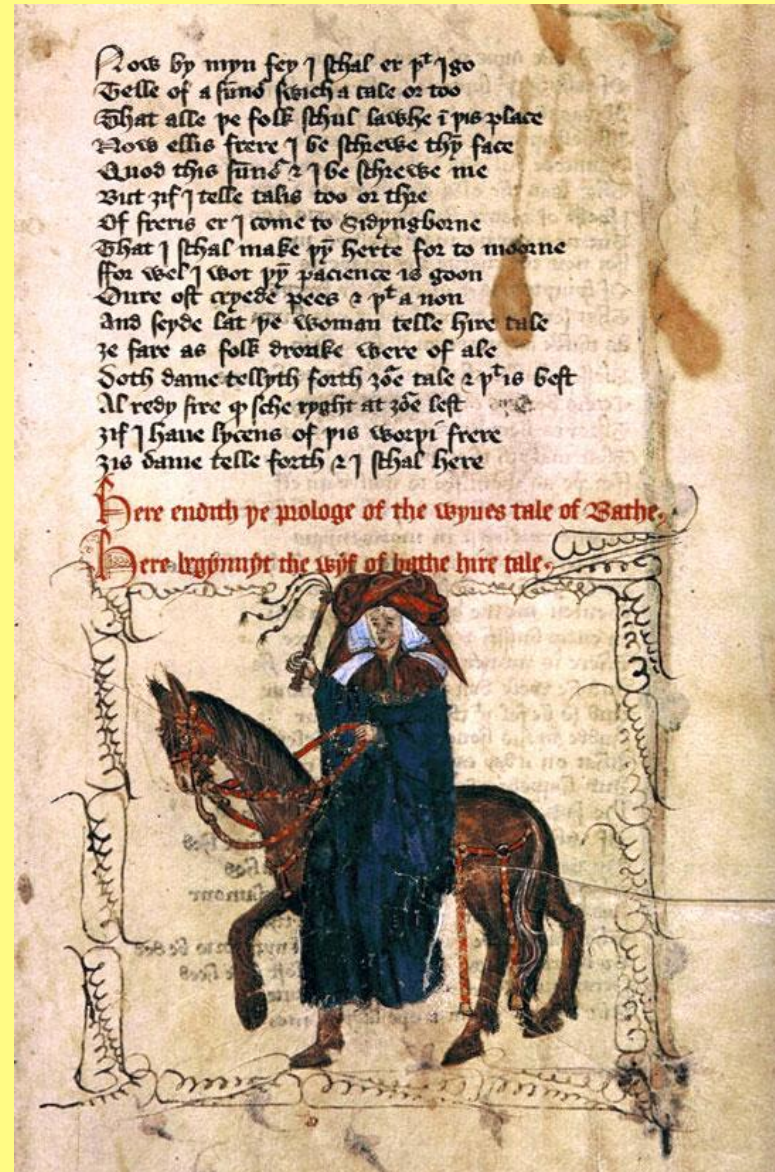
1391 April-May 4,104.

4th May 1390: Wm Canston 4 dosenis spectacles 2s2d.

Chaucer 1390: The crone in the wife of Bath's, Tale

Poverty a spectacle is, as thynketh me
Thurgh which he may his verray (true)
freends se

I think poverty is a pair of spectacles thru which we see our true friends. (A friend in need...)



Early spectacle manufacture in England

Spectacle-making: not cited in the list of trades pursued in London as recorded by the Brewers' Company in 1422

Customs records show spectacles imported into London on vast scale. Often by Dutch Merchants.

July-Sept 1384: 1,151 pairs imported

Satirical 15thC poem; London Lyckpenny, urged by Flemish pedlars at the door of Westminster Hall to try on

“fyne felt hatts, or spectacles for to reede”

Dutch immigrants made spectacles locally, **Paul van (de) Bessen of Suthwerk** (active 1458-9) the first recorded spectacle maker

Spyke Dowd 1485: First English spectacle maker.

Nun wearing rivet spectacles

Cast of corbel from North Aisle of St. Martins church Salisbury c1430 possibly earlier. Note depiction of pupil:

Watercolour by Turner



Sforza glasses

Francesco Sforza:

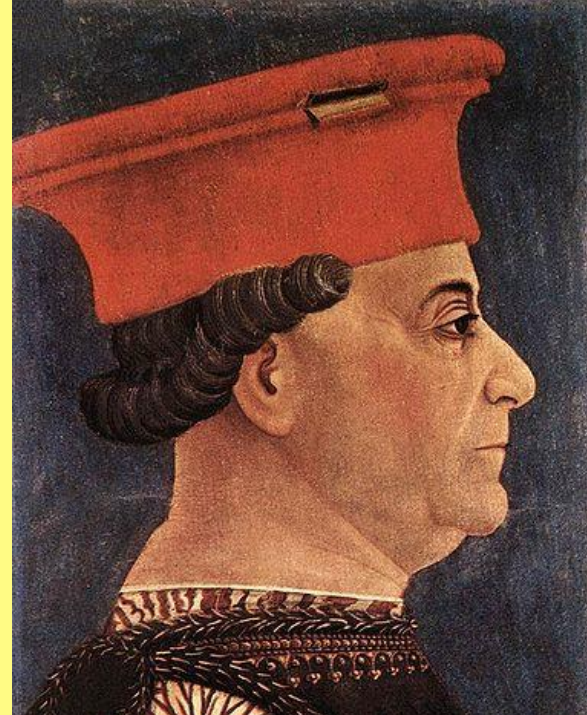
Illegitimate son of condottiero Muzio Sforza. Fights with his father, famous for being able to bend metal bars.

Marries Polissena Ruffo 1416 Countess of Montalto; their infant daughter dies and she is poisoned by one of her relatives, 1420.

Visconti line dies out and eventually, after rioting and famine; Francesco made Duke of Milan by city senate 1450.

Rules wisely and well. Fathers between 22-120 illegitimate children.

Because there are many who request of us eyeglasses that are made there in Florence, since it is reputed that they are made more perfectly than in any other place in Italy, we wish and charge you to send us three dozens of the aforesaid eyeglasses placed in cases so that they will not break; that is to say, one dozen of those apt and suitable for distant vision, that is for the young; another [dozen] that are suitable for near vision, that is for the elderly; and the third [dozen] for normal vision. We inform you that we do not want them for our use because, thank God, we do not need them, but we want them in order to please this one or that one who asks us for them. Send them by the post of our couriers directing them to our secretary Giovanni Simonetta. Inform us of their cost so that we can send you the money. Given in Milan, 21 October



Portrait of Francesco Sforza (c. 1460) by Bonifacio Bembo. In his worn dirty old campaigning hat. Pinacoteca di Brera, Milan.



Letter dated October 21, 1462 sent by Duke Francesco Sforza of Milan to his resident ambassador in Florence, Nicodemo Tranchedini da Pontremoli

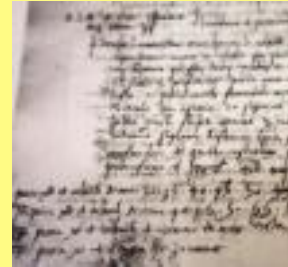
Galeazzo Maria Sforza (1444 – Dec 26, 1476).

Order for 200 pairs of glasses

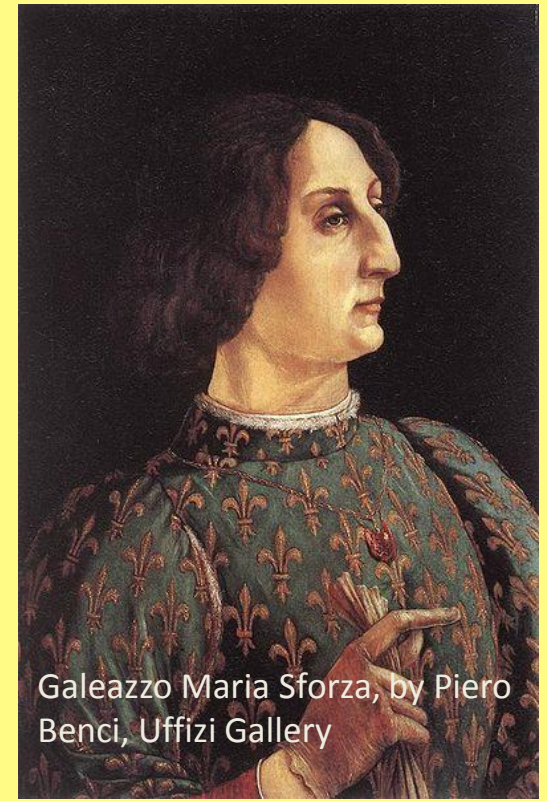
Duke of Milan 1466. Famous for being cruel and tyrannical. Assassinated in basilica of Santo Stefano Maggiore (where Caravaggio was to be christened). Culprits hunted down and executed, one Olgiati cried under torture, "**Mora acerba, fama perpetua, stabit vetus memoria facti**" (Death is bitter, but glory is eternal, the memory of my deed will endure).

Because we earnestly desire to have the eyeglasses as noted in the list here enclosed, we desire that upon receipt of this letter you should endeavor to acquire them perfectly made according to the ages specified in the aforesaid list. Send them in a box, well arranged and separated with attached labels for each category, so that when we receive them we shall be able to distinguish one category from the other. Inform us of their cost so that we can make provision for the payment. Milan, 13 June 1466.

*XV pairs of eyeglasses for ages 30, 35, 40, 45, 50, (55 crossed out), thin Item, XV pairs of eyeglasses for ages 40, 45, 50, 55, 60, 65, 70. Item, X pairs of eyeglasses for medium vision for the young **Item, X pairs for distant [vision] for the young.***



Some interpret this as meaning myopia



Galeazzo Maria Sforza, by Piero Benci, Uffizi Gallery



Sforza Hours

Book of Hours: collection of Christian prayers for recitation at different times, 'hours', of the day. Simplified versions of the eight periods of daily prayer observed by monks and nuns, from matins in the morning to compline at night. For individual use at home, Popular, appeal for women, emphasis on prayers to the Virgin Mary.

The Sforza Hours decorations were painted in two episodes, the first undertaken around 1490 for Bona of Savoy, widow of murdered Galeazzo Sforza.

Giovan Pietro Birago: court painter at Milan completed only part of the book but the rest was stolen.

The last of his full-page miniatures appears in the Office of the Dead. The Virgin, awaits death. St Peter, administers the last rites. He wears glasses to read from the prayer book as he sprinkles holy water. The kneeling apostle also uses glasses to read..

1517 and 1520, Bona's heir Margaret of Austria, Regent of the Netherlands, commissioned her own painter, Gerard Horenbout for 16 additional miniatures.



Myopia

Agnolo Bronzino

Pope Leo X 1555-65

Oil on tin, Galleria degli Uffizi,
Florence

Second son of Lorenzo di Medici
(1475 – 1521)

Pope from 1513 to his death in 1521.
He was the last non-priest to be
elected

Time of Luther and turmoil.
Controversy over selling indulgencies
to fund rebuilding St. Peters.



Myopia

concave lenses for the nearsighted.

Pope Leo X, who was very shortsighted, ~-10D; wore concave spectacles when hunting and claimed they enabled him to see better than his companions.

Biconcave lens with handle 60x180mm:
Istituto e Museo di storia delle Scienza

Traditionally thought to be owned by Leo X.
However perfect glass not made at that time.
Modern analysis reveals it is rock crystal.



Once he became Pope, Leo dispensed with his glasses in public. Caused some amusement

“His holiness is in good health and does not wear spectacles because he sees with the assistance of the Cardinal of Aragon and of Divine Providence”

Mario Equicola.



RAFFAELLO Sanzio

Pope Leo X with Cardinals Giulio de' Medici and Luigi de' Rossi 1518-19: Uffizi, Florence

The Death of the Virgin. Master of Heiligenkreuz, ca. 1400-3

Refined style beautiful gold punchwork and figures with long fingers show influence of the courts of Paris and Prague.

Christ's disciples surround the Virgin's deathbed. St. Peter, wearing the papal tiara, administers last rites.

The angelic orchestra punched into the gold ground, welcomes the Virgin's soul, shown as a child in God's arms.

Originally one of a pair, the other St. Clare (1194-1253), the companion of St. Francis of Assisi is in the National Gallery of Art, Washington.

Both panels depict the deathbeds of women, so may have been used for funeral ceremonies in a convent.



St Peter and St Paul. 1490

Tempera on wood, Gallerie dell'Accademia,
Venice

Crivelli

Italian painter, Venetian school (b. 1430/35,
Venezia, d. 1495, Camerino, March

Eventful life: 1457 imprisoned in Venice for
adultery; left soon after, never returning, but
still signed as 'Carlo Crivelli of Venice';

1465 citizen of Zara in Dalmatia;

1468 in the Marches, at Ascoli Piceno.

1490, he was knighted (an unusual honour for
a painter) by Ferdinand II of Naples.

All of his surviving paintings are religious
and in a distinctive, archaic, style, altarpieces
still employ gold backgrounds and raised
gilded gesso for haloes.



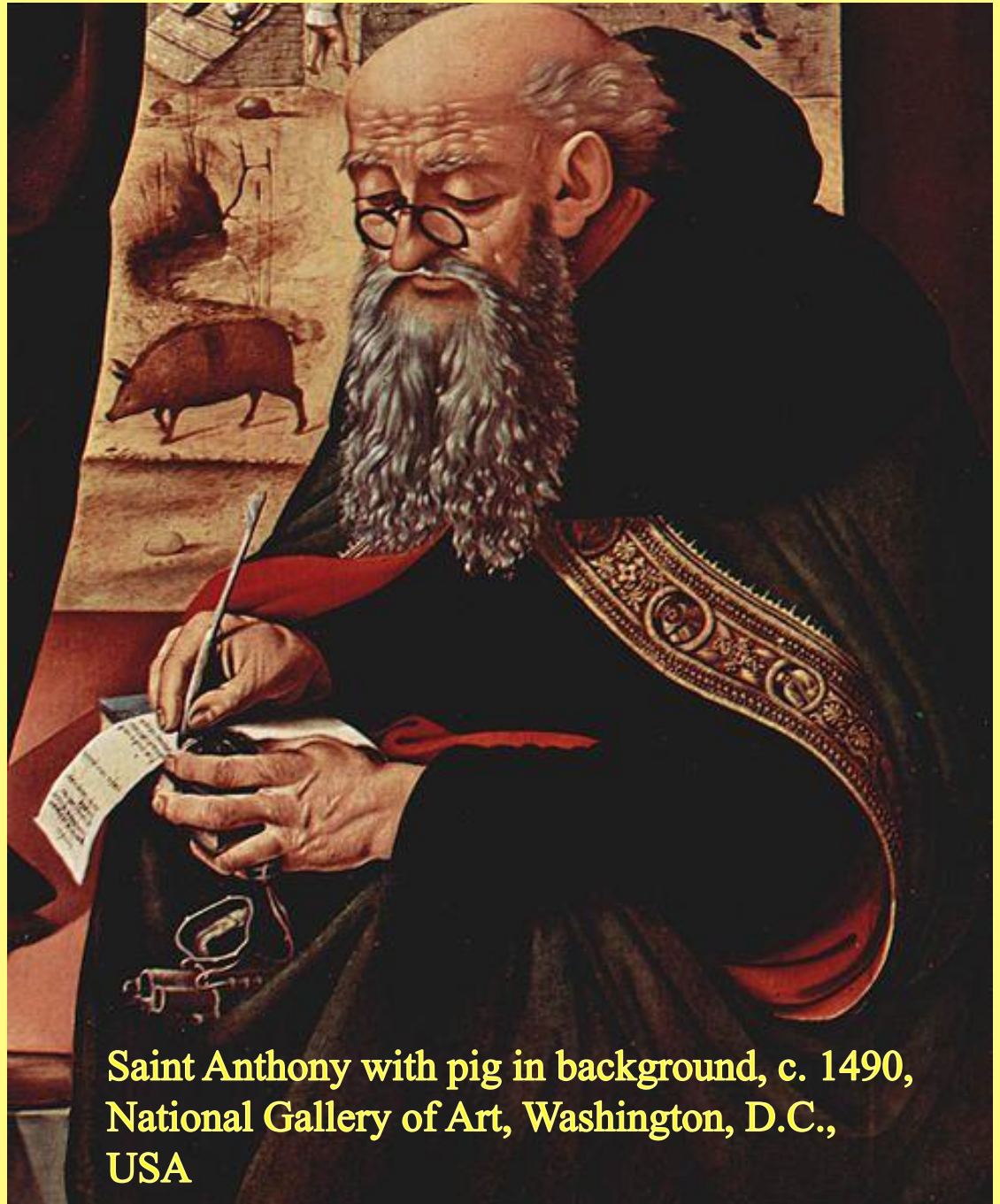
The visitation with St. Nicholas and St. Anthony.

Piero di Cosimo (Lorenzo) (1462-1521)

Nat gallery Washington

b. Florence, son of a goldsmith. Apprenticed under the artist Cosimo Rosselli, whom he assisted in the painting of the Sistine Chapel in 1481, deriving his popular name. Frightened of thunderstorms, and fire, rarely cooked food; living mainly on hard-boiled eggs, prepared 50 at a time whilst making glue.

He resisted any cleaning of his studio, or pruning of his orchard; he lived "more like a beast than a man", Vasari



Saint Anthony with pig in background, c. 1490, National Gallery of Art, Washington, D.C., USA

Jan Van Eyck

La Madone au Chanoine Van der Paele (1434)



Coloured spectacles

Lübeck Marienkirche: 1250-1350: 125' brick vaults

Antwerpener Altar (Antwerp Altar) (1518).

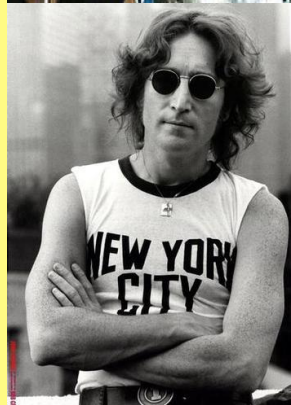
Death of the virgin

Johannes Ockeghem: c1420-1497:

Contrapuntist, pupil of Gilles Binchois and Guillaume Dufay. One of the fathers of Renaissance music. As a singer, he served Charles, Duke of Bourbon, from 1446 to 1448. 1453 chief chanter at the Court of Charles VII of France. Virtuoso tour de force **Missa cuiusvis toni.**

medieval music was not organized as modern musical “keys”; It used 8 musical “modes“, and 4 added “finales”, protus, deuterus, tritus, and tetrardus. Each finale produced a musical scale, or “tone”.

Missa cuiusvis toni is remarkable; it can be sung cuiusvis toni =in any of the tones. Notated once, but can be read in four different ways



Widespread dissemination of spectacles

Spectacles were cheap 2 or 3 soldi (shillings). Middle range 6 to 18 soldi.

Most expensive high quality crystal/glass lenses and gold or silver frames 1 ducat (~82 soldi).

A mason in 15thC Florence paid 17 soldi a day

So no longer only the preserve of clergy, the wealthy, and intellectuals, but instead were extensively used by artisans as well.

Average labourer \$120/d Lenscrafter custom ground reading specs \$155 so optics cheaper 500 yrs ago than today! (C. Falco)



Jan Sanders van Hemessen (c. 1500 – c. 1566

The Surgeon, 1555 Prado

First printed image of spectacles

Rudimentum Novitiorum by Lucas Brandis, printed in Lübeck, Germany, in 1475.

Comprehensive history of the world derived from the Bible, Church Fathers, mythology and previous compilations.

Provided primer of history for training clerics.

Genealogical charts, portraits and scenes, including the first printed map of the world.

The philosopher shown wearing spectacles viewed from the side could be Philo, Empedocles, Seneca, or Pythagoras

(Letocha and Dreyfus *Arch Ophthalmol.* 2002;120:1577-1580.



Liber Chronicarum 1493

Latin History of the world
published by Hartmann Schedel
Nurenborg.

Block print shows generic
philosopher/wise man. Here
labelled as Rhazes.



Explosion of books and spectacles

1452, printing presses were invented, books became more readily available, increasing demand for spectacles.

Ship of Fools 1494 Sebastian Brant.

foolish scholar, surrounded by too many books, uses a feather duster to turn pages faster than he can read them. Oversized spectacles emphasise satire.

Widespread use of eyeglasses made it possible to start reducing the size of books.

More words could be squeezed on a page

The cost of books dropped, sales rose.

Demand for even more spectacles.



Der Brillenmacher 1568

H. Schopper Panopia 1568

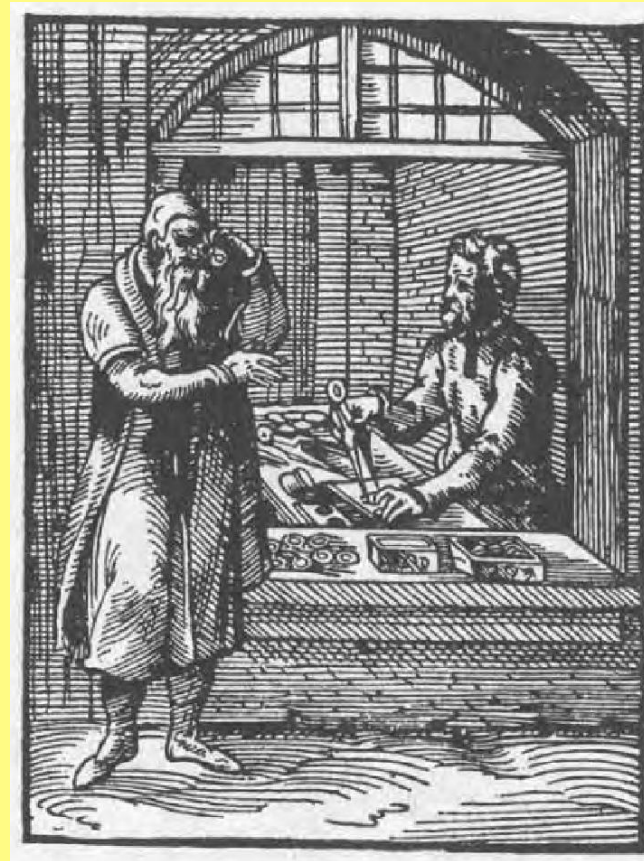
There were several stages in producing lenses.

A pair of templates made of iron.

The glass blank was cemented to the top of the convex tool. This was placed on a pole. The operator worked the concave tool in bold strokes by swinging the whole body, trying to cover the whole surface in every direction and at all angles. An abrasive material such as emery and water was used to grind the glass until the surface smooth.

For polishing, the tool was covered with a heavy woollen cloth without its nap and with its pores filled with calcined tin (putty powder).

L'occhiale allocchio CA Manzini: Bologna 1660



C17th

Bow spectacles: curving bridges. Minor modifications increased flexibility and comfort for wearers. Multiple slits in the bridge requiring expert craftsmanship to produce.

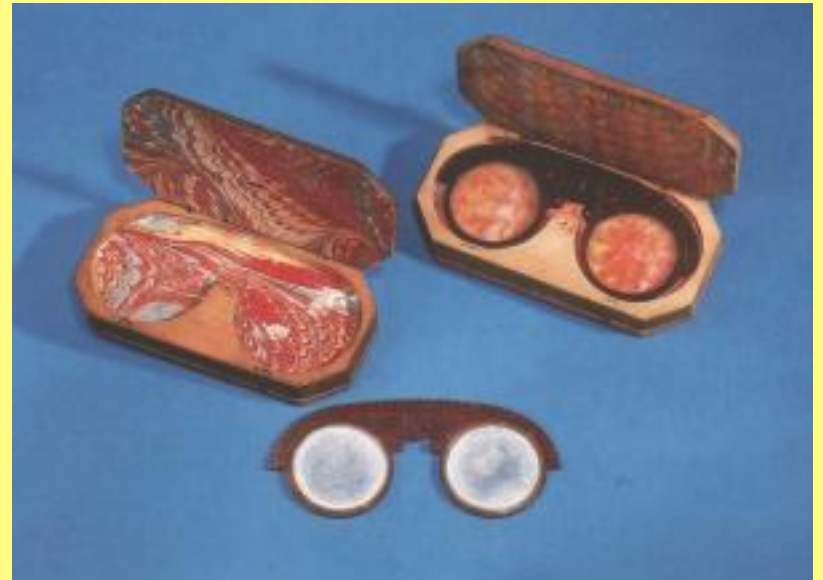
The sprung steel bridge was introduced about 1690 however the rims were horn or whalebone.

The highest quality frames were made in German centres such as Nuremberg and Regensburg and optical goods from these centres would sometimes be imported to England.

Nuremberg 'Masterpiece' frames made by qualifying apprentices. extremely rare;

BOA Museum: Melchior Schelke Masterpiece of 1663, buffalo horn with a filigree pattern of hearts and clover leaves.

Regensburg Masterpiece frames also produced though none are known to have survived.

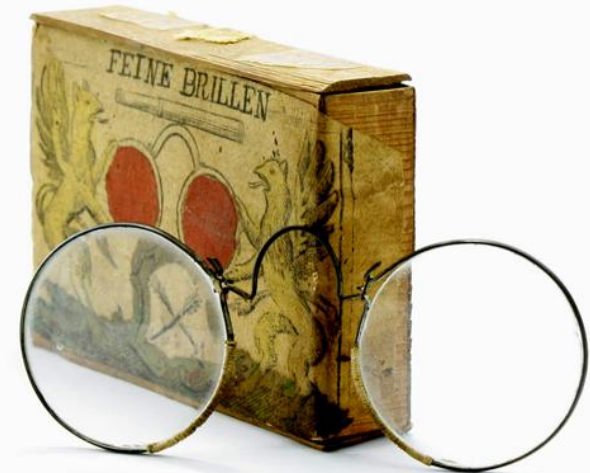


Nuremberg

The German craft was regulated earlier than in England, the Nuremberg Spectacle Makers Guild issuing a regulatory code in the previous century, as early as the 1530s.

The Nuremberg-type one-piece spectacles very common and persisted into the eighteenth century. Dating individual examples is almost impossible without additional contextual evidence.

Many came to America with Hessian Troops and were confiscated when soldiers were captured.



17th century

Fortune teller reading a soldier's palm 1640 Pietro della Vecchia.

Man sharpening quill. After Gerrit Dou 1613-1675.

His student Gottfried Schalken 1643-1706. Visited England but considered uncouth.

Man by candlelight.

The Misers:

Style of David Rychaert III 1612-1661

Nuremberg style of nose spectacles made from a single piece of copper wire.



Samuel Pepys (1633-1703)

1666: He thinks the soreness of his eyes is due to overwork by candlelight. He buys a pair of spectacles with green lenses from the 'great' spectacle maker John Turlington, Master of the Spectacle Makers Company.

BOA has a pair: 1600's

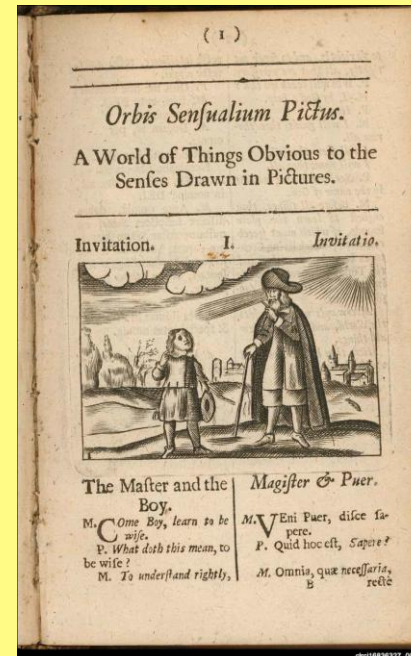
May 1667: *I did entertain myself with my perspective glass up and down the church, by which I had the great pleasure of seeing and gazing a great many very fine women; and what with that and sleeping, I passed away the time till sermon was done.*



Orbis Pictus Sensualium 1658

(The visible world) by Czech
Johann Amos Comenius.

First illustrated book for children.
Names were given in Latin and
the reader's native tongue, initially
German, translated into English in
1659.



Many commonplace objects in the
book. Including a mirror,
spectacles, a telescope, a
magnifying lens, and a burning
glass.



PLUYM, Karel van der
(b. 1625, Leiden, d. 1672)

**Old Man Holding a Pair of Spectacles-Oil on canvas,
The Hermitage, St. Petersburg**

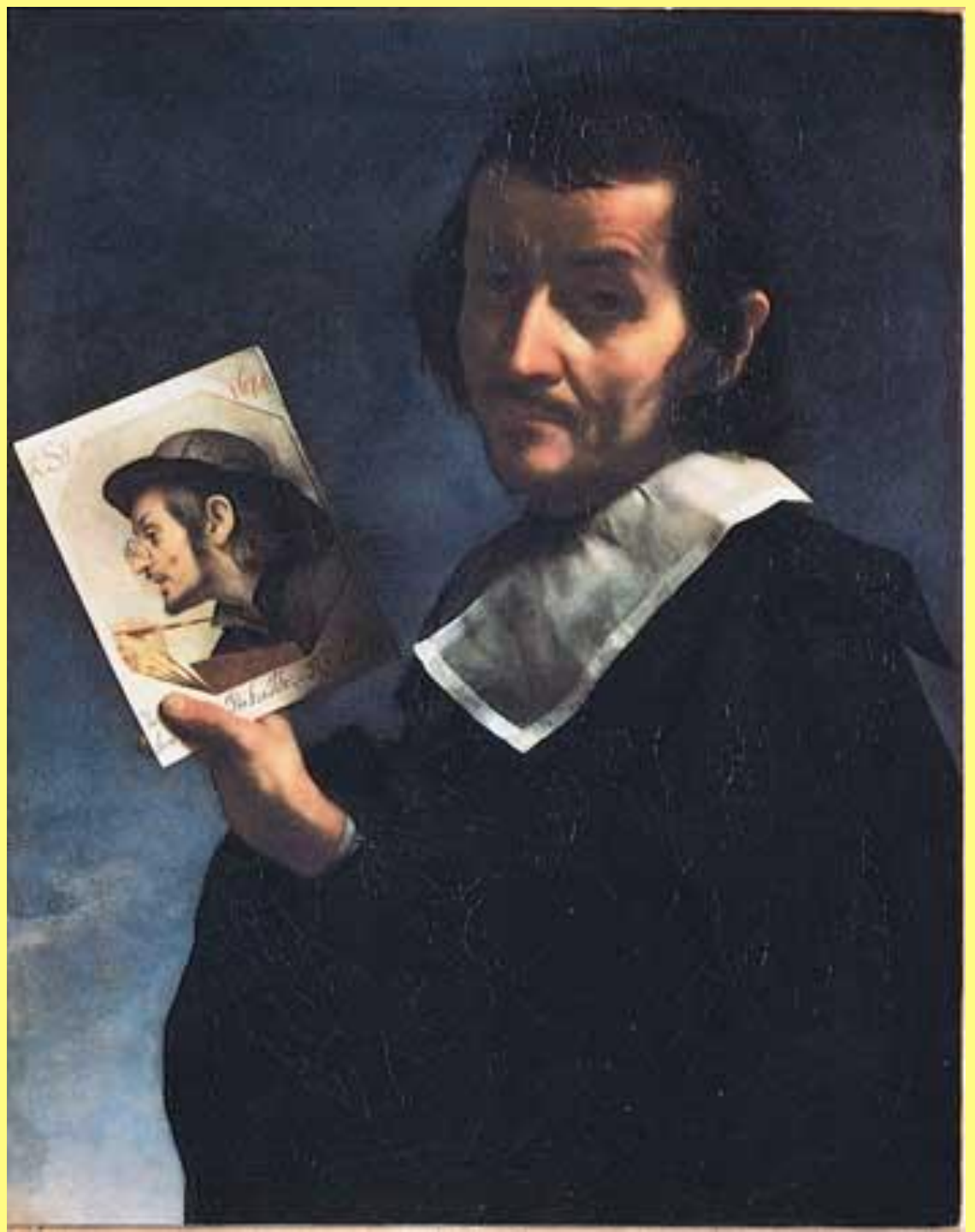
Best known as a second cousin
and pupil of Rembrandt.

1648 member of the newly
formed Leiden Guild of St Luke;
He also held other public offices
in Leiden, so only painted a few
works.



Carlo Dolci

1674: At Dulwich exhibition 2007



Spectacle Makers Guild

C17th London: most opticians members of Worshipful Company of Spectacle Makers, founded 1629. 13 of the founders were spectacle makers in the Brewers Guild.

quality control over trade and protect the interests.
minute of 1671:" ...two and twenty dozen of English spectacles, all very badd both in the glasse and frames not fitt to be put on sale... were seized and taken away by the Master and the Wardens ...condemned to be broken, defaced and spoyled both glasse and frame the which judgement was executed accordingly in Canning Street on the remaying parte of London Stone where the same were with a hammer broken all in pieces."

John Marshall (1659-1725) freeman of the Turners' Company and optician to George I. New method of grinding.

1693: Halley and Hooke asked to assess method: Approved by the Royal Society.

English spectacles became better than continental rivals.

London opticians proudly advertised their spectacles and instruments; made with lenses ground by the method approved of by the Royal Society.

Bryden BMJ 1994; 309 : 1713



Copy of Jacob Jordaens 1593-1678:
"As the old people sang the young piped"
parents must be mindful of their actions and words,
because children will copy their elders. Louvre



Quevedo (1580 – 1645)

Francisco de Quevedo y Villegas, R. Ximeno
Madrid, Instituto Valencia de Don Juan

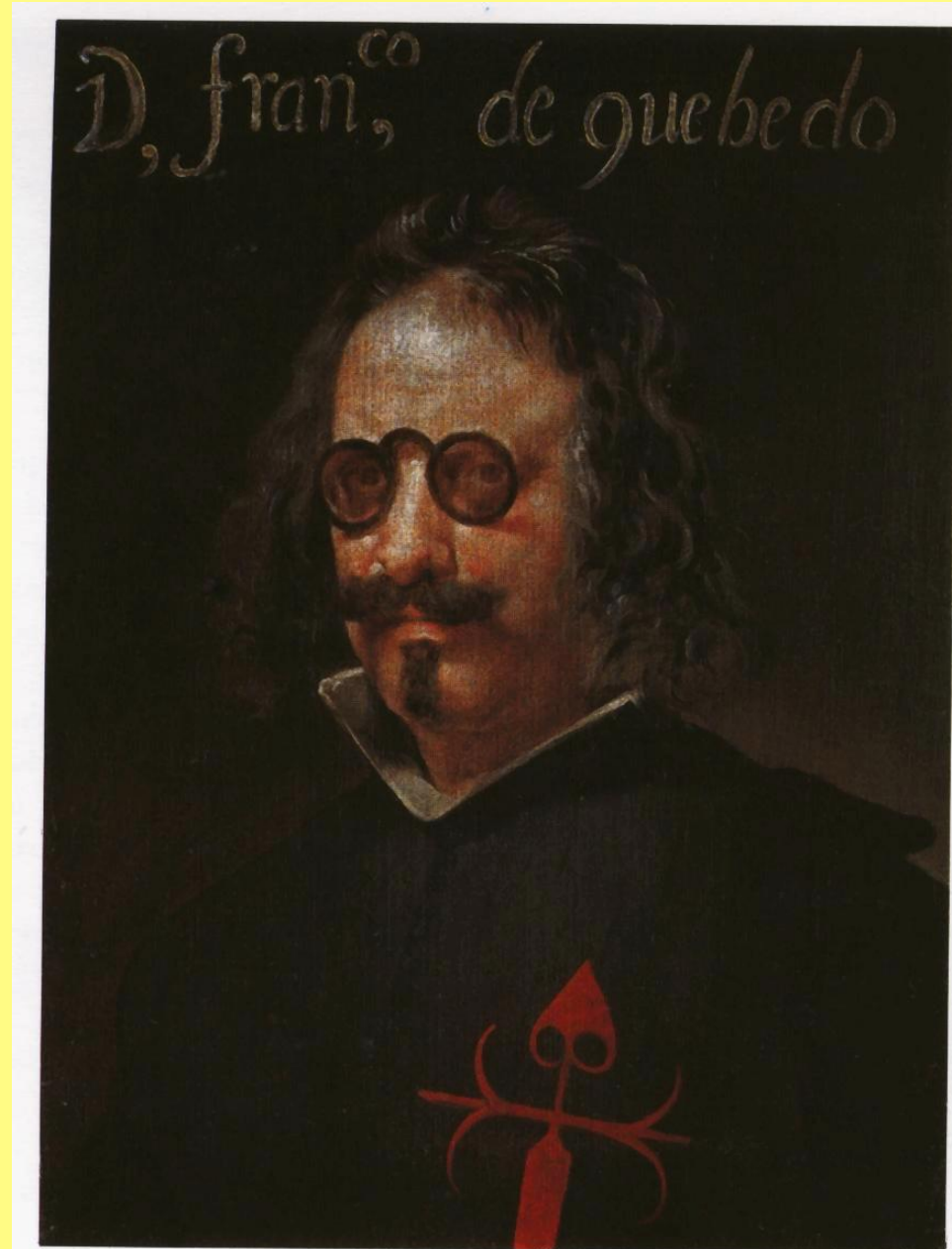
Nobleman, politician, poet and writer of the Baroque era. Poetic style characterized by *conceptismo*, rapid rhythm, simple vocabulary, witty wordplay rather than complicated vocabulary.

*Ayer se fue, mañana no ha llegado,
Hoy se está yendo sin parar un punto;
Soy un fue, y un seré y un es cansad*

Quevedo's father, Francisco Gómez de Quevedo, was secretary to Maria of Spain, daughter of emperor Charles V and wife of Maximilian II, Holy Roman Emperor.

His mother, lady-in-waiting to the queen.

Intellectually gifted, Quevedo was physically handicapped with a club foot, obesity, and myopia. Since he always wore pince-nez, his name in the plural, *quevedos*, came to mean "**pince-nez**" in the Spanish language.



18th century

Published in 1766 'The Vicar of Wakefield' was Oliver Goldsmith's only novel.

The Primroses lose their money and dispatch their teenage son Moses to a fair to sell the colt. He is deceived and returns with a groce of green spectacles with silver rims and shagreen cases: ~£3.5s.2d (5 1/2d each) expensive as

by 1773 German metal specs cost 1d wholesale.

1800: English specs 1s.6d to 3s pair.



The Gross of Green Spectacles, illustration from 'The Vicar of Wakefield' by Oliver Goldsmith

18thC

Emergence of the modern spectacle

1700s: daily newspapers.

Spectacle-makers produced wide range of spectacles in many materials: tortoiseshell, horn, whalebone (flexible and tough) and silver.

“Characters who frequented Button's Coffee House”.

1720, engraving: William Hogarth

Martin Folkes (holding nose spectacles) and Joseph Addison.

A parliamentary news sheet headed 'Votes of the Commons' lies on the table.



Design improvements

Edward Scarlett of Soho (1727)

Father and son: The old spectacle Shop at the sign of the Archimedes and Globe:

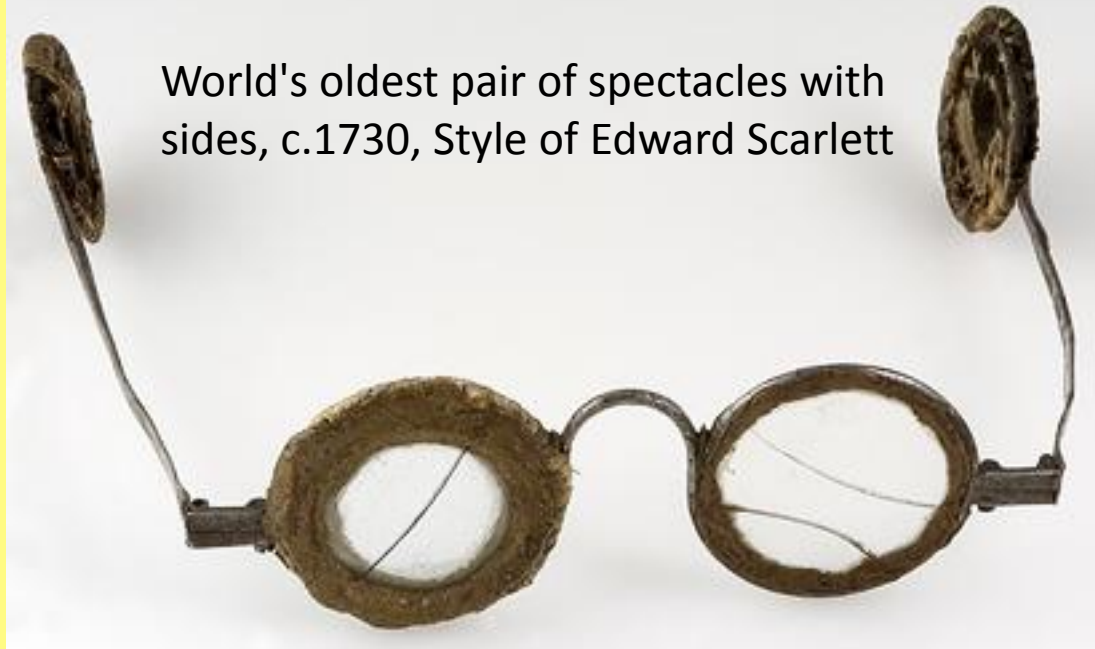
The most famous of the early makers, with his spectacles being marketed as having 'the Exactest way of fitting different Eyes'.

Spectacles purchased off-the-shelf or made-to-measure.

The prescription, dioptric strength, marked on the frames. Previously sold by recommended age for use.

He also introduced sides to spectacles

World's oldest pair of spectacles with sides, c.1730, Style of Edward Scarlett



Developments

James Ayscough, invented the double-hinged temple in 1752

Double folding temple spectacles with the large wig loops are the first improvement on Edward Scarlet's temples specs

“So contrived as to press neither upon the nose nor upon the temples”.

information@eyeglasseswarehouse.com



Turner

Pair of spectacles, the snuff box, magnifying glass and card case all from Maria Tanner who helped clean Turner's studio on Queen Anne Street in Chelsea. Maria Tanner was a friend of the painter's housekeeper, Hannah Danby, and the two women lived on together in Turner's house after his death

Made by Benz.

The case is later 19thC from the optician Stanley Pearce of Wardour Street

-2.5D

Another 2 pairs preserved by Ruskin, the artist's executor, presented to Ashmolean museum in Oxford.

Ashmolean pairs are plus three and plus four; ?used in later life for close work.



Turn pin temples

Turn-Pin temples: 1760-1880.

Another improvement over the short temple style of Edward Scarlett, had an extension on the end of the temple.

The extension was held in place by a rivet and was formed to fit the crown of the owner's head.

The proper position for the turn-pin extension was upward around the 1 o'clock position.

This type of spectacle was more stable than straight temples and sliding temples.

Brass turn-pin spectacles made by Benz of Germany This frame dates back to around 1775



Turn-pin spectacles in their original shagreen case. These eyeglasses date to the mid 1700's. They are made from coin silver and have many English Hallmarks.

Jean-Siméon Chardin
1699-1779

Self portrait with a visor

Pastel on blue laid paper mounted
on canvas 1776. Chicago

Suffered from eye problems
attributed to lead poisoning from
paints. In last decade moved from
still-life to pastel portraits



Pompeo Batoni 1708-1787

Don José Moñino y Redondo,
Conde de Floridablanca 1776

Lawyer and ambassador for Charles
III to Holy See 1772-6

Wears Order of Isabella the Catholic
Expensive gold glasses



Peter Dolland

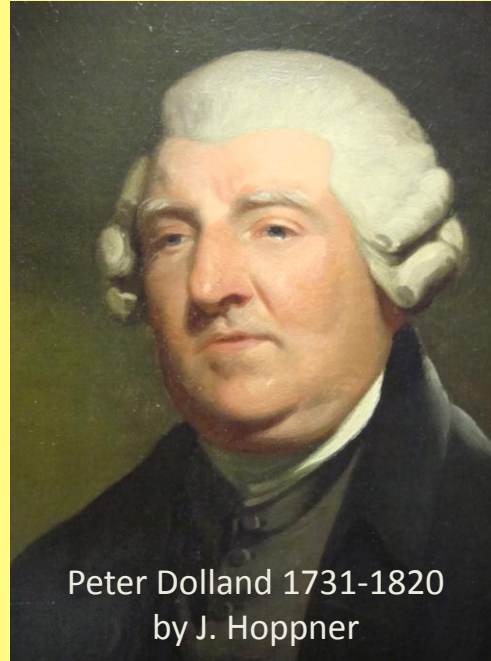
Optical business founded 1750. Invented triple achromatic lens. Premises in the Strand

Supplied spectacles to BF a famous thinker and scientist living nearby in Craven Street.

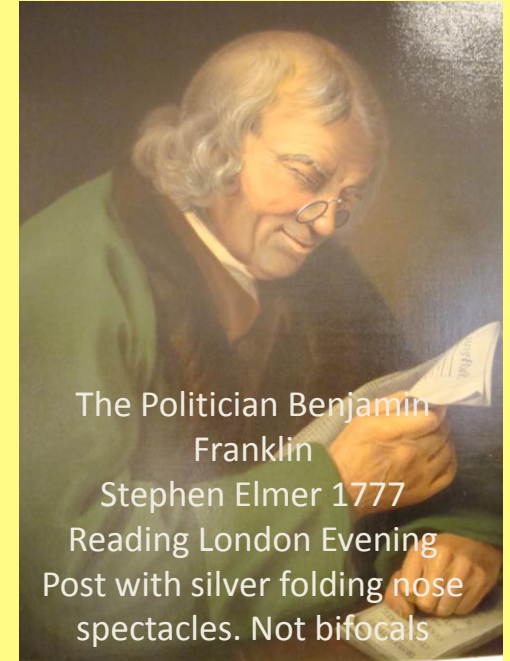
Spectacles now 5d to 2s.1d

1800 1s6d to 3s

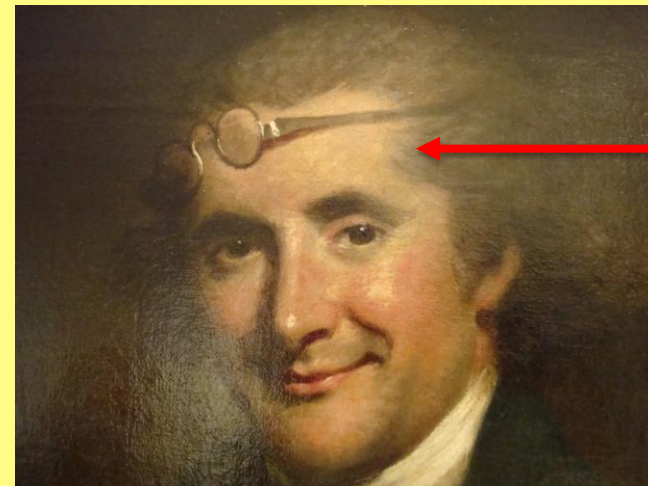
Inventory of Nathaniel Adams (Scarlett's apprentice) of Charing Cross in 1741: he died with 499 pairs of ready-made spectacles in stock, ranging from the cheapest horn frames at little more than a few pence, to silver ones at a shilling each.



Peter Dolland 1731-1820
by J. Hoppner



The Politician Benjamin Franklin
Stephen Elmer 1777
Reading London Evening Post with silver folding nose spectacles. Not bifocals



Thomas Hurst (Mandolin Player)
Benjamin Vandergucht 1782

Bifocals

Split bifocal spectacles c.1780s-1790s: formed of two pieces of glass divided horizontally.

1779: US ambassador to France, Franklin ordered a pair of spectacles from English optician, Sykes, Place du Palais-Royale. The price (18F). Delay due to breaking during cutting suggests an unusual bespoke order.

August 1784, letter to George Whatley, 'happy in the invention of double spectacles, which serving for distant objects as well as near ones, make my eyes as useful to me as ever they were'.

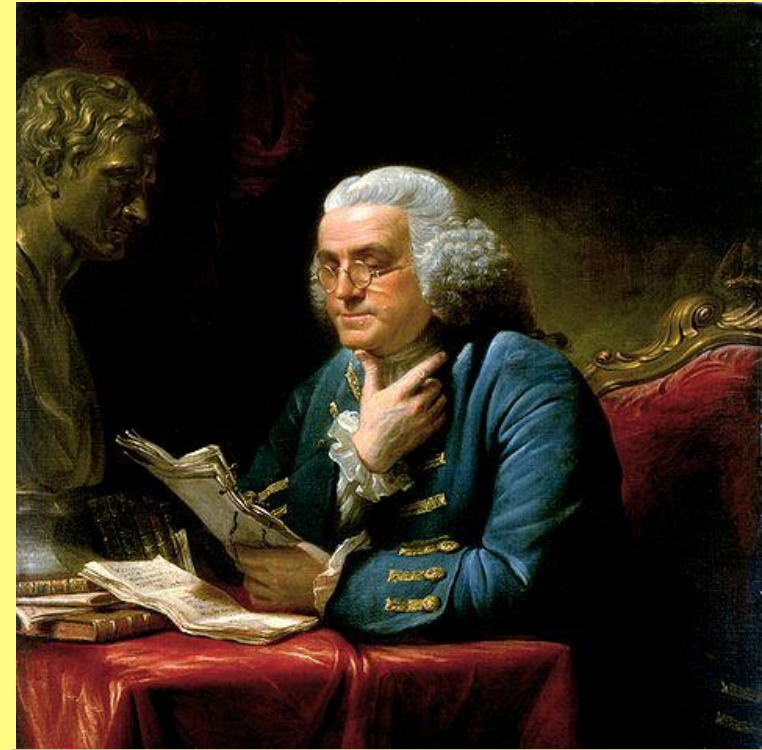
The Dollonds 59 St Pauls Church Yard, were producing bespoke spectacles of this, or a similar, type, but no commercial potential anticipated.

Whatley's letter July 22, 1785; "The Dollonds are obliged by what you have been at pains to say, and describe of your double spectacles. They fully comprehend it at the same time say, for such sight as yours are common. That therefore they only make for such as like yours when bespoke"

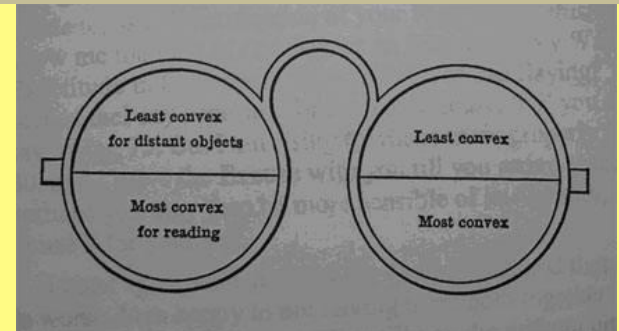
John Fenno, editor of Gazette letter to his wife 1789, describes meeting with Franklin 'He informed me that he had worn spectacles for 50 years". Since Franklin was long-sighted, requiring spectacles by 1730s he would have benefited from bifocals by the time he arrived in London in 1757.

Only portrait of Franklin in which he is depicted wearing bifocals is one by Charles Wilson Peale, dated 1785. Peale paints himself 17 years later in bifocals.

John Isaac Hawkins, engineer and inventor of the trifocal in 1826, coined the term bifocal in 1824 and credited Franklin with the invention of the bifocal.



Benjamin Franklin by Charles Wilson Peale: a late copy of 1767 portrait by Scot painter David Martin commissioned by Robert Alexander to mark a favourable review of his work by BF. American Philosophical Society (Philadelphia). Peale met Franklin in London 1767, while studying under West.



Martins Margins

Admiral Peter Rainier by Arthur Wm Devis
1805.

Commander in Chief of the East Indies fleet
Raised to admiral of the Blue in Trafalgar
celebration promotions.

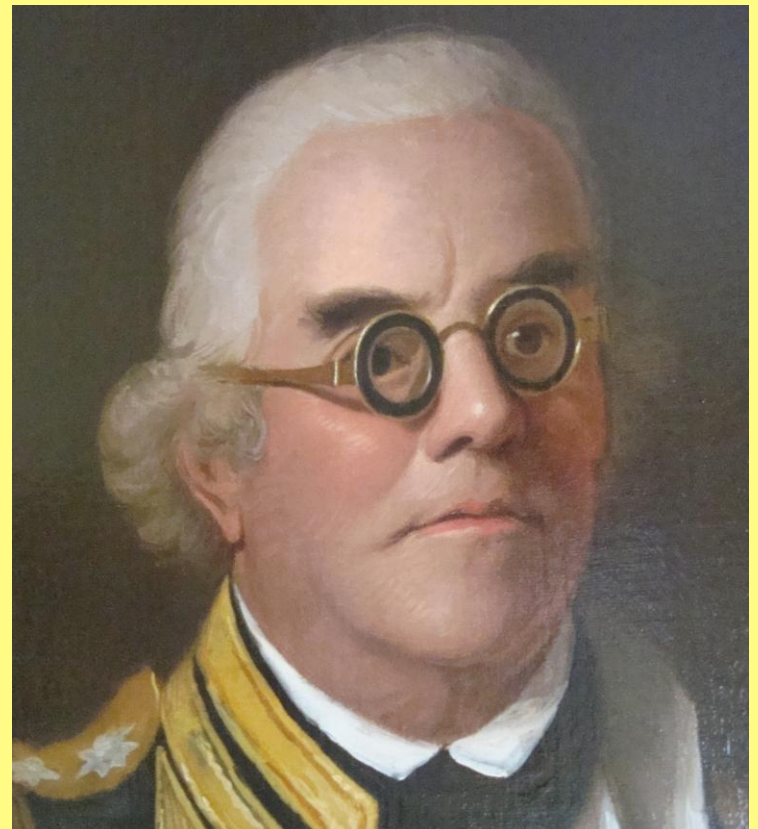
Gold specs with Martin's Margins

Benjamin Martin (1704-1782), a London
optician

1756: "Essay on Visual Glasses (Vulgarly
called Spectacles)" his theory was that the
common spectacle use was "prejudicial to the
eye" because the large lenses allowed too
much "light to enter the eye."

Martin made spectacles in which one third of
the lens opening was filled with the horn of
the Ox and in which the "lens tilted inwards so
that the axes of the eye converged on the
object of regard."

Most frames by Martin were made from steel



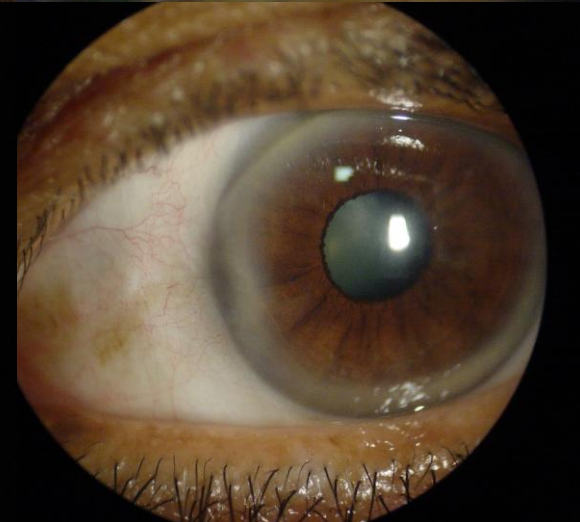
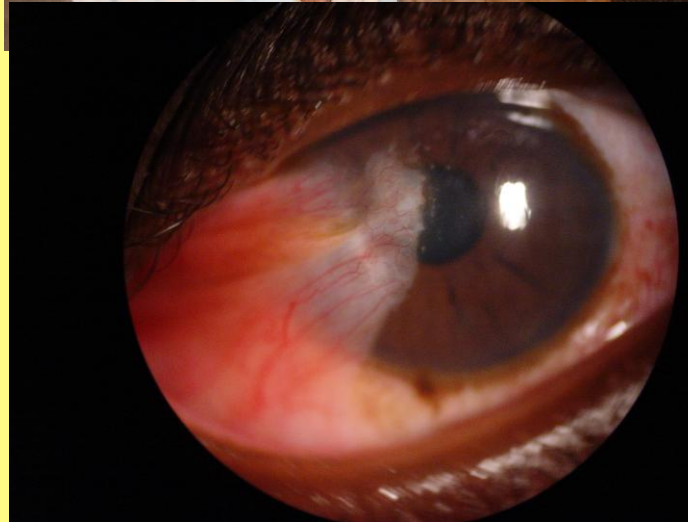
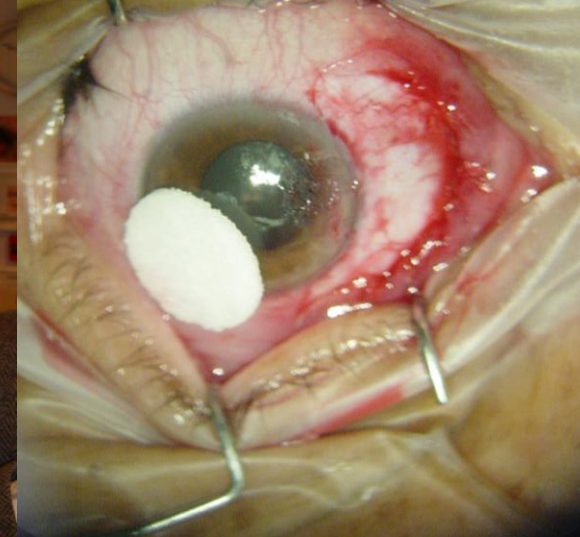
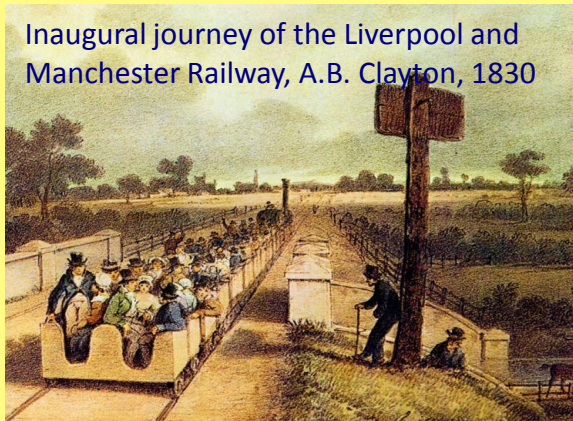
Idiosyncratic designs

The four lens frame was designed and patented by a Dr. Richardson in London.

The first four lens frames featured oval lenses. "D" shaped lenses followed in the early 1800s. Many of the "D" shaped four lens frames were used like safety glasses. Stage coaches and early railroad passengers used such frames to keep coal cinders and dust out of the eye. Rail coaches were not enclosed. The four lens frame faded from popularity around 1875.

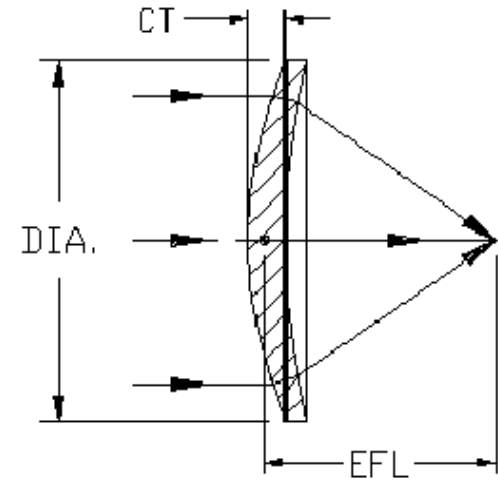
2010: Pterygium prevention

Inaugural journey of the Liverpool and Manchester Railway, A.B. Clayton, 1830

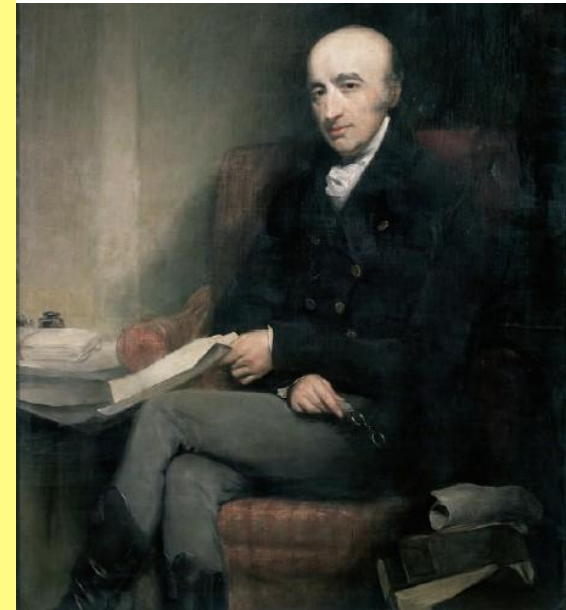


Wollaston: 1804 worked on optics. Meniscus lens shapes better quality images.

The lens was designed to improve the image projected by the camera obscura. By changing the shape of the lens, Wollaston was able to project a flatter image, eliminating much of the distortion that was a problem with many of that day's biconvex lenses.



Positive Meniscus Lens



William Hyde Wollaston by John Jackson (1778–1831)

Astigmatism

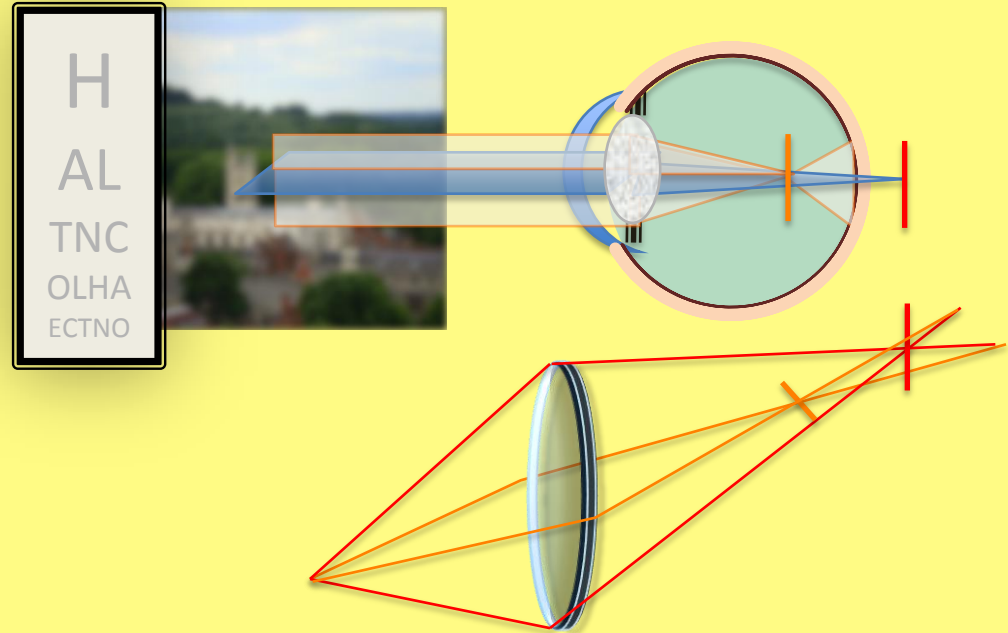
1794: **Thomas Young** mentions his visual defect to the instrument maker William Carey who replies that many people were obliged to tilt a concave lens to see clearly.

Sir George Airy had a higher astigmatism and tilting his glasses was not enough and furthermore induced distortion.

Whilst a student at Cambridge, he had noticed that images of circles formed elliptical images in his left eye .
Developed cylindrical lens to correct the defect.

Paper read Feb 1825 before the Cambridge Philosophical Society. Later Whewell master of Trinity suggested the term “astigmatism”.

1825: Fuller of Ipswich produces astigmatic lenses.



Caricature of Airy, wearing a pair of oval spectacles.
(Vanity Fair 13 November 1875)

19th century

Les Lunettes Louis-Léopold Boilly (1761-1845)

Admired Gerrit Dou and shared optical interest with many of his works depicting optical devices and spectacles.

Hand-coloured lithograph ca 1823. 5 types of optical corrections used in the 19thC.

a quizzing glass, a pair of scissor spectacles with a handle, a pair of wig spectacles with jointed sides, a pair of nose spectacles and a spyglass.

lorgnette is a pair of spectacles with a handle, used to hold them in place, rather than fitting over the ears.

They were invented by George Adams, instrument maker and later optician to Prince of Wales.



Scissor spectacles

Eyeglasses in the Colonies came from England and Europe with round lenses.

Major-General Israel Putnam (Old Put): Narrowly escaped being roasted alive by Indians Glens Falls 1758. Joins up at Bunker Hill “Don’t shoot till you see the whites of their eyes” wore the new oval lenses so that his spectacles "did not look as those of my enemy.”

1783, the end of the revolutionary war. Continental Army had fought for years without pay. Rumored that Congress intended to disband the Army and its debt. Mood grew ugly, ultimatum: If they were not paid, would march on Congress and government.

To prevent crisis, General Washington addressed the soldiers in a chapel in Newburgh, New York. He counseled patience, and reminded the men that he, too, had served without pay

Following the speech Washington could see that they were still agitated. Sighing, he took a letter from his pocket telling them it was from a member of Congress.

He looked at the letter for a while in silence. The audience wondered what was wrong.

Then he brought out a pair of new reading glasses, having only recently needed them, he had never worn them in public.

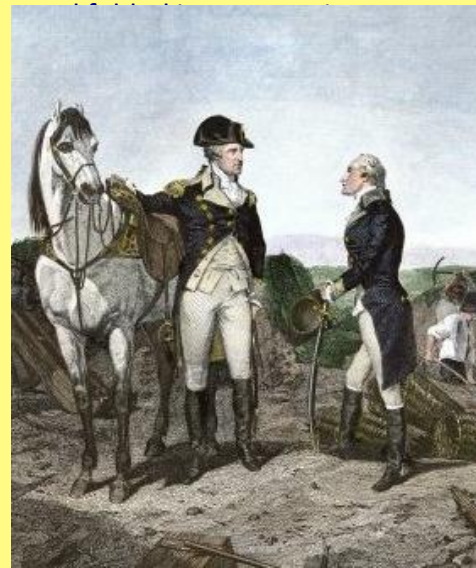
"Gentlemen, you will permit me to put on my spectacles, for I have not only grown gray but almost blind in the service of my country."



George Adams of Fleet Street, London patented scissor glasses in 1780. His scissor frames were made from silver



French Empire gilt scissor glasses c. 1805 Scissor glasses were popular in the French Court from 1785 to 1799. French scissor glasses are more delicate, ornate, and more of a fashion accessory



Na... sses and his
we... other-of-
pe

Pince-nez

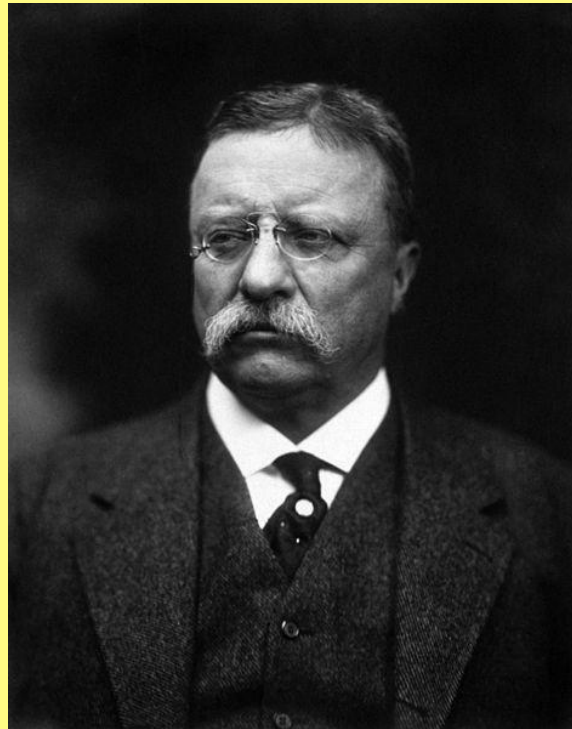
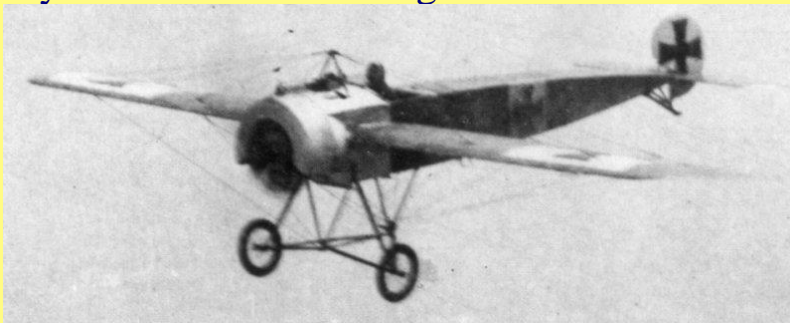
French – *pincer*, to pinch, and *nez*, nose.

Used in Europe in the 15th, 16th and 17th centuries,

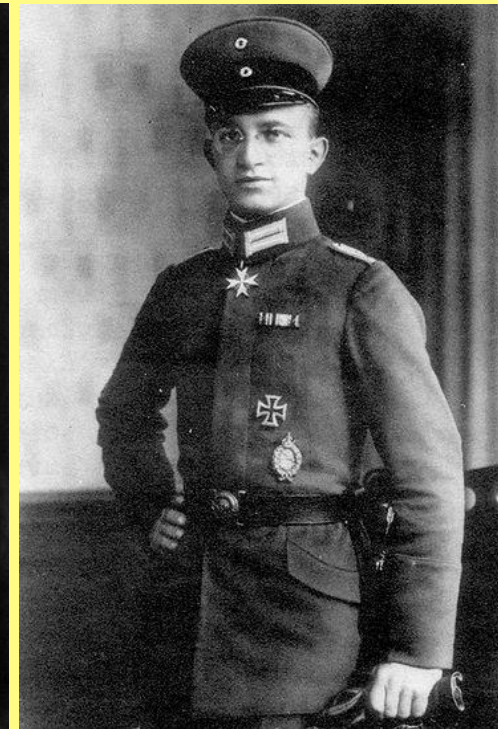
modern pince-nez made their 1840s, peak popularity c 1880 to 1900.

By the late 1930s, only used by the elderly

Leutnant **Kurt Wintgens** (1894 - 25 Sept 1916) German WWI Fighter Ace. First pilot in aviation history to shoot down an opposing aircraft with synchronized machine gun.



Theodore Roosevelt wearing a C-bridge type pince-nez



Kurt Wintgens wearing hard bridge pince-nez



1915 photo of Kurt Wintgens' Fokker M.5K/MG "E.5/15" Fokker Eindecker,

Contact lens

Leonardo, codex of the eye Manual D 1508:
Immersing head in bowl of water to alter effective corneal power. Studies to understand accommodation. Not intended as an optical correction.

Descartes 1636: suggested a fluid filled tube, with a optical correction in the glass ending.

Thos Young proposed an eyecup

Sir John Herschel (son of astronomer Sir Wm) 1845: suggested taking a mould of the cornea impressed on a transparent medium: collagen (animal jelly).

"Should any very bad cases of irregular cornea be found, it is worthy of consideration whether at least a temporary distinct vision could not be procured, by applying in contact with the surface of the eye some transparent animal jelly contained in a spherical capsule of glass; or whether an actual mould of the cornea might not be taken and impressed on some transparent medium. The operation would of course be delicate, but certainly less so than that of cutting open a living eye"

footnote to his treatise on light in Encyclopedia Metropolitana



First Therapeutic CL

1880: **Adolph Fick**: Zurich fitted scleral contact lenses on animals, himself and volunteers.

Kontak-brille;

considers CL for refraction. 18-21mm diam

1892: second lens made for Dr. Fraenkel who has Trachoma.

Ernest Abbe (associate of Carl Zeiss) made ground glass shells optic zone radius 8mm scleral zone 15mm: 'Glascornea'. Used for irregular corneas proposed use for keratoconus, aphakia and myopia. Only 1/6 patients fitted good result, so did not pursue them further,

1902 "Unfortunately I have found no cases exactly suited for the application of such a contact glass, but the improved visual acuity in proper cases of irregular corneal astigmatism has been surprising."

Reader in Ophthalmology and Physiology at the University of Zurich 1887-1914. Patriotic, volunteered; commissioned to field hospitals on various fronts. Captured by French; released 1919. Died 1937 age 84 having survived a leg amputation following a sporting accident.



First practical CL for vision

August Müller (1864 – 1949), No relation to the Friedrich Adolf dynasty

b. Mönchengladbach, medical student Kiel, pioneer in the manufacture of contact lenses.

1889, he presented his doctoral thesis *Brillenglaser und Hornhautlinsen* Eyeglasses and corneal lenses:

The reduced image and aberrations of the strong minus lenses stimulated him to investigate contact lenses.

Cadaver eye casts showed the curvature of the cornea was 7.5mm and the sclera 14mm.

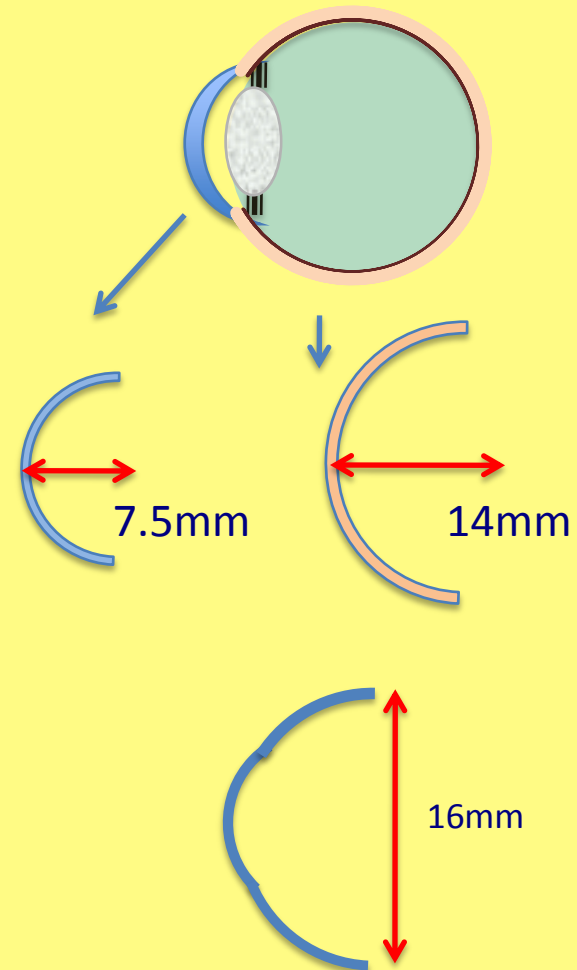
Ground glass scleral lenses from blown glass made by Himmler of Berlin.

Corrected his severe -14D myopia to within 0.50

However uncomfortable so limited wear time even with the use of cocaine anaesthetic drops.

Poor vision curtailed his career in Ophthalmology so he took up orthopaedics gaining the moniker “Knocher-Muller” (Bony Muller).

Andrewgasson.co.uk



Artificial eye makers. Thuringen centre of glass making.

Friedrich Adolf Muller-Uri 1838-1879 & sons Friederich Anton and Albert Carl; made more realistic eyes from Kryolith glass. Moved to Wiesbaden; Firm still exists.

Artificial eyes to demonstrate pathological conditions for the use of many Universities

1887 Dr Samisch referred pt cancer; lids partially removed because of cancer. Blindness from drying. Muller blew a thin glass shell, like an artificial eye. Patient used the Mullerschen Kontakt-schale night and day, retaining usable vision until his death in 1907.

The shell had a clear corneal section whilst the scleral portion had artificial veining to match the other eye, concealing any redness.

1920 grandson, Friedrich Edward, (1891-1945) son of Friedrich Anton, doctoral thesis *Uber die korrektion des Keratokonus und anderer Brechungsanomalien des Auges mit Muellerschen Kontaktshalen.*

11 keratoconics, wearing lenses for 1-8 years. He concluded that Muller lenses could be worn for the correction of keratoconus and other visual defects without irritation; were safe for continuous wear.

Modern usage: Better materials, gas permeable. Severe inflammation.



Pioneers

Richard Smellie: 1921: One of the early UK contact lens practitioners working for Hamblins.

Josef Dallos: Hungarian doctor, invented new way of molding from the living eye. 1937 he moved to England with his brother-in-law, **George Nissel.**

Fitted 84 cases of mustard gas keratitis with flush-fitting glass CL fenestrated in order to avoid corneal oedema and to increase wearing time. 1937-64 fitted 6,000-7,000 patients with scleral CL.

George Nissel Transylvanian engineer in Czechoslovakia. G. Nissel and Co. in July 1946, originally making glass sclerals then PMMA. 1963 produces first soft lenses outside of Czechoslovakia.

Adolf Müller-Welt (1904-1972)

Reichskontaktlinsen: He and his wife, Ruth 1942-44 travelled to fit German officers. Hand-blown, not moulded glass scleral lenses.



Modern materials

Plastic corneal lenses:

1930: PMMA. **William Feinbloom**

1948: **Kevin Tuohy**: lathing a scleral lens lost the haptic portion. Placed the polished corneal section in his own eye.

Multicurve aspheric designs and newer materials improve comfort, wear-time and reduce complications.

Heinrich Wohlk (1913-1991) PMMA Engineer for nautical instruments Anschuetz & Co. Fitted by Heine with glass lenses in 1936. At Kiel University Eye Clinic made moulds of living eyes as basis for standardising the haptic. A separate bevelled optic section, was fitted in a v-groove: a lens with interchangeable optics.

Wohlk returned to lens manufacture - in his garage - in 1946, founding Wohlk Contact Linsen.



contact lens cases from circa 1960 – lenses were supplied in expensive jewellery boxes, the lenses themselves were ~ the cost of a small car.

Soft lenses

Professor Otto Wichterle (1913-1998) had the greatest influence on contact lenses since the second world war. He invented **Hema**, developed the spin casting process, the first effective production method for soft contact lenses. Germany invaded Czechoslovakia and closed Universities. Worked with Bata Research developing many polymers. Perfected way to spin cast soft contact lenses with good edges

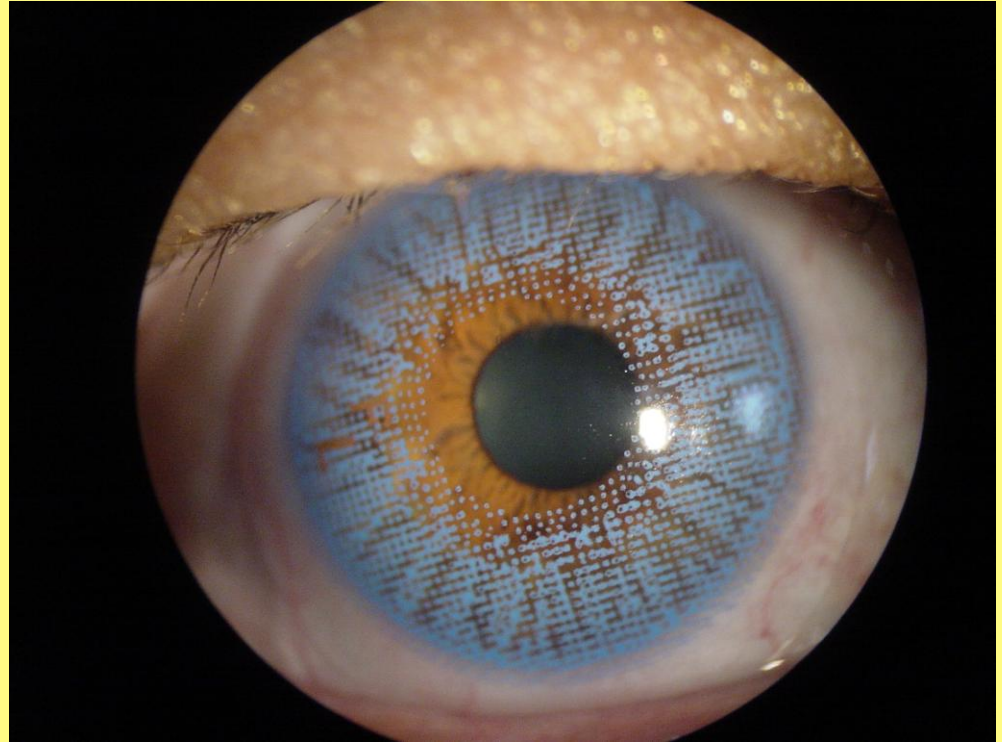
Silicone elastomer 1965: Soft material but does not contain water.

Still used as a bandage lens.

1994: daily disposable. Award plc in Scotland

1998: Si hydrogel; Focus night and day and PureVision.

1988: first disposable lens



Contact lenses are safe and ulceration is rare

It's not the lens it's the way you wear it

- Until recently ulcers were rare:
- DW: 4:10,000
- EW: 20:10,000

(Schein NEJM 1989, Cheng Lancet 1999)

- Newer materials lower bacterial binding, better O₂ permeability (surrogate analysis)
- Corneal ulceration still occurs
- Croydon Eye Unit: (300,000 population)
- 2003-5: **33 severe cases** over 2 yr
- 2006-7: **60 severe cases** in one yr

CONTACT LENSES SAFE BUT UNSUPERVISED WEAR OR CARELESSNESS CAN LEAD TO BIG PROBLEMS

38 million CL wearers in USA

3m new per yr

3/10,000/yr infection

~10% of these lose vision

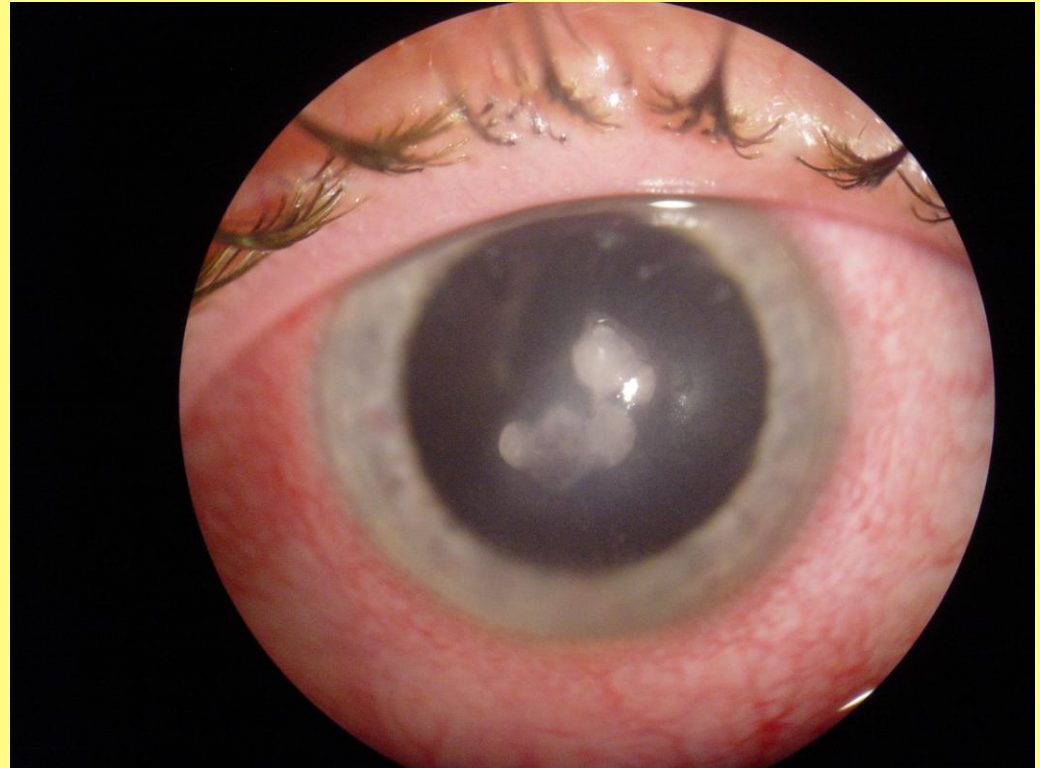
RISK FACTORS

Sleeping in lenses

Swimming

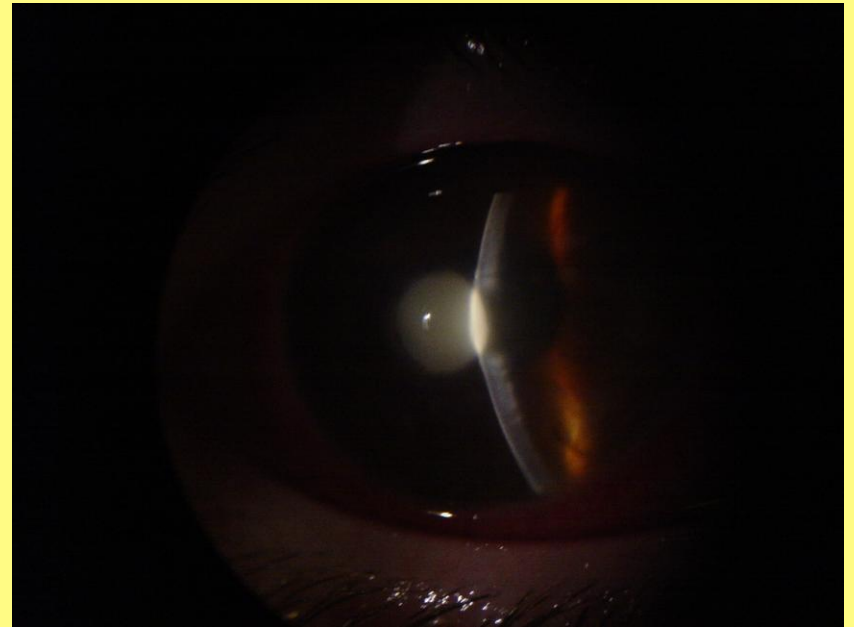
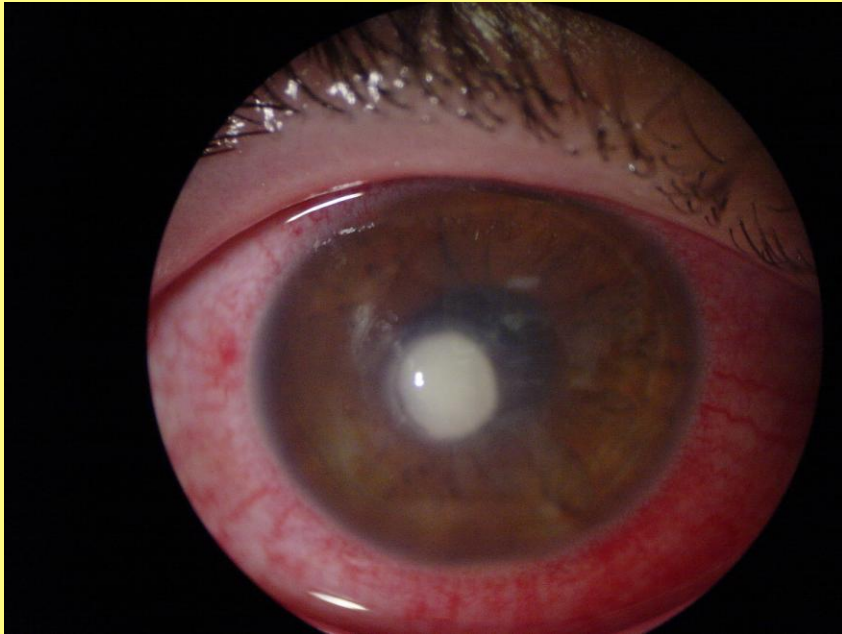
Male

Smoking



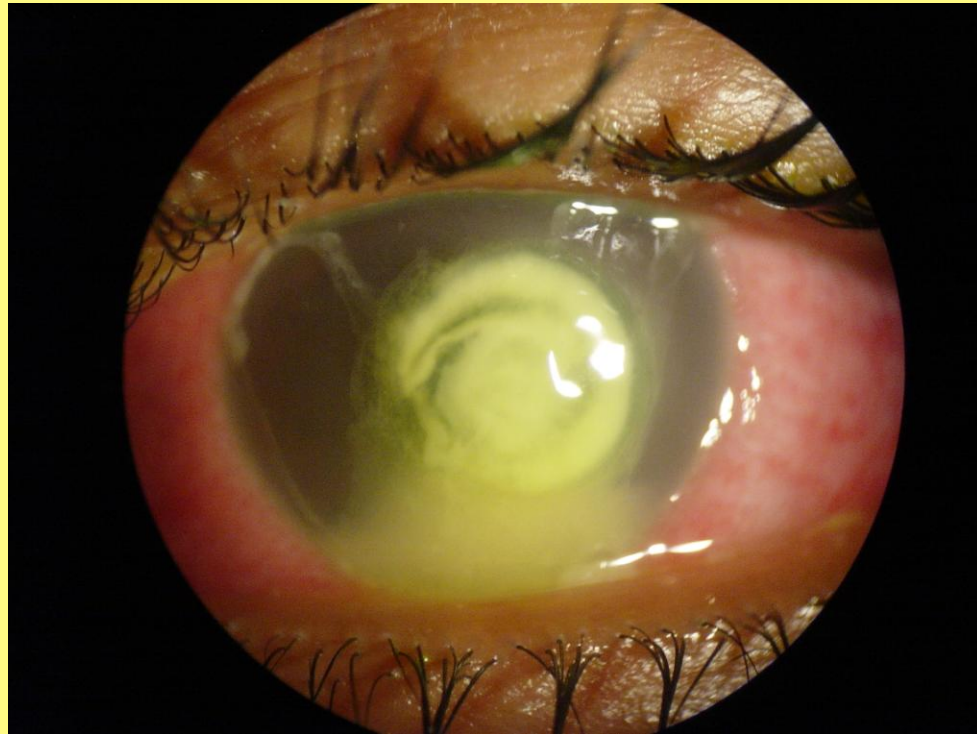
Daily wear monthly

JG 19/5/77: pneumococcus



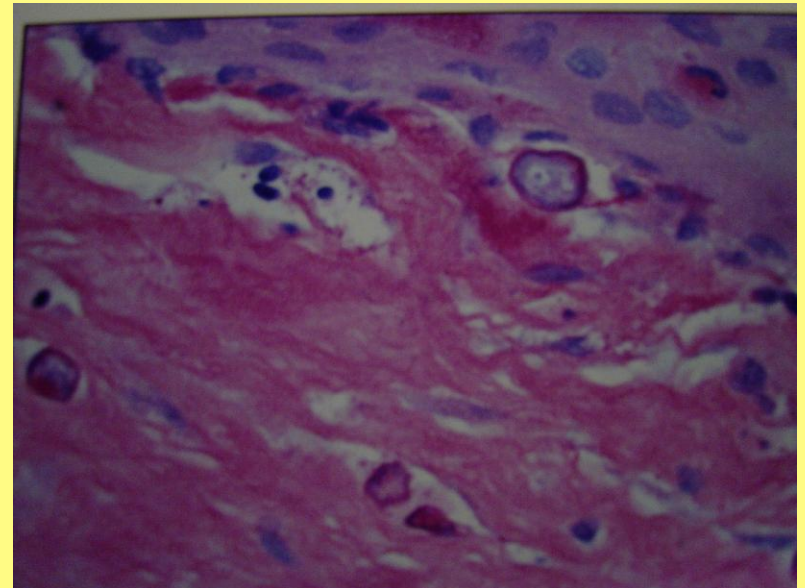
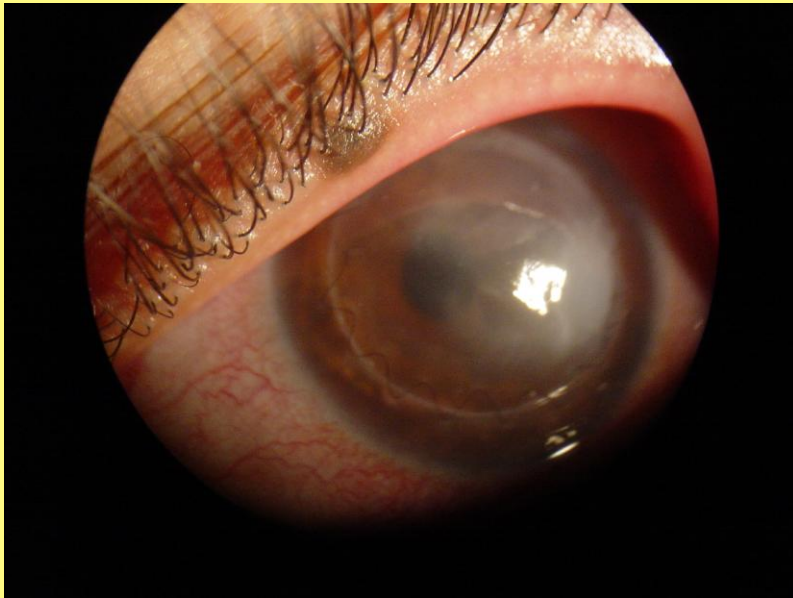
Extended wear

20 year old student: pseudomonas



Daily wear monthly disposable

Acanthamoeba: 26 male self employed



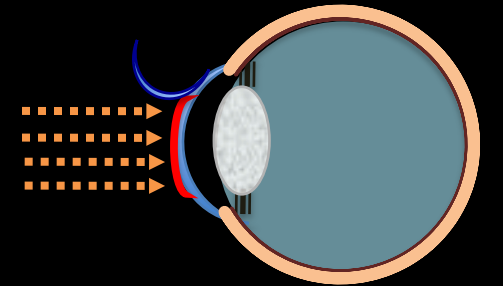
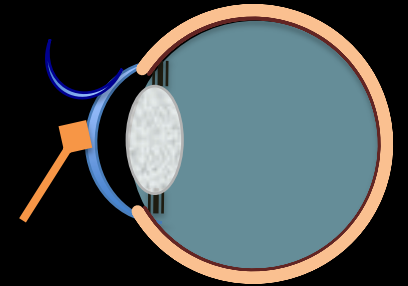
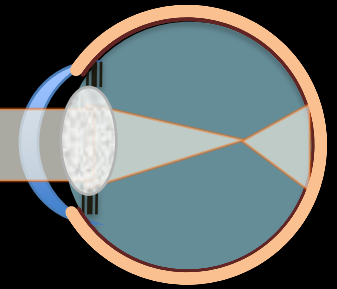
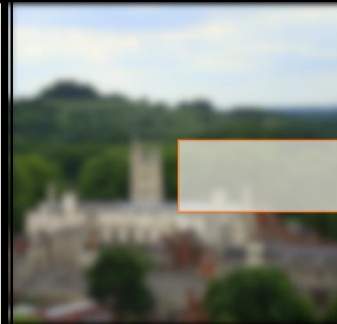


“Much has been written, ranging from the valuable to the worthless about the invention of eyeglasses; but when it is all summed up, the fact remains that the world has found lenses on its nose without knowing whom to thank.”

Vasco Ronchi 1946.

THANK YOU

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