

SPECTACLES AND PREDICAMENTS¹

In previous chapters we have looked at a number of the most important uses of glass. One specialist use deserves extended and separate treatment. This is the use of lenses to make spectacles. This is particularly important for two reasons. It was the development of eye glasses or spectacles which led, finally, to the development of those quintessentially important extensions to human vision, the microscope and telescope. Without spectacle development in the west, they would not have been invented. Furthermore, as we shall see, the effect of the spectacle revolution in the west was very great through extending human intellectual activity into older age. So let us look first at the history of spectacles in the west and their consequences.

It is one of the ironies of life that just as a person reaches their peak of knowledge, in the late forties and fifties, many people find it impossible to continue reading because they have to hold what is to be read at such a distance away from their eyes that they cannot distinguish the characters. What was a serious drawback up to the fifteenth century, especially for bureaucracies and companies where the most skilled in literacy and accounting had to give up early, became an even more serious disability after the printing revolution made books for scholarship or private enjoyment widely available. It is therefore no surprise that it is exactly at the period of growing wealth and bureaucracy that the making of spectacles developed rapidly, the eye glasses made of two double convex lenses suspended on the nose having been invented, as we have earlier stated, around 1285 in northern Italy.

The effects of this development in western Europe in terms of prolonging intellectual life were immense. This point was noticed, as usual, by Mumford. He first noted the inter-connections between increasing reliable knowledge and glass for eyes. 'The first set of inventions rested upon the improvement of glass manufacture, which made it possible, thanks to the increased scientific knowledge of optics, recorded in Roger Bacon, to supply pure glass for spectacles, by which defects of eyesight, particularly those brought on by old age, could be corrected.' Mumford then points to the way this then flowed back into increasing the resources for further discovery. 'The invention of spectacles prolonged and enriched the mental life of mature people by an average of fifteen years, if sixty be taken as their expectation of life at forty-five; and in many cases, where nearsightedness began earlier, it added an even longer period of mental activity. Amid all the factors that have been uncovered to account for the "revival of learning" the effect of spectacles was surely not the least.'² Earlier he had attributed this idea to the historian of science and technology Singer, who had 'suggested that the revival of learning might in part be attributed to the number of additional years of eyesight for reading that the spectacles gave to human life.'³

¹ This is the title of a book by Ernest Gellner, which deals with mental rather than actual spectacles.

² Mumford, *Myth*, 250

³ Mumford, *Technics*, 126

The effect was both multiplied, and in turn made more rapid, by another technological revolution to which it was connected. The importance of spectacles was enormously advanced by the other great invention that came a few centuries later: the printing press and its perfection through the invention of movable type for setting up a printed page.⁴ Obviously, the need to read standard sized print from metal types in older age was another pressure for the rapid development and spread of spectacles, and the presence of spectacles encouraged printers to believe they had a larger public.

The point has been supported by several scholars since. In 1971 John Larner saw spectacles as one of two developments (the other being the improvement of script) of 'far reaching significance', though 'an underrated factor in explaining the growth of humanism' during the early Renaissance in Italy. The discovery of spectacles 'increased the potential reading public, giving scribes, scholars, writers, and readers a longer working life.' To this he adds a second point. 'Moreover, most great scholars require time to mature, and the use of spectacles now permitted them to pursue their studies into extreme old age.' He gives as an example the work of that most influential of medieval writers, Petrarch. 'Petrarch, who boasted of the good sight he possessed as a young man, had to wear glasses from his sixtieth year. Although he enjoyed copyists extensively, it is doubtful if without spectacles he could have produced the fifth version of the **Canzones**, would have completed the **De remedies** and **De viris illustribus**, could have compiled the **Epistolae seniles**, or could have written at all the **De ignorantia**, the **Letter to Posterity**, the **Treatise on Princely Government**, or the Latin translation of Boccaccio's **Griselda**.⁵

More recently Norman Davies has commented on how the 'use of spectacles extended the reading span of monks and scholars, and accelerated the spread of learning.'⁶ David Landes has also stressed their role. He starts with the familiar point concerning the lengthening of a working life, but extends it outside intellectual work. He argues that 'the invention of spectacles more than doubled the working life of skilled craftsmen, especially those who did fine jobs: scribes (crucial before the invention of printing) and readers, instrument and toolmakers, close weavers, metalworkers.' To this he adds the effects on instrument making: 'eyeglasses encouraged the invention of fine instruments, indeed pushed Europe in a direction found nowhere else. The Muslims knew the astrolabe, but that was it. The Europeans went on to invent gauges, micrometers, fine wheel cutters - a battery of tools linked to precision measurement and control. They thereby laid the basis for articulated machines with fitted parts.' He also links spectacles to the argument that 'Europe was already moving toward replication - batch and then mass production', which he thinks lies in the enormously precise workmanship.⁷

⁴Mumford, *Myth*, 285

⁵ John Larner, *Culture and Tradition in Italy 1290-1420* (London, 197), a reference I owe to Elvin, *Another History*, p.63.

⁶ Davies, *Europe*, 369

⁷Landes, *Wealth and Poverty*, 46-7

There can be little argument with the first part of the argument. In western Europe presbyopia, that is the inability to see closely and hence to read, probably struck people as it does today around fifty. Many people, especially lawyers, philosophers, artists were at their peak. The invention of spectacles was of enormous benefit. The second part of the argument, that is the effects of not having spectacles in other civilizations is more complicated and needs to be considered.

Spectacles in Japan and China

As far as I know, spectacles were not developed to any great extent in Islamic civilizations or in India. The story in Japan was similar. It would seem that spectacles were not unknown in Japan - yet, as far as I know, they were pretty rare despite the fact that in Japan, at least, there was a very high literacy rate, at least from the seventeenth century. Why did glass spectacles not develop? There are several theories. One is that the Chinese, at least, had an alternative natural substance which could be, and was occasionally, used, namely crystals and quartz. Yet even quartz spectacles are rare in Japan.

It does not, as we shall see from the history of China, seem to have been because the concept of spectacles was missing. Nor was it probably the absence of an ability to make good glass. It is quite clear, as we have seen, that the Japanese could make fine, clear, glass from very early on, although they did tend to lose the art for some centuries. It is also quite clear that many Japanese suffer from bad eyesight. Many Japanese now wear glasses or contact lenses, perhaps one of the highest rates in the world. When spectacles could be manufactured widely, they became very popular. An interesting sidelight is thrown on this by Isabella Bird in the 1880's as follows. 'The entire police force of Japan numbers 23,000 educated men in the prime of life, and if 30 per cent of them do wear spectacles, it does not detract from their usefulness.'⁸ Thus there was a huge demand for spectacles and the ability to make them at that time. Furthermore, we know that eye diseases and attention to the eyes was very widespread in Japan, with constant polishing and cleaning of eyes. Yet, as far as I can see spectacles were practically unused in Japan until the nineteenth century. We are left with the intriguing puzzle of why they were not developed.

The puzzle takes us to China, from where Japan received most of its major technologies before the nineteenth century. Rasmussen published a survey of 'Early Chinese Spectacles'. He wrote that 'Historically considered, available data leave little doubt that spectacles, holding plain, coloured crystals, were used for singular [lenses?] and as a remedial agent in the time of Confucius (551-479 B.C.), but there is no evidence they were used for old sight, or presbyopia, earlier than the thirteenth century A.D....' He continues that the 'first authentic reference to the use of reading spectacles is attributed to Marco Polo... (1260-1368 A.D.) He reported that old people used lenses with which to read fine print. Nothing more. He did not say what sort of lenses they were, or even if they were in spectacle form, but from the term "fine" we can assume they were for purposes of magnification.'⁹ He states that 'Glass was

⁸ Bird, *Unbeaten Tracks*, 165

⁹ Rasmussen, *Spectacles*, 18

never used', for these were made of crystal.¹⁰ This was extremely expensive. 'There are no references in literature to the manufacture of lenses, cutting of tortioseshells, or the grinding of quartz crystal.'¹¹ There is also evidence that some kind of magnification to help sight is recorded in a text called 'Dong Tien Qing Lu' in the South Song Dynasty which states that 'Ai Dai can help the old to read small words and if without it, the old cannot see to read.'¹²

We can expand this by looking at the account given by Joseph Needham. The information he gives suggests that spectacles were known a couple of centuries after those in Europe. His evidence is as follows. The 'earliest books which refer to spectacles were written in Ming times' (between the middle of the fifteenth and sixteenth centuries). 'From their accounts it is clear that spectacles were known in China, though not very common there, during the early years of the Ming dynasty, i.e. the +15th century.' One example was said to have come from Malacca, another one in the sixteenth century was obtained from 'barbarians' (Arab or Persian merchants). 'All these Ming accounts say that the spectacles were monoculars which could be connected together at will. Another record notes the giving of ten pairs of spectacles by the King of Malacca in +1410. (p.119) Thus spectacles were first noticed, coming from abroad. Needham believes that their transfer to China 'must have taken place comparatively fast...' (p.121) He argues, however, that the 'Sung people, however, did have two techniques which may be considered introductory to spectacle lenses; one was the magnifying glass, and the other dark glasses as eye-protection.' He notes a reference in +1117 to the fact that various judges 'used to use various magnifying lenses of rock-crystal (**shui ching**) for deciphering illegible documents in criminal cases.' The judges also wore 'dark glasses made of smoky quartz', 'so as to disguise from litigants their reactions to the evidence.'(p.121) Needham also infers the use of magnifying glasses from 'the old and favourite practice of inscribing very minute characters on art objects.' (p.121)¹³

Some information on the later adoption of spectacles in China is given by Mark Elvin. He states that 'Ming accounts mention only spectacles for farsightedness and middle-aged sight', but then quotes a revealing text by Ye Mengzhu in the early Qing (i.e. later seventeenth century) about the spread of glasses. On the situation before about 1640 Ye Mengzhu wrote: 'When I was young I sometimes chanced to see old people wearing them. I had no idea, however, how much they cost. later on I heard that those made in the West were the best, and cost from four to five ounces of silver the pair. Glass was used for the body and elephant hide for the stems. Only the very rich could afford them.' Then, 'After the Shunzhi reign [1644-61] the price gradually fell, and a pair cost no more than 0.5 or 0.6 of an

¹⁰ Rasmussen, Spectacles, 12

¹¹ Rasmussen, Spectacles, 18

¹² Chan, 'Chinese Opthamology', 182; the Southern Song = 1127-1275

¹³ For further evidence on early spectacle makers in seventeenth century China see Needham, Optick Artists, pp.197-200.

ounce of silver. Recently many people in Suzhou and Hangzhou have been making them. They are on sale everywhere, and everyone can get them. At the most expensive a pair is only 0.007 or 0.0008 of an ounce of silver, or even 0.002 or 0.003. All of these are suitable for the general purpose of brightening vision.'

Two other accounts of the use of spectacles in China are worth quoting. The first is Gillan's from the McCartney Embassy of 1793-4. 'The Chinese make great use of spectacles...The eye glasses are all made of rock crystal.' He then gives a helpful account of how the crystal, mostly mined in 'the mountains of Canton' is worked. He concludes that 'I examined a great number of polished eye glasses after they were ready for setting, but I could not observe any diversity of form among them; they all appeared to me quite flat with parallel sides. The workmen did not seem to understand any optical principles for forming them in different manners so as to accommodate them to the various kinds of imperfect vision.' This fits well with Rasmussen's account.

Hommel touches on spectacles in the later nineteenth century as follows. He quotes the missionary A. Williamson who observed in 1868 the making of rock crystals into spectacles in Shantung province. Hommel continues 'I was told in Tsingtao that the famous optical works of Zeiss in Jena has procured from the same locality rock crystal for optical instruments.' (p.198) Hommel continues that 'Only in very recent times have Chinese opticians revolutionized their trade by the introduction of foreign methods for testing the eyesight and fitting glass lenses according to their tests.' This puzzles Hommel, who wonders why, if it is true that European glass spectacles were introduced to China in the fifteenth century 'the Chinese took the revolutionary step to abandon the use of glass for lenses, and employ instead a material but poorly fitted for the purpose.' After all the 'use of glass had been known to them since the 5th century A.D., and in carving it like gems, they were masters.'

Hommel notes again that rather than instruments for correcting vision, Chinese spectacles were 'primarily conceived ...to protect the eyes against the glare of a tropical sun, against sandstorms, and then to act as a screen for officials and literati from behind which, as it were, they could observe without being observed.(ref XXX)' This was a one-sided protection, however. Dyer Ball writing of the nineteenth century tells us as follows. 'It is considered impolite to wear spectacles before a guest or superior. A short-sighted man must be ready to submit to any amount of awkwardness rather than infringe this rule of etiquette.' He then describes the situation in law courts, where witnesses are afraid to put on glasses.¹⁴

On the question of concave lenses for myopia, Ye Mengzhu gives important evidence that even by the late seventeenth century they could not be made in China. 'There is another kind in the West, however, with lenses thicker than leather ... which enable the nearsighted to see clearly the minutest details. Farsighted and elderly persons who wear them will, on the contrary, find their vision blurred. There is still no-one selling them in the markets, but I suspect that in a few more years the cunning artisans of this region will be making them in large numbers.'¹⁵

¹⁴ Ball, *Things Chinese*, 219-20

¹⁵ The passages are quoted in Elvin, *Another History*, p.83

Elvin then makes an interesting point. He notes, as we have seen, that 'John Lerner has suggested that spectacles were a major factor in the growth of textual scholarship in Italy after the beginning of the fourteenth century.' He then continues that it is 'intriguing, in this comparative perspective, that the rise of the school of "empirical research" in China, with its delight in the minutiae of textual criticism, should have coincided with the spread of spectacles in the seventeenth century.'¹⁶ This links spectacles to the altered nature of vision, which may be another intriguing influence of spectacles.

So there is another mystery here. The Chinese had the idea of a material for protection of the eyes and they had the notion of lenses for magnifying (made out of crystal). Why did they wait to import the idea of magnifying spectacles from the West and (something Needham does not consider) why did they make so little use of spectacles once they had them?

Rasmussen's theory for the non-development in China.

One way to make a start on this problem is to look at the theories of one of the first to notice this important fact, Otto Rasmussen. Rasmussen was brought up in China in the late nineteenth century and was moved by the sight of blind beggars in Shanghai. The blinding light of the Chinese sands made him suffer from sun-blindness for a while. He trained as an ophthalmic surgeon and on the basis of twenty five years of research in China from 1908 he built up an unrivalled picture of Chinese eye-sight.

Rasmussen discusses the various uses made of spectacles in China. They were early developed for various purposes; to stop evil spirits entering the eye (p.3), as a guard against sun glare and dust (p.15) and as a medicine for sore eyes. In relation to sun glare he writes: 'By far the earliest need in a land from the colour of whose soil many of its big rivers and seas took the name "Yellow" was a shield against sun-glare.' (p.15) In relation to the medical properties of the crystals contained in the glasses he writes that the 'ancients' 'held that rock crystal contained a sort of solidified "medicine". Light passing through was supposed to pick up particles and deposits them on the eye surface. The Tea-Crystal was best of all.' (p.9) Those who could afford to buy these expensive crystals did so. Rasmussen believes that they did some good by cooling and protecting the eyes.

Rasmussen goes further than this and suggests that spectacles may have not only been used for sun glare and therapy but the Chinese 'as a natural consequence put magnifying lens in spectacles for the magnification of fine print, certainly as early as the tenth century. But it is not suggested they were in anything like general use.' (p.26) This is just a guess and I do not know of any evidence to support it apart from comments by Marco Polo noted above. Certainly, if they did, the art was later forgotten. Almost all spectacles were made of crystal, and to judge from later accounts the crystal was not shaped into lenses. The method of making these flat crystal spectacles is discussed by Rasmussen (p.27).

Rasmussen notes that 'glass was never used in the construction of spectacle "lenses" in ancient China, either for sun-glare or optical purposes.'(p.15) This was partly because of the non-development of glass in China. Rasmussen suggests that glass 'of an inferior quality' is mentioned about the fifth century A.D., but this was probably a 'by-product of the primitive smelting wells in which the Chinese produced

¹⁶ Elvin, *Another History*, 83-4

copper and zinc.' And 'it is mentioned as being used merely for decorative purposes.' (p.75) The soothing effects of crystal made it much more desirable, if prohibitively costly for the majority of the population.

[This para might be better in the chapter on Chinese glass and just alluded to here.] The absence of glass in China and the fact that this largely accounts for its non-use for spectacles is spelt out as follows by Rasmussen. 'For reasons already stated, it is not surprising the Chinese never used glass. They did not invent it and did little to improve what was imported. They did not even suspect its possibilities for windows, and even today most houses still use the little oiled paper roller blinds.... This is a peculiar hiatus in Chinese ethnology because they had received glass from Alexandria as early as the second century A.D.' He points out that the Chinese names for transparent and coloured glass are derived from Sanskrit. Rasmussen mentions the use of an '18-inch green glass domestic mirror' in the twelfth century, and of 'burning lenses', coloured glass lenses, for lighting touch-paper. Both of these were imported, he says, from Indo-China. He notes that the 'Chinese, however were not attracted to glass products, and preferred their own ceramic wares. What they did manufacture was inferior in substance and utility.' A transient boost to the art was given by the Arabs who settled in the coastal towns of South China in the ninth and tenth centuries, but this faded away. Rasmussen concludes that this 'indifference would readily account for its absence in spectacle lenses. Unless glass is scientifically prepared it is greatly inferior to natural rock crystal in transparency and durability.' (pp.22-3) Only in 1680 did Kang Hsi give his blessing to a glass factory to make 'Imperial glass'.

We could end our search here by suggesting that the Chinese (and consequently Japanese) did not develop spectacles because they did not develop glass. This may be enough. But I would like to explore a supplementary and rather extraordinary hypothesis which is also generated by Rasmussen's work, although he himself does not make the link.

This involves looking more closely at the nature of what the eye was expected to read, and variations in eye sight. In relation to the objects of vision, it is worth remembering the difference between printing and writing at the two ends of Eur-Asia. In Europe, there developed a uniform, fairly small, 'secretary hand' in XXX. This required good eye sight. In China and Japan, the art of painting on paper in the form of shapes, namely calligraphy, allowed people easily to vary the size of the writing. If there was a serious problem in older age, the size of the writing could be increased. Secondly, Chinese and Japanese printing was done by making wood-blocks. These were again easily made in different sizes and re-drawn as needed. There developed in the west, on the other hand, expensive metal type printing which led to the printing of numerous, often fairly rough and small, standard-sized books which would have been very difficult to read in older age without spectacles.

All of this, of course, makes one large assumption. That is that the nature of the eye problem at the two ends of Eur-Asia was the same, namely presbyopia or the growing inability to see close objects clearly after the mid-forties. This assumption needs to be tested. We know that this was the major problem in western Europe, as it is today. But supposing this was not the great difficulty in eastern Asia? Suppose that the major problem was the opposite, namely myopia, that is the ability to see close objects very clearly, but deteriorating far sight. If that were the case, it would have a strong effect on the development of spectacles. There are several reasons for this.

Myopia usually starts to manifest itself in childhood, between the age of five and ten. To cure this

would require making spectacles for a relatively powerless group (children). Furthermore, it would not seem so necessary since in relation to reading or other close work, the difficulty can be overcome by holding things up very close to the eyes. Added to this, the concave lenses which are needed to correct myopia are far more difficult to grind than convex ones. Spectacles for myopia were only invented in the west after some two hundred years of making convex lenses for presbyopia. Finally, as the child became a man and the retina stretched, the myopia might partially cure itself and sight would normalize. Thus spectacles are very unlikely to develop in a civilization whose main problem is myopia.

In a civilization which suffers mainly from presbyopia, the opposite is true. Presbyopia characteristically develops from about the age of 40 as the person reaches the peak of their career. These people had the political power and were needed for bureaucratic and other purposes. They also had the money to invest in spectacles. Furthermore, the lens is easier to grind, a natural development of the convex lenses which are found in nature (in pebbles) or created by blowing glass bubbles and filling them with water. Finally, for the presbyope, there is no way round the problem. The object to be seen is either close up and blurred, or far away and unseeable. Without spectacles, most people, unless they have others to read for them, are incapable of one of the major intellectual activities, reading.

These speculations are prompted by the work of Rasmussen because he found very high rates of myopia among his patients in Shanghai in the 1920's and 1930's. He discovered that it was myopia which was the major eye problem, not presbyopia. Although he does not draw the connection to the development of spectacles, it is worth investigating further to see if there is any possible substance in this hypothesis.

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