

MYOPIA: ITS COMPARATIVE INCIDENCE AND PROBABLE CAUSES

What Rasmussen encountered in his many years of working with Chinese eye problem astonished him. He summarized his impressions thus. 'Three facts stand out clearly in both ancient and modern records of Chinese eyesight: one that they are a highly myopic nation; two that keratomalacia is the major cause of ocular disease; and three that presbyopia is earlier than in the West by about five years. They stand out against an historical background of neglect and abuse, malnutrition, and centuries of State indifference.' (p.48)

Moving on to the statistics of myopia, he summarized the research of a quarter of a century by saying that 'only 20 per cent. of all lenses supplied by the ancients, and similar amount by the moderns (excluding high astigmatic) were for old-sight lenses. It is the other 80 per cent. that matters; the 65 per cent. for myopia and the 15 per cent. for glare and therapeutics.' (p.20) Elsewhere he gives slightly different statistics, which applied to those aged under forty years, showed that approximately 75 per cent. of the lenses were supplied for myopia. In a detailed table he presents the figures; in the 'Ancient Chinese Sight Records', 65% were for myopia; in the 'Modern Chinese Sight Records' myopia (simple) or with astigmatism combined accounted for 70% of the lenses.(p.48) The second figure of 70% was based on 120,000 case histories collected by Rasmussen and his colleagues over a period of 25 years. (p.49)

The significance of the degree of myopia only comes out if we compare the Chinese figures with those for other nationalities. In 1930 a Chinese expert published figures for 569 Chinese and 568 white residents of Peking who had been examined in the previous two years. Some 70% of the Chinese investigated, but only 30% of the foreigners had myopia. Furthermore the degree of Chinese myopia was far higher than that of foreigners. (Rasmussen, Causes, 32) Comparative figures he cites suggested that among American Indians and Negroes the incidence of myopia was about 2 to 3 per cent, and in a group of country school children the rate was about 15%. (p.57) Although unfortunately Rasmussen does not specify the sources and dates of the 'Old Chinese Records', he was convinced that 'myopia is, and has been for centuries', the greatest cause of eye problems. (Spectacles, 49) His most graphic account is as follows. 'almost a quarter of the nation was, and probably still is, myopic. Seventy-five per cent. of all spectacles worn are for short-sightedness.' (p.6)

The puzzle is made all the more intriguing by a hint of Rasmussen's that there may have been a progressive deterioration in the situation over the centuries. Speaking of the situation in C14 China he writes, 'if we were to accept the contention', China was 'fast becoming a myopic nation'. (p.20) In order to pursue the consequences of this largely unnoticed but dramatic situation, whereby a nation with one quarter of the world's population suffered from serious and widespread myopia we need to look more closely at the situation in China and Japan.

Rasmussen's early figures for high myopia in China and the implications for Japan can be checked against more recent figures. In 1980 Trevor-Roper suggested that 'Among humans the

proportions of myopes and hypermetrops are surprisingly constant in nearly all the Western races, 15-20 per cent being myopic and about 50 per cent hypermetropic; but in China and Japan myopia is about four times as common (60-70 per cent).¹ In the west, a graph of the incidence of myopia by age shows that by the age of 17 it is about 15%, and the highest peak is at about 40 when it is a little under 30%.² This contrasts with rates in the Far East which are often far higher. A recent interview with Dr. Fitcroft, a myopia specialist, in the **Independent** suggested some extraordinary figures. He is quoted as saying that "Eighty five per cent of schoolchildren in Taiwan are short-sighted." He comments that "The highest incidence of myopia ever recorded was in Singapore, where 98 per cent of medical graduates were found to be myopic." Furthermore, in the same country "they had to alter the regulations covering short sight in the air force because by the time they graduated and completed five years of training, recruits were short-sighted."³ In an interview I conducted with Dr Takashi Tokoro, a leading eye specialist in Tokyo in April 1999 while tests were being carried out in a primary school, it emerged that among children aged about 11 some 30 per cent suffer from serious myopia, by the age of 15, some 50 per cent, and by university entrance at 17, some 70 per cent.⁴ Given the fact that there is a high level of 'late onset myopia' as well, it would look as if the rates might easily reach 80% of the adult population as seriously myopic.⁵

One interesting feature of the rates is that they are almost universally increasing, both in the west and the east. In the United States, we are told that 'The Catholic Digest' (Nov.1980) reported that 40 percent of American wear glasses or contact lenses for myopia, in contrast to 18 percent of the population in 1939.⁶ Of course, this could be caused by better diagnosis, changes of fashion or availability of lenses etc. but we are told that 'In the US, the latest study shows that it is heading towards 45 per cent. That compares to about 20 per cent in the earlier part of the century, and studies of families have also shown that the younger siblings tend to have more myopia'⁷

The same article suggests that 'In parts of the Far East where eye tests are compulsory at 13, it's been found that the prevalence of myopia is increasing in less than a generation.' Dr Tokoro's research in Japan summarizes his findings as follows. The 'frequency of uncorrected visual acuity of less than 1.0 in high school students was 53.0% in 1986 and 62.7% in 1996. These results show a 10% increase in myopia over a 10 year period. In addition, an increase in

¹ T-Roper, Blunted,20 - the figure is repeated in his 1983 article in the British Medical Journal, p.1822

² See Myopia book, 15

³ Independent, 20/5/1999

⁴ The interview was shown as part of the C4 'Day the World Took Off', program 4, and is reported on in the book of the series (with a photograph of the class I visited) on pp.122-3 of the book of the series.

⁵ See also Takashi Tokoro, 'Vision Care in Japan', 1998 for more detailed figures.

⁶ Reported in Goodrich, Perfect Sight, 24

⁷ Independent, 1999

late-onset myopia has recently been reported.⁸

Stepping back from the detail for the moment, what stands out very strongly is that certainly in Japan, Taiwan and Singapore the rates are very high, and one suspects the same is true in China. Thus the current situation suggests that myopia may well have been, as Rasmussen argued, the central eye problem in much of eastern Asia in the twentieth century. But our work has mainly been concerned with earlier periods, in particular the twelfth to eighteenth centuries. The direct evidence for that period is very thin. There is a certain amount of anecdotal evidence or indirect evidence. There is the considerable concern in traditional Chinese medical tracts with eye diseases of various kinds.⁹ Older ethnographies record the widespread presence of eye medicine shops, some of which had been in operation for more than seven generations.¹⁰ There is considerable evidence of widespread eye diseases of various kinds in nineteenth century Japan as well.¹¹ There is evidence that some ordinary Japanese children had amazingly acute microscopic vision. Edward Morse in the 1870's described how he was showing 'a little country boy' the features of a beetle which 'when placed on its back jumps into the air'. Morse showed him how this worked 'with the aid of a pocket magnifier'. In the west 'only entomologists are familiar with this structure; yet this Japanese country boy knew all about it, and told me it was called a rice-pounder...' The boy was 'delighted, however, to see this structure magnified with a fine lens.'¹² As we noted above, a third of Japanese police force in 1870's wore glasses, presumably for myopia, according to Isabella Bird.

Another curious hint comes from an unlikely source. In the work by Li Yu translated as **The Carnal Prayer Mat**, originally published in 1634, we are told of a lady who was 'nearsighted'. He explains that this made her especially attractive. 'Most nearsighted women are pretty and intelligent. And for women there is a certain advantage in nearsightedness: it makes them save their feelings for the serious business of marriage instead of squandering them prematurely on passing adventures.' He approvingly quotes the 'popular saying' that 'She may be nearsighted, but in the marriage bed she knows what she is doing.' Thus 'nearsighted

⁸ Tokoro, 'Vision Care in Japan', p.47. The article contains fascinating graphs of the rise, by age and gender, since 1913. Although there has been a steep rise since 1948, it is interesting that the figures in the 1920's and 1930's were also very high, with over 50% of those in Universities and the old system high schools with uncorrected visual acuity of less than 1.0.

⁹ See, for example Eugene Chan, 'The general development of Chinese ophthalmology from its beginnings to the 18th century', **Documenta Ophthalmologica**, vol.68 (1988) (a copy of which is in the Wellcome Library).

¹⁰ See Gamble, Ting Hsien, 277

¹¹ See Macfarlane, **Savage Wars**, 266-8

¹² Morse, *Day By Day*, II, 105-6; it is intriguing that the Japanese from the eighteenth century were noted for their minute observations of nature, a skill which led to notable success in biology and medicine at the end of the nineteenth century.

women are largely immune to temptations of this kind... It has been recognized from time immemorial that marriage with a nearsighted woman is usually happy and free from scandal.'¹³ Another reason for their attraction may be, as a Japanese friend told me, that 'Myopic women are attractive because they gaze at men'.¹⁴

A great deal of the evidence is tantalizing. For example, what are we to make of the following description by Fortune in the later nineteenth century? 'A great proportion of the northern Chinese seem to be in a sleepy or dreaming state, from which it is difficult to awake them. When a foreigner at any of the northern ports goes into a shop, the whole place inside and out is immediately crowded with Chinese, who gaze at him with a sort of stupid dreaming eye; and it is difficult to say whether they really see him or not... I am quite sure that, were it possible for the stranger to slip out of his clothes and leave a block standing in his place, these Chinese would still continue to gaze on, and never know the difference.'¹⁵ This could be dismissed as arrogant nonsense, or as reflecting bemusement, inability to fit the foreigner into any category, deference, or something else. It is certain an intriguing remark in a country which half a century later we know had very high rates of myopia.

Apart from the problems of getting any hard evidence, there is the added problem of seeing whether the rates were changing. We know that they were very high by the 1920's in China. Had there been a long-term change, and when had it begun? One final hint is given by Mark Elvin. He writes that 'The long-term shrinking of the average size of characters in woodblock, and, later, typeset, books is also suggestive [Song-late Qing].'¹⁶ It would be interesting to look at this in more depth, and also in relation to Japan. For example, Elvin has also commented to me on the extraordinarily small tiny size of characters on Japanese consumer products for the home market after the second World War, an interesting indication of myopia.

We shall have to proceed by two indirect methods, neither of them entirely satisfactory, but at least providing circumstantial evidence. One is to see what are the probable reasons for the high levels of myopia in eastern Asia, as compared to other parts of the world. If these can be discovered we can then look to see if they were present in the earlier period. If so, it seems reasonable to argue that myopia may well also have been widespread. The second involves a detour. There has been considerable speculation on the possible effects of widespread myopia, both at the individual ('myopic personality') and wider institutional and cultural level. If we can establish some of these effects, we can then look to see if there is evidence of these effects during the earlier periods. If they are there, again it does not seem unreasonable to guess that myopia was widespread. This second venture is also important for it links with our wider

¹³ Li Yu, *The Carnal Prayer Mat* (Wordsworth Classics edn., 1995), 117.

¹⁴ Professor Airi Tamura, August 1999

¹⁵ Fortune, *China*, 5

¹⁶ Mark Elvin, personal communication. The period is wide, from the twelfth to nineteenth centuries.

attempt to see how changes in human vision, whether by glass or in other ways, have shaped cultures, and in term been shaped by culture.

The genetic theory.

'Myopia causation is the topic of hundreds of scientific papers and numerous scholarly treatises.'¹⁷ Here we will consider only the three major theories to account for myopia. One of these is the genetic one. Rasmussen rejects genetic explanations. For example, he points out that there is no innate association between 'Mongolian' and 'Aryan' eyes. Thus he writes that 'There is little evidence to suggest that skull and orbital indices need be considered, because myopia affects all indices in China, from the brachy-cephalic of 70 millimetres interpupillary distance to the dolicho-cephalic female of 52. It is found in receding as well as prominent eyeballs; in the Mongolian palpebral fold and the loose-lidded Aryan types.' (p.62) He also rejects 'heredity' which, he suggests, explains little.

In fact current theory suggests that the situation is more complicated than this. There is to start with some relationship between heredity and myopia. As Mann and Pirie observed, 'Certain families tend to be short-sighted, and others long-sighted, since shape and size of the eye are inherited just as are shape and size of nose, colour of hair, etc.'¹⁸ Trevor-Roper agrees that 'That myopia is hereditary can indeed be illustrated where it has left its mark down the family-trees of many distinguished houses...Perhaps the best myopic pedigree available is that of the Medici family compiled by Dr Alaerts.'¹⁹

He suggests that 'myopia is essentially the result of an anatomical defect'.²⁰ It leads to a particular shaped eyeball.

'The myopic eyeball is almost by definition a large eyeball, and for that reason also tends to be prominent, and usually has a large pupil...'²¹ The problem is to find out exactly how the myopia is passed on, and how important a factor this is when compared to others.

A recent major survey of studies of myopia notes that 'Several studies have reported prevalence of myopia as a function of parental history of myopia.' The studies are summarized in a table and 'show that parental history of myopia is a risk factor for myopia development.' Unfortunately, the limitation is that 'common family lifestyle as well as inheritance may be part of that risk', so that a 'review of pedigree studies on myopia concluded that a consistent mode of transmission of myopia has not been identified.' All that one can conclude is that 'Refractive

¹⁷ Myopia Book, 49

¹⁸ Mann & Pirie, 151

¹⁹ T-Roper, Blunted, 24

²⁰ T-Roper, article

²¹ T-Roper, Blunted, 28

error is affected by multiple genes (polygenic) rather than one gene'.²² The complexity is shown by the fact that 'surveys show that identical twins are not both myopic.'²³

Particularly interesting is a well-known study of Canadian Eskimos (Inuit) which shows that genetics is not at the root of the matter in a simple way. We are told that 'the eyes of Canadian Eskimos were examined over three generations. Only five percent of the eldest generation displayed distance blur whereas 65 percent of their grandchildren were showing elongated eyeballs.'²⁴ Another report of this research is as follows. 'A study of Eskimos found that the number of people with myopia increased from 2 per cent in one generation to 45 per cent in the next generation. There had been no changes in diet or lifestyle, but the researchers concluded that their deteriorating eyesight was due to a shift in educational practices. The oral tradition of Eskimo schooling had been replaced by formal, written education, with several hours a day of reading and writing.'²⁵ This, as I shall argue, may well be a key to what happened in China and Japan, except on a much larger scale.

The wider question of whether the known differences between the genetic make-up of what used to be called 'races', for example Caucasian and Mongoloid, is of considerable importance, but I do not know of any sustained analysis of the problem. On the surface, it looks as if there may be intriguing differences. For example, Trevor-Roper summarizes a good deal of the evidence when he notes the 'prevalence of high myopia in Egyptians and Jews as opposed to other Caucasians, in Europeans as opposed to Eskimos and African Negroes and in Brahmins as opposed to non-Brahmins...' He comments that this 'has been attributed to their longer histories of civilization, the laws of natural selection (which would tend to weed out the less competitive high myopes in a primitive society) being relaxed in civilized groups.'²⁶ Before we accept such a theory, we need to look at other theories which, for instance in relation to Brahmins and Jews, seem to account for the phenomenon better.

The nutritional theory.

Rasmussen himself advanced two theories. One of these was nutritional. Early in his classic booklet he wrote that blindness and eye troubles in China were due 'above all' to 'malnutrition, due to the absence of Vitamin A in their foods.' (Spectacles, 5) This deficiency 'brings about, among the poorer classes, a condition of the eye known to ophthalmology as Keratomalacia, in which the corner or window of the eye dries up and ulcerates. Millions more have little white spots on one or both eyes, scars that left them among the minor casualties.' (p.6) In a table of

²² Myopia Book, 49; see also p.16

²³ Goodrich, Perfect Sight, 35

²⁴ Goodrich, Perfect Sight, 35

²⁵ Independent, 20.5.99

²⁶ T-Roper, Blunted, 20

causes of blindness among the Chinese which he reproduced, he showed that over a third of the cases of blindness were caused by keratomalacia, by far the largest cause. In the footnote to the table he states that Keratomalacia is 'caused by a deficiency of Vitamin A in food.' (p.48)

Rasmussen refined his study by looking at the regional incidence of myopia. He found that while myopia was high in all regions, it was 'highest of all in the yangtze valley and Central China regions'. He wonders whether in this area 'the primitive farming methods, particularly of rice and vegetables, exhaust the Yangtze valley soil more than elsewhere and produce inferior crops.' He suggests that the vegetables in this region are 'neither as tasty nor satisfying as the same things in the West or imported to China.'²⁷ (p.51)

The importance of Vitamin A deficiency comes out when we compare the situation in China with that in the West. He notes that 'Keratomalacia is extremely rare in Western countries where, with the exception of Germany, myopic errors are in the minority.' He links this to farming methods. In the West 'agriculture is too far advanced scientifically to permit crops to exhaust the soil, or farmers to keep taking its fruits without putting back sufficient chemical fertilisers.' He believes that the 'natural animal' fertiliser used on rice and market gardens 'is obviously insufficient both in quantity and chemical content to maintain a balance.'(p.52) Despite recent (i.e. C20) importation of fertilizers Rasmussen believed that there had been a long-term deterioration of the quality, if not the absolute quantity, of Chinese foodstuffs. The recent imports, 'came far too late to counteract the gradual decline in China's farming industry over the past few centuries, due largely to rapid growth of population, government neglect, and the more recent movement of workers away from the land caused by the huge unemployment of farmer-handicraftsmen...' All this 'bears heavily on the chemical content of foodstuffs and this in turn bears just as heavily on the resulting deficiencies in the anatomy and physiology of the people who must live off those foodstuffs.' (p.52-3) Rasmussen then provides a brief synopsis of the growth of Chinese population over the last centuries.

At the end of his booklet he comes back to the same theme, drawing attention to partible inheritance and the sub-dividing of plots as population built up. 'As this situation developed, the land was over-cultivated and under-fertilised.' Rasmussen then summarizes what he now guesses is something going back over a thousand years. 'In such circumstances, it could not be expected otherwise than that the quality of grain, tubers, and general produce for domestic consumption deteriorated in chemical content and sustenance value.' He then refers to 'the evidence of modern Western and Chinese medical and farming experts that foods were deficient in vitamins and were the direct cause of diseases that sent millions blind or reduced their vision.' If this was true in the last twenty years, he asks how far back this went. 'I suggest that in the older and more thickly populated areas of the river basins it must have been a developing

²⁷ Of course, in many respects, Chinese agriculture was amazingly sophisticated, and not 'primitive', as Mark Elvin pointed out to me in a personal comment.

problem at least 1,500 years ago.' (p.64)

Several comments can be made about this suggestion. Firstly, it is generally agreed that vitamin A deficiency (as well as other deficiencies such as calcium), does indeed have a serious effect on the eyes. There are numerous studies to this effect. For example Mann and Pirie noted that 'The chemical relationship between visual purple and vitamin A was first suspected when it was found that rats which had been fed on food which did not contain vitamin A had little visual purple in their retinas.'²⁸ In relation to the well known observation that many Japanese have traditionally found seeing in the dark rather difficult, and still find poor lighting a trial, the fact that 'the vitamin-A-deficient animals cannot adapt themselves to the dark' is interesting.²⁹ These authors give a good account of where vitamin A is to be found, that is to say in liver, eggs, butter, milk and cheese and in fatty fishes; also 'about half a pound of carrots or a pound of cabbage will provide in carotene the equivalent of a day's dose of vitamin A.'³⁰ The traditional vegetarian diet of the Japanese had hardly any of these, and even the fish diet was usually miniscule.³¹

They then provide a good account of further effects of vitamin A deficiency, citing a Report of Committee on Nutrition in Colonial Empire in 1939 which states that "Diseases caused by deficiency of vitamin A are perhaps the most common of all in the Colonial Empire. There are reports from a wide selection of territories of affections of the eye, night-blindness, xerophthalmia, keratomalacia..."³²

The way in which vitamin A deficiency affects human sight has been widely described in textbooks of nutrition, which explain for example that 'retinol is found only in foods of animal origin' and that the 'official chemical name of vitamin A is retinol'.³³ The link between poor Japanese eye-sight and vitamin A deficiency was specifically discussed by Huntington.³⁴ He cited the work of Weston Price on **Nutrition and Physical Degeneration** to show the effect of withdrawing vitamin A on pigs and other animals.

²⁸ Mann and Pirie, 99

²⁹ Mann & Pirie, 99; many anecdotes have come to my attention concerning poor light. For example, visiting scholars from Japan in Cambridge often complain to me about the poor light and one of them recently told me that she believed the very dim light in the University Library had suddenly made her myopic in her mid-20's. Conversely, I find the lighting in Japanese homes and public spaces very oppressively bright. Perhaps the carrying of lanterns, a traditional Japanese activity at night, is connected to this.

³⁰ Mann and Pirie, 112

³¹ See Macfarlane, *Savage Wars*, pp.XXX

³² Mann and Pirie, 114

³³ Davidson, Passmore and Brook, 121; see also Parakrama Chandrasoma & Clive R.Taylor, **Concise Pathology** (Connecticut, 1991), 156.

³⁴ Huntington, *Mainsprings of Civilization*, 454-455

In relation to China, two sources are worth citing. James Cameron Scott in his study of **Health and Agriculture in China** published in 1952 observes that 'Adequate amounts of vitamin A are often destroyed by the method of cooking.'³⁵ Like Rasmussen, he notes that 'In the soils of South, and to some extent Central, China there has been a great deal of leaching of nutrients.'³⁶ He quotes Richardson to the effect that 'It is obvious to the discerning eye that most Chinese soils are nutrient deficient...', and hence there is a need in North China for 'nitrogenous fertilizers and organic matter'.³⁷ It would be interesting to know what effect the huge amount of re-cycling through the traditional use of human night soil had on the vitamin content of vegetables.³⁸

Mark Elvin, in a personal comment on Rasmussen's theory writes as follows. 'Late-imperial Chinese diet is hard to analyze for two main reasons: (i) the exact nature of many recorded 'vegetables' (in the broad sense) is unclear, and (ii) the recorded presence of an item in the local gazetteer of an area rarely goes beyond, at best, indicating "widely grown", "regularly eaten" or, on the other hand, "not much cultivated", so the extent of consumption is problematic. This said, there were a lot of second-or-third-level sources of carotendoids (and calcium, too) mostly from the dark leaves of various vegetables.' He lists a number of these, of numerous kinds, and concludes that 'Demonstrating crucial deficiency in vit. A from this dietary end may not be an easy matter.' This is a note of caution, but if it is true that retinol only comes from animal sources, these vegetables would not help there. Certainly in Japan, it is not difficult to see how the virtual elimination of animals from the Japanese diet over the centuries, and even of their products such as cheese, milk and eggs, probably had a considerable effect.

The problem, however, is that we are dealing with an effect (myopia) which has a set of inter-acting causes. The effects of nutrition undoubtedly inter-act with genetic factors (the shape of the eye, heredity) and the next major causal factor, eye-strain through close work. This can be seen in the present situation in Japan. Currently, as we have seen, there are extremely high rates of myopia among Japanese school-children. Yet they have free school milk and nowadays eat a lot of meat, cheese and vegetables. From this one might surmise that this rules out the role of vitamin A deficiency. This is clearly the case now, but it may well be that in the past it was an important contributory factor, weakening the eyes, causing difficulty in reading in dark class-rooms etc., and hence exacerbating the effects of close work. The fact that the diet is now much richer in vitamin A has been more than compensated for by added pressure on the eyes through various kinds of strain which I shall discuss shortly. All of this contrasts very strongly both with the earlier eating patterns of the Mongoloid peoples when they were hunters or pastoralists, and with the high animal protein diets for which western Europe and particularly

³⁵ Scott, p.49

³⁶ Scott, p.50

³⁷ Scott, 52.

³⁸ For an account of night soil in Japan, e.g., see Macfarlane, *Savage Wars*, pp. XXX

north-western Europe (Holland, Scandinavia and above all England) were famous in the past. Clearly there are some intriguing leads to be followed.

The eye-strain thesis.

Rasmussen' second theory was that nutritional deficiency was compounded by various features of Chinese daily living which caused unusual pressure on the eyes. He here develops the well known 'eye strain' thesis which currently dominates research on myopia. He argues that the effects of malnutrition were increased by 'the strains, pressures and contractions' caused by straining the eyes. The distortions, he argued 'must take the form of flattening in the horizontal plane, elongation of the part of the axial diameter, contraction or tapering of the ciliary region, with increased curvature and forward displacement of the crystalline lens. The sum of these distortions, varying with each individual, squeezes the optical system away from the retina, lengthening the distance between the retina and the nodal points.' (see diagram)

What then were the causes of the 'strains, pressures and contractions', and is there anything unusual which might suggest that they were worse in China (and Japan, Taiwan and Singapore) than in other civilizations? Here Rasmussen develops an intriguing chicken and egg argument. The tendency towards myopia (nutritional?) led the Chinese to concentrate on close, intricate work, which then made their myopia worse. For instance, he writes that 'their gross abuse of sight, uncorrected for many hundreds of generations, not only affected their art and tendency to concentrate on literary pursuits to the exclusion of outdoor games and sports...'(p.20) He expands on this by writing that 'the myope, whose distance vision is blurred from early life, more often than otherwise seeks tasks he can see distinctly - those at close quarters, books, writing, drawing, painting and so forth.'(p.53)

This takes Rasmussen to a discussion of the early development of Chinese literature for, like Japan, it was a great literary civilization with a higher concentration on writing than any other. Close attention to writing and reading put an extra strain on the eyes, but was added to by other favourite pastimes and occupations. He draws attention to the early and extensive development of calligraphy and painting which required 'intensive use of the sight' and to porcelain and cloisonnee manufacture 'both arts requiring intensive use of the sight'.(p.55) He expands on this elsewhere. Asking what the 'Chinese' have been doing with their eyesight for some two thousand years that should not be done' (p.62) he suggested that 'First they developed an organised society, bound by and committed to the written word, a civilization - through - the -eyes, long before existing Western civilizations.' He draws attention to the ubiquity and reverence for the written word in the Chinese past and present.(p.62) So he concludes that 'All of these things taken together mean just one thing: that the Chinese used their eyesight for fine and difficult tasks, on a wider scale throughout the community and for centuries before Western peoples.' (p.57)

The situation was compounded by the lack of glass windows and of appropriate furniture,

which added to the strain. In relation to craftsmen he writes that their 'handicraftsmen worked in ill-lighted barns and back-room "factories"... one-story huts, insanitary and illuminated by little more than "porthole" windows, shut by... oiled paper roller blinds to keep out sun and wind.' (p.63) The problem was particularly serious in relation to education. It is well known that myopia tends to develop in children between the ages of three and eight (Rasmussen, Causes, 2,11) Accompanied by the famous photograph of children crouching over their work he wrote at length about the study habits of children. For example, that the 'writer has seen children resting their left cheeks on the left fists while pointing to characters or writing with the right hand scarcely two inches away. It was not uncommon a few years ago in China to see a class of children bent low over their books, the only part of their heads visible to the teacher being the tops.' The 'over-concentration on written characters as a source of learning... was bound to create eyestrain and seriously develop inherent tendencies'. Classrooms 'were not merely poorly illuminated, but in most cases hardly illuminated at all.' (pp.57-8) In his work on 'Old Chinese Spectacles' he summarized the effects of close work as follows. 'Improper housing, imperfect light and illumination, impossible study and school methods, and an Ancestry of studious book-learning all serve to bring about this condition.'³⁹

Suppose we take the thesis that intensive education, particularly when combined with a difficult script, is highly significant, what evidence is there for this? One way to proceed would be to look at class and occupational differences. Very early work at the start of the twentieth century suggested much higher rates of myopia in the higher classes, who were presumably more intensively educated.⁴⁰ Particularly interesting are two cases. One is the very high incidence of myopia in parts of traditional Germany. Rasmussen noted, as we have seen, that 'with the exception of Germany', rates in the west were relatively low. In 1910 Souter noted in passing that the figures for myopia in close workers was 'about 25 per cent in this country and about 50 per cent in Germany', but did not go on to speculate on the reasons.⁴¹ The figures and an intriguing hypothesis were made by Harman in 1916. He writes that 'The first estimates of the incidence of the defect were made by Cohn in Germany, and the report which he gave was alarming. Amongst the children attending the gymnasium or higher schools he found the percentage exceedingly high, and increasing from the lowest classes to the highest. The figures varies from 15.5 per cent. in the lowest class to 55.8 per cent. in the highest...' On the contrary, in England, 'the figures are much better. I have published the returns of 2500 London school children who had bad vision: 68 per cent. were hypermetropic [long sighted] and 32 per cent. myopic.... These defective children represent about 10 per cent. of the school population, so

³⁹ Rasmussen, Old Chinese, 22

⁴⁰ Reported in Souter, Refraction in Eye, 1910,226; for example in Konigsberg, Russia, there was 11 per cent of myopia in the lowest classes and 62 per cent in the highest, in New York the contrast was between 3.5 and 27 %.

⁴¹ Souter, Refractive Eye, 218

that it follows some 3 per cent. of the children are myopic.⁴² How can this be explained he asks, and answers that 'Part of this difference may be due to the different reading types: the gothic type of Germany is particularly difficult to read, and certainly engenders eye-strain in even normal eyes.'⁴³

Another intriguing case are Orthodox Jewish males, made to read, learn and intensively study from very early onwards. It has been noted that '...teenage Orthodox Jewish male students, who had considerable near work requirements, had much higher prevalences of myopia (81.3% compared with 27.4% of males in general schools).'⁴⁴ This might be related to wider features, for example Trevor-Roper's suggestion, noted earlier, that 'Semitic races are also prone to myopia, often of high degree, while this is very rarely found among Nubians.'⁴⁵ But the fact that 'Another survey of Orthodox Jews, found that men had much higher rates of myopia than women' was explained by the 'the fact that the men spent several hours a day, from an early age, reading religious texts (and the women didn't)⁴⁶, suggests a more likely cause.

It would be intriguing to pursue this, given the extraordinary rate of over 80% myopia among Orthodox male Jews. All sorts of connections with personality, close work in the jewel-cutting or other occupations, might be suggested along the lines which I shall develop later when I analyse the effects of high myopia in Japan.⁴⁷ Just one amusing possible effect is worth recounting in relation to the famous effect of myopia on games playing. A television program in July 1999 entitled "The Worst Jewish Football Team in the World" showed a team of under 13 players in the north Manchester league lost 17-0, 20-0, 23-0, 25-0. Intriguingly their sponsor was a local optician - who had perhaps got to know many of them quite well. He 'said that he hadn't known when he agreed to sponsor them just how bad they were. When he did see them, his first thought was that they needed their eyes testing, though most of them were already wearing glasses'. One of the young boys suggested the following reason why they were different from other teams: "They just pass it while we're busy standing there or sitting down or whatever".⁴⁸ The optician may well have been right; even with glasses, as I noted in Japanese and Korean schools where the children brought their faces right up to their reading, distant vision may be difficult. Better to sit down and wait until the ball bumps into you.

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⁴² Harman, Eyes, 1916, 49

⁴³ Harman, Eyes, 53

⁴⁴ Myopia Book, 51

⁴⁵ T-Roper, Blunted,20

⁴⁶ Independent, 20.5.1999

⁴⁷ This gives a new twist to XXX well-known books trying to argue that the Jews and the Japanese are basically the same people, see XXX

⁴⁸ Unfortunately I missed the film, which is here described by Robert Hanks in the Television Review for the Independent on 7 July 1999,p.16

Let us look a little more closely at some of the discussions concerning the effects of close work. The connection has been suggested for a very long time. In the work of Ramazzini, published in 1713, there was a chapter on the disastrous effects of fine work and what could be done about it.⁴⁹ Moving on nearly two centuries, Browning in a widely re-printed text-book (17th edition, 1896) wrote that 'Short-sight is due to two causes: - concentrating our attention almost exclusively on near objects - as in reading, drawing, needlework, etc.; and never using our eyes for any length of time in examining objects at a distance. Small-type school-books are most destructive of the sight, especially for very young children.'⁵⁰ Half a century later, Parson and Duke-Elder wrote that 'There is evidence that habitual close eyework, such as that of clerks, seamstresses, compositors, &c., if habitually undertaken in poor illumination and poor hygienic conditions, is harmful to the eyesight of myopes...'⁵¹

It is not just a matter of small print or bad light, but a whole set of factors, and these were explored in depth a few years later by West. In a chapter on 'Eye Strain' he shows how such factors as posture, poor definition, poor contrast, the actual size of objects, poor legibility, all have considerable inter-acting effects. There are photographs of processes such as sewing, embroidering, stereo finishing, print setting, threading a needle, which are all affected by the compound interplay of small detail, poor contrast, close viewing distance, bad light and so on.⁵² He suggests that the reason for the strain is that 'It is a natural consequence of the possession of visual apparatus constructed for minutely discriminative seeing that we are always impelled to adjust the eyes themselves to give us the sharpest and clearest picture of any object at which we look.'⁵³

A recent standard over-view collection on myopia suggests that the 'environmental factor that is frequently associated with myopia is near work'. A number of reviews of research 'show that the prevalence of myopia is greater among persons who have occupations requiring near work. As a group, myopes do more reading and nearpoint activities...'⁵⁴ Particularly important is education. 'Bear... concluded, "the association of myopia with formal education is strong, remarkably consistent, and dose-dependent"'.(p.65)' Furthermore 'Myopia is less common in populations in which there is no compulsory schooling...'⁵⁵ At a broader level, it is noted that 'Cross-sectional studies have shown that factors associated with higher prevalences of myopia

⁴⁹ Bernadino Ramazzini, **De Morbis Arificum**, published in Padua in 1713, English trans. by Wilmer C.Wright, Univ. Chicago Press, 1940; cited in West, Sight, p.29

⁵⁰ Browning, Our Eyes,109

⁵¹ Parson and Duke-Elder, 1948

⁵² West, Sight, pp.50ff.

⁵³ West, Sight, 28

⁵⁴ Myopia Book, 51

⁵⁵ Myopia Book, 51

include occupations requiring higher levels of near work, higher educational status, and higher socioeconomic status.⁵⁶

As for the actual mechanism which links close work and eye strain, the same source describes it thus. 'One hypothesis suggests that sustained accommodation causes increased intraocular pressure in the vitreous chamber, which then causes stretching of the posterior segment and axial myopia.⁵⁷ This is put in a slightly different way later. 'A commonly held theory today is that defocus of the retinal image, such as by a high lag of accommodation during reading, induces accelerated axial elongation of the eye and produces myopia.'⁵⁸ Another suggestion is that 'Reading for too long at an early age produces a spasm in the accommodative muscle of the eye - the ciliary muscle. This chronic tension elongates the eyeball'.⁵⁹

One example of what happens is reported in the **Independent** article. 'A British study revealed that workers who spent eight hours looking at samples through microscopes became myopic after just two years.' Dr Ian Flitcroft is quoted as saying "The researchers measured the eye lengths of these adults when they started the job, and went back a few years later and a third of them had become myopic; their eyes had ended up too long. Within two years the eyes had started to change...'⁶⁰ Another expert, Dr Richard Wormald states in the same source that 'Human beings are extraordinarily adaptive to their environment, and if you spend most of your time focusing on near objects they will adapt.'⁶¹ It is perhaps because of this attention to minutely detailed writing over long periods of time that has led to what is known as 'Lawyer's Myopia'. Famously in **Some Like It Hot**, Marilyn Monroe made the connection and sought a man who was prematurely wearing glasses as a result of scanning the tiny figures of stock exchange transactions in the newspapers.

Here we come to one of the most intriguing parts of the argument. If attention to detail and close work in bad light over long periods affects the eyes, and if it is more than a matter of direct eye-strain, but also, as we now know, the connection between the eyes and the brain, in other words the amount of concentration that is being performed, we might look at the question of education and writing anew. Western opticians have long suggested that the increasing hours of school work of our pressured lives may be driving up the rates of myopia (along with other suggestions such as computers, television etc). As Wormald notes, the 'amount of time children spend studying has increased compared with even a few years ago and Flitcroft states, 'What is different and quite remarkable about the Far East is the amount of school work done by children, six hours at school and another six hours' homework. Teenage homework diaries are quite

⁵⁶ Myopia Book, 21

⁵⁷ Myopia Book, 51

⁵⁸ Myopia Book, 59

⁵⁹ Quoted, without reference in Goodrich, Perfect Sight, 35

⁶⁰ Independent, 20.5.99

⁶¹ Independent, 20.5.99

outrageous'.⁶²

This is indeed true. I have spent some time in Japanese and Korean schools, and talked to parents and academics about the situation, and the hours are indeed extraordinary. Children in Japan often go to pre-school and start serious education when they are three or four. When they are in primary school they do very long hours. I summarized my visit to a Korean girls middle school as follows. 'Visit a girls' middle school and am allowed to film a class learning Korean.... Children start school at 8.30 am., finish at 4.30 pm, then go to "crammers" where, in bad light and general noise, they continue to study until 10 pm. We were told that when they return home they often engage in internet chat until 2 am. Their eyes have about five hours' rest.'⁶³ By the age of seventeen, they might well have extended the cramming period to beyond midnight. There are very few breaks for games, cultural activities or anything else.

We may think that this is a new phenomenon, and it is true that pressures have famously increased. But it has for very long been a feature of a Confucian influenced culture where education and learning the classics meant so much. An excellent account of the examination system in the nineteenth century in China itself by Dyer Ball gives a slight indication of the pressures of intensive education. In an article on 'Examinations', describing the system of civil service examinations which lasted until 1903, he writes as follows. 'In this strange land there was in vogue for centuries, and even millenniums, a system of examinations, which originally started with the object of testing the ability of these already in office, gradually widened in scope till it became all-embracing in point of geographical extent, and was the test of ability which all had to undergo who desired admission into the Civil Service of the immense empire with its thousands of official; with this end in view, boys were incited to learn their lessons and be diligent; with this aim, men pursued their weary course of study, year in and year out, till white hairs replaced the black, and the shoulders, which at first merely aped the scholarly stoop. eventually bent beneath the weight of years of toil. No other country in the world presents the curious sight of grandfather, father, and even son, competing at the same time.' He describes how people went on trying to pass until their eighties, with 'untiring perseverance and indefatigable toil.'

This system was 'widespread as the empire: every petty district city even had its Examination Hall...Out of the two thousand or so, only twenty of the best received the degree...meaning 'budding genius' [equivalent to a B.A.] This gave admission into the lower ranks, exemption from corporal punishment, entitlement to wear the lowest grade of gold button on their hats etc. The next exam, equivalent to an M.A., lasted through 'three sessions of nearly three days each'. The tiny proportion who passed this, 'still got no appointment, nor office, but rose higher in the public estimation, wore a grade of gilt button' and could put on their houses 'Promoted men'. Lots were drawn for vacant posts and possibly they might get a job. The extraordinary locking up of the candidates so that they could not cheat and the strain they were under is well

⁶² Independent, 20.5.99

⁶³ 'Don's Diary' THES 7.7.2000

described.⁶⁴ This is just part of a system which one can still see reflected if one visits a Japanese school, where enormous pressures to memorize classical writings and master a vast literary inheritance through a maze of complex language puts enormous pressure on young children. Likewise, the fact that education is the one gateway to a good job and status in a meritocratic civilization puts huge pressure on parents and children. The fact that big department stores have areas which specialize in recommending and selling the appropriate clothes for mothers who are taking their tiny infants for an interview at a good kindergarten is just one tiny mirror of this. Likewise the famous images of Japanese children sitting past midnight, literally holding their eye-lids open with match-sticks in the cramming establishments, are true to life. But it is not just a matter of the hours or work, the lighting, the pressures, there is probably something else which has scarcely been noticed but I think is just as important. This is the nature of what is being learnt, and in particular the writing system.

When I talked to Dr. Tokoro and asked him what he thought was really crucial, beyond the long hours, and he suggested, though it is not in his article, that the extreme pressure was caused by trying to write and memorize the three vocabularies which constitute Japanese writing, in particular the two or three thousand 'kanji' or Chinese characters which are essential even to read a newspaper. This is so difficult that almost half the time that a Japanese child spends in school is devoted to language learning - hence putting pressure on other subjects and lengthening the studying day. The characters are very intricate, have to be very accurate (and preferably beautifully executed in a world that values calligraphy so highly), and above all remembered for life. This is a subject that needs to be expanded, but three things can be said here now.

Firstly, that it seems more than a coincidence that the high myopia belt is concentrated in the places where the Chinese characters are learnt. Singapore, Taiwan, China and Japan are the most extreme cases. Korea is a very interesting example. The pressure of hours and cramming, as I have noted. But the Koreans developed a phonetic script (hangul) in the fifteenth century and this is now used in all teaching until High School. So language learning only constitutes about one sixth, rather than a half, of the school lessons. So one has the school pressure (including little things like the fact that girls have their hair cut in a way that makes it fall over their school books so that there is poor light on the book, even though the windows are large). But one does not have the Chinese characters. What are the results in terms of myopia figures?

Intriguingly, they are just what one might predict - intermediate between Japan and the West. A small survey by Kimberly Prendergast suggested that in two elementary schools (average age 9.5), the proportion of children wearing eyeglasses was between 8-12%. IN a boys middle school, aged 12-14, the averages were between 10-20%, and in a girls school, one quarter of the 12 students in one class had glasses. In the 15 year old class I visited, about one third of the 36 pupils were wearing glasses. A little over a third of 54 elementary school teachers wore

⁶⁴ Ball, Things Chinese, 226-9

glasses.⁶⁵ The general impression from these figures is that the proportions lay exactly between the rates one would find now in Japan or England. Unprompted, the English master said that he believed that children's eyes were getting worse, and all the teachers were hostile to the crammers, but said nothing could be done because the 'biggest problem in Korea' was parental pressure on their children to study hard and get into a good University, preferably in Seoul. Many families ruin themselves paying for this extra tuition.

Returning to the more general level, we may conclude as follows. We now have some idea of some of the inter-acting factors which lie behind fluctuations in rate of myopia. Of particularly importance are nutrition and especially close work. We note that the extraordinarily high rates of myopia in Japan and Singapore nowadays are likely to be closely related to the educational system, and perhaps the learning of Chinese characters. What remains to be investigated is the long-term evolution of this situation and its possible consequences on differences between Eastern and Western Eur-Asia.

⁶⁵ I am extremely grateful to Kimberley Prendergast for carrying out this survey of 14 school classes and three sets of elementary school teachers and for processing the statistics, as well as for being our hosts and arranging for the visit to the school.