**RACE, SEX AND ENVIRONMENT IN THE
DEVELOPMENT OF MYOPIA***
(Preliminary Communication)

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THE presence of a large Jewish population in the East End of London offers exceptional facilities for the study of racial differences in errors of refraction by making comparison between the Jewish and non-Jewish populations. There is also the fact that the Jewish boys in the East End do an exceptionally large amount of close work, which affords an opportunity of testing the effect of close work on the production of myopia by investigating whether an undue percentage of myopes is developed among the Jewish boys as they go through their school life.

It will not be out of place to say a few words about social conditions among Jews in the East End. As immigration into this country has practically ceased since 1914, the children attending the elementary schools are almost all born in this country, though in the vast majority of cases their parents are of Polish or Russian origin.

The children are brought up in very much the same way as the non-Jewish child population, except in the case of the boys, who in addition to attending the ordinary elementary day school, also attend classes for the study of Hebrew for two and a half to three hours every evening (except Friday and usually also Saturday when there is no attendance, and Sunday, when attendance is in the morning).

The conditions under which these studies are conducted are by no means ideal. The vast majority of the classes are held in rooms and buildings that ought never to be used as school rooms. In addition the lighting conditions are often exceedingly bad. (Much of this is being rectified owing to the activities of the fairly recently established Jewish Health Organization of Great Britain.)

Those acquainted with the Hebrew alphabet know how tiring its letters are on account of the alternate thick and thin strokes, and the little difference (such as a slightly longer thin stroke) that exists between one letter and another. Difficult as these conditions are they are made still more difficult by the fact that the books in use are almost all badly printed, poor type on poor paper; and as the schools are supported by voluntary contributions they

* This investigation was carried out under the auspices of the Jewish Health Organization of Great Britain.

experience the usual financial embarrassment associated with such institutions, so that in most schools only one book is provided for the use of two pupils. All this together with improper use or the total absence of desks, must throw a strain on the eyes, such as the non-Jewish boys can hardly experience.

In the East End, therefore, there exist conditions; which, if the theory that excessive close work is productive of myopia be true, should produce an abnormally high percentage of visual defectives among Jewish boys; and furthermore, a group of East-End boys from 6 years to 14 years should show a progressive increase in the number of defectives with each year of school life, greater than that (if any) among non-Jewish boys. For any comparison to be made it will, of course, be necessary to have corresponding data about the two groups of children.

The incidence of visual defect in the non-Jewish children has been established by many observers, but unfortunately most statistics on the subject are vitiated by some factor or other. Thus some observers give the vision with both eyes open simultaneously; others (including the London County Council authorities) test vision with such glasses as the child may have. From various sources it would appear that the defectives (vision less than 6/9) constitute about 20 per cent. of the non-Jewish child population.

However, in order to have strictly comparable figures Drs. F. G. Thomas and G. Chaikin of the London County Council have very kindly undertaken a special investigation among non-Jewish boys, conducted under conditions identical with those under which the inquiry among Jewish boys was carried out.

One thousand six hundred and forty-nine boys in the Hebrew Evening Classes (Talmud Torahs) were examined for visual acuity. Each eye was tested separately, and the child classified in the group corresponding to the eye with poorer vision.

On a similar basis 600 non-Jewish boys were examined at London County Council Schools in the East End.

TABLE I.

Showing the proportions of good and defective vision among Jewish and non-Jewish boys in the East End of London.

Subjects.	Total number.	Ages.	Vision of 6/9 and 6/6.	Vision of 6/12 and 6/18.	Vision less than 6/18.
Jewish boys ...	1,649	6-14	56.8%	22.1%	21.1%
Non-Jewish ...	600	8-14	78.3%	15.0%	6.7%

Table I shows that whereas among the Jewish boys only 56.8 per cent. succeeded in passing the test for good vision (6/9 or better) among the non-Jewish boys as many as 78.3 per cent. passed; that is 43.2 per cent. among Jewish and 21.7 per cent. among non-Jewish boys are defective. The incidence, therefore, of visual defect among Jewish boys is undoubtedly considerably greater than among non-Jewish boys; it is in fact double.

The figures on the whole are in agreement with those published in the Report for 1924 of the School Medical Officer for the London County Council. There the findings were that among "Leavers" the defectives (6/12 or worse) among Jewish boys constitute 43.2 per cent. and only 20.9 per cent. among non-Jewish.

The suggestion that excessive close work is a cause of defective vision is therefore strong. But when we come to analyze the figures according to age (Table II) we are struck by the fact that the heavy incidence of defect among the Jewish boys is apparent

TABLE II.

Analysis of visual acuity among Jewish boys in the East End according to the different age groups.

Age group.	6/6.	6/9.	6/12.	6/18.	6/24 and less.
6 and under 7 ...	29		13		6
48 cases		60.4%		27.1%	12.5%
7 and under 8 ...	77		42		19
138 cases		55.8%		30.4%	13.8%
8 and under 9 ...	95		47		20
162 cases		58.7%		29.0%	12.3%
9 and under 10 ...	156		64		50
270 cases		57.8%		23.7%	18.5%
10 and under 11 ...	165		59		74
298 cases		55.4%		19.8%	24.8%
11 and under 12 ...	201		54		70
325 cases		61.8%		16.6%	21.6%
12 and under 13 ...	171		68		80
319 cases		53.6%		21.3%	25.1%
13 and under 14 ...	44		17		28
89 cases		49.4%		19.1%	31.5%
TOTAL	938		364		347
1,649		56.8%		22.1%	21.1%

at the very beginning of school life, at the age of 6; and is not very markedly less than towards the end of school life. If one ignores the groups at 6 years and 14 years (and they do not constitute very large numbers) the almost stationary percentage of defectives (about 43 per cent.) at the different age groups is really remarkable, and is not at all what one would expect, if the strenuous school life of the Jewish boys were productive of myopia. There is certainly but little evidence of any large decrease in the percentage with good vision among Jewish boys during school life.

It might be argued—and indeed some authorities do argue—that the percentage of children with good vision increases with advancing school age. This is almost certainly true of children up to the age of 8 years, as the cerebro-visual mechanism is not fully developed by then, but there is little evidence that the percentage with good vision increases after the age of 8. If among non-Jewish children the percentage of boys with good vision increases with school life, whilst among the Jewish it remains constant, then we are dealing with a relative increase of defect among the Jewish boys. The distribution of defectives according to age groups among non-Jewish boys is therefore of interest.

TABLE III.

Analysis of visual acuity among non-Jewish boys in the East End according to the different age groups.

Age group.	6/6. 6/9.	6/12. 6/18.	6/24 and less.
<i>8 and under 9</i> 100 cases	86	12	2
<i>9 and under 10</i> 100 cases	79	16	5
<i>10 and under 11</i> 100 cases	75	15	10
<i>11 and under 12</i> 100 cases	77	16	7
<i>12 and under 13</i> 100 cases	81	14	5
<i>13 and under 14</i> 100 cases	72	17	11

(This table shows the number of cases and the percentage simultaneously as 100 cases of each age group were taken.)

Whilst these figures are too small to draw any fine conclusions as regards the actual distribution of errors, it is felt that they justify the drawing of conclusions as regards the tendencies seen in childhood. Table III shows that, on the whole, among non-Jewish boys the percentage of good vision (about 77 per cent.) remains fairly stationary with progressing school life; the tendency is towards deterioration rather than towards amelioration. (The figures for the age group 8 are probably a "freak": the first 50 cases gave 12 defectives and the second 50 only 2.) The stationary percentage of cases with good vision among the Jewish boys therefore does not represent a relative deterioration, but shows a close parallel to the non-Jewish boys in the fluctuation it undergoes.

The evidence, therefore, is quite conclusive that Jewish boys have a much heavier incidence of visual defect than the non-Jewish, but also equally conclusive that it is present very early in school life and whatever deterioration takes place has its parallel among non-Jewish boys.

These figures suggest that the heavy incidence of visual defect among Jewish boys is racial rather than acquired and is not due to the strenuous school life to which the Jewish boys are subjected. But we require data about the actual refractive errors seen among Jewish children before any safe conclusion can be reached.

With this object in view the records of the London County Council Treatment Centres at the London Jewish Hospital and the Royal Eye Hospital were extracted to establish the relative incidence of the various refractive errors among the defectives in the Jewish and non-Jewish population, both these centres dealing mainly with the children that are found defective in the routine school examinations conducted by the London County Council.

It will be of interest to see whether Jewish defectives reveal a qualitative difference in the refractive errors in addition to the quantitative difference.

SECTION A

The type of refractive error seen among visually defective Jewish children and comparison with the Non-Jewish

From the records of the London Jewish Hospital 516 cases were extracted. These represent Jewish children only (who constitute about two-thirds of all the children attending the Eye Department of that Hospital). The ages vary from 5 to 14 inclusive, and the records date from April, 1923, to July, 1927.

A similar group of 892 cases of non-Jewish children comes from

the Royal Eye Hospital, the records dating from April, 1925, to July, 1927.

As there is no generally accepted method of analyzing the results of refraction, it is necessary to explain the purely arbitrary system adopted here.

The hypermetropes were divided into low and high according to whether they had less or more than 3D. of hypermetropia.

The myopes below 3 were regarded as low; between 3 and 6 as medium, and above that as high.

Astigmatism below 1.25 was ignored as such, but its value was added to the spherical error. Thus +2.5D. sph. $\bar{c}$ +1.0D. cyl. was regarded as simple hypermetropia of the high variety.

Similarly spherical errors below 1.25 were ignored in the classification of simple and compound astigmatism where astigmatism was the dominant error (astigmatism over 1D.).

Astigmatism between 1.25 and 3 was regarded as low; over 3 as high.

Only when opposite signs were present was the case considered as anisometropic; a marked difference in cases with the same signs, *e.g.*, (R. +6, L. +1), was classified according to the eye with the higher refractive error.

Mixed astigmatism calls for no explanation.

Finally, certain cases were not easily classified, and were grouped together as "Unclassified," *e.g.* :

In the Tables anisometropia, mixed astigmatism, and the unclassifiable cases are grouped as "Others." In some Tables (and it is indicated) this group was added (though the addition is clearly shown) to the myopes, on account of the myopic element they all contain.

An analysis of these 516 Jewish and 892 non-Jewish cases reveals that taking the broad classifications of hypermetropia (including hypermetropic astigmatism), myopia (including myopic astigmatism), and "Others" (which include mixed astigmatism, anisometropia and the cases difficult of classification), the difference in the distribution of refractive errors in these two racial groups is not very marked, apart from the rather higher percentage of myopes among the Jewish children.

TABLE IV.

Showing the distribution of refractive errors in the two groups of visually defective children :

<i>Jewish Children.</i>		<i>Non-Jewish.</i>
Total 516.		Total 892.
320=62%	Hypermetropia and Hypermetropic Astigmatism.	620=69.5%
130=25.2%	Myopia and Myopic Astigmatism.	180=20.2%
66=12.8%	"Others."	92=10.3%

A further subdivision of the above cases is of interest.

TABLE V.

Showing the comparative percentages of errors in the several subdivisions.

(a) *Subdivision of Hypermetropia.*

<i>Jews.</i>		<i>Non-Jewish.</i>
Out of 320 Hypermetropia and Hypermetropic Astigmatism.		Out of 620 Hypermetropia and Hypermetropic Astigmatism.
184=57.3%	Simple Hypermetropia	349 = 56.3%
	Simple and Compound Hypermetropic Astigmatism	
136=42.7%		271 = 43.7%
Out of 184 Simple Hypermetropia.		Out of 349 Simple Hypermetropia.
117=63.5%	Low Hypermetropia	170 = 48.7%
67=36.5%	High Hypermetropia	179 = 51.3%
Out of 136 Simple and Compound Hypermetropic Astigmatism.		Out of 271 Simple and Compound Hypermetropic Astigmatism.
	Simple and Compound Low Hypermetropic Astigmatism	
85=62.5%		190 = 70.1%
	Simple and Compound High Hypermetropic Astigmatism	
51=37.5%		79 = 29.9%

(b) *Subdivision of Myopia.*

Out of 130 Myopia and Myopic Astigmatism.		Out of 180 Myopia and Myopic Astigmatism.
99=76.1%	Simple Myopia	136 = 75.5%
	Simple and Compound Myopic Astigmatism	
31=23.9%		44 = 24.5%

Out of 99 Simple Myopia.		Out of 136 Simple Myopia.	
70=70.7%	Low	102 = 75.0%	
22=22.2%	Medium	28 = 20.6%	
7= 7.1%	High	6 = 4.4%	

(c) *Subdivision of "Others."*

Out of 66 cases.		Out of 92 cases.	
17=25.7%	Anisometropia	23=25.0%	
32=48.6%	Mixed Astigmatism	30=32.6%	
17=25.7%	Unclassified	39=42.4%	

We have seen from Table IV that myopia is rather more common among the Jewish children (25.2 per cent. against 20.2 per cent. of the total number of defectives). Table V reveals that the Jewish hypermetropes show many more with low hypermetropia than the non-Jewish (63.5 per cent. of the total hypermetropia as against 48.7 per cent.), but apart from the greater incidence of myopia (including mixed astigmatism), and of the lower degrees of hypermetropia there is but little difference in the two groups. The percentage of astigmatism, whether myopic or hypermetropic, as compared with the purely spherical errors (23.9 per cent. and 42.7 per cent. respectively among Jewish children, against 24.5 per cent. and 43.7 per cent. among the non-Jewish), is practically identical in each group. (Though there seems to be a greater incidence of high hypermetropic astigmatism among Jews.) These figures, therefore, lend no support to the suggestion that astigmatism is rare among Jews (K. Pearson), though there is some force in the belief that hypermetropic astigmatism is more common among them (Javal), when one remembers that though the percentage of astigmatism in the two groups of defectives is the same, we are dealing with a population that has about double the number of defectives. But then the same remark is true of myopia and also of hypermetropia.

The dominant suggestion of these Tables is that whilst hypermetropia—simple or compound—is the predominating refractive error in both Jewish and non-Jewish children, low hypermetropia is the common error among the Jewish hypermetropes, whilst high hypermetropia tends to be more common among the non-Jewish.

The excessive incidence of low hypermetropia among the Jewish children suggests an explanation of the rather high incidence of myopia among Jews.

The Tables, however, do not tell us whether the low hypermetropia seen among Jewish children is a congenital and a racial factor or the result of environmental conditions (such as excessive close work) which reduces an original high reserve of hypermetropia.

As the Tables deal with the rather long period of ten years it was thought advisable to subdivide them into two periods of five years each, from 5 to 9 (inclusive) and 10 to 14 (inclusive), and see how far low hypermetropia is still more common in the first period among Jews as compared with non-Jews at the time when the effect of school life cannot have been very marked.

TABLE VI.

Showing the distribution of refractive errors in the two groups of visually defective children arranged in two Age-Groups, 5-9 (Period I) and 10-14 (Period II).

<i>Period I.</i>			
Jewish total 170.		Non-Jewish total 315.	
42=23.9% } 43=24.4% }	48.3%	60=19.4% } 40=12.7% }	32.1%
Low Hypermetropia			
Astigmat. c̄. " "			
34=19.3% } 23=13.1% }	32.4%	89=28.3% } 72=22.8% }	51.1%
High Hypermetropia			
Astigmat. c̄. " "			
16= 9.1% } 18=10.2% }	19.3%	32=10.2% } 22= 6.6% }	16.8%
Myopia			
Others			
<i>Period II.</i>			
Jewish total 340.		Non-Jewish total 577.	
75=22.1% } 48=14.1% }	36.2%	110=19.7% } 85=14.6% }	34.3%
Low Hypermetropia			
Astigmat. c̄. " "			
33= 9.7% } 22= 6.5% }	16.2%	90=15.4% } 74=12.7% }	28.1%
High Hypermetropia			
Astigmat. c̄. " "			
114=33.5% } 47=14.1% }	47.6%	148=25.5% } 70=12.1% }	37.6%
Myopia			
Others			

From Table VI it is seen that between the ages of 5 and 9 low hypermetropia (simple and compound) accounts for 48.3 per cent. among Jews and only for 32.1 per cent. amongst non-Jews, whereas 32.4 per cent. and 51.1 per cent. constitute the percentage of high hypermetropia for Jews and non-Jews respectively. The percentage for myopia is remarkably similar, 9.1 per cent. and 10.2 per cent. respectively, though the unclassified errors (anisometropia, mixed astigmatism, and those difficult to classify) show a rather heavier percentage amongst the Jews (10.2 per cent. against 6.6 per cent.). Thus even among young Jewish children low hypermetropia is more common than high hypermetropia, the reverse being true for non-Jewish children. This tends to confirm the suggestion that Jewish children on the whole have a tendency to low hypermetropia and non-Jewish children to high hypermetropia, and that the excessive number of myopes is a

concomitant to the excessive number of low hypermetropes. The quantitative differences in the hypermetropic errors in young Jewish children would explain the qualitative differences in their myopia in later life.

Still it might be argued that whilst it is true that Jews have many more low hypermetropes, that would not explain the rise from 19.3 per cent. of myopia in the first period to 47.6 per cent. in the second period in the case of Jews, whilst in the non-Jews it only rises from 16.8 per cent. to 37.6 per cent. the increase of myopia in the case of Jews being 28.3 per cent. against 20.8 per cent. amongst non-Jews. It might be urged that a difference of nearly 8 per cent. in the myopes is too large when the difference in the incidence of low hypermetropia (in the first period) is only 16.2 per cent. and that, after all, the excessive close work causes the excessive incidence of myopia.

Before such criticism can be countered it is necessary to establish the percentage of low hypermetropes of the first period that become myopes in the second period, and to see whether an unduly high percentage of Jewish low hypermetropes pass over to the myopes. Unfortunately we know but little of this particular phase of the growth of the eye. The procedure suggested is impossible with the available material but the following calculations based on Table VI are an attempt to evaluate the percentage of low hypermetropes (of the first period) who lose their hypermetropia (thus becoming emmetropes or myopes). If close work is responsible for the excessive reduction of hypermetropia, the Jewish children should show a large percentage of low hypermetropes who lose their hypermetropia. Whilst this attempt to reduce the facts to mathematical exactitude might be open to criticism it does not influence the conclusions reached so far on general principles.

Calculation to show the percentage of low hypermetropes in each group who lose their hypermetropia during school life.

Number of Low Hypermetropes among Jews in 1st period=48.3%					
"	High	"	"	"	" =32.4%
"	Low	"	"	2nd	" =36.2%
"	High	"	"	"	" =16.2%

Therefore the high hypermetropes of the first period have lost
 $32.4\% - 16.2\% = 16.2\%$.

It is reasonable to assume that these went over to the low hypermetropes of the second period.

And since the low hypermetropes in the second period constitute 36.2 per cent., 16.2 per cent. of which have been recruited from the high hypermetropes of the first period, there are left 36.2 per cent. - 16.2 per cent. or 20.0 per cent. of the original

48.3 per cent. of low hypermetropes of the first period. Therefore out of 48.3 per cent. low hypermetropes 28.3 per cent. have become emmetropes and myopes; 28.3 per cent. out of 48.3 per cent. constitute a percentage of 58.6 per cent.; therefore 58.6 per cent. of Jewish low hypermetropes lose their hypermetropia. A similar calculation yields a result of 64.8 per cent. of non-Jewish low hypermetropes losing their hypermetropia.

These figures are more favourable to the Jewish low hypermetropes than to the non-Jewish, fewer among the Jews losing their hypermetropic reserve. All the evidence points to the fact that the Jewish myopes are recruited from the low hypermetropes by a perfectly parallel process to that obtaining among the non-Jewish children and the excessive number of myopes is fully explained by the excessive number of low hypermetropes in early childhood, and not by some extraneous factors which turn a hypermetrope into a myope. Taking Jewish children as a whole there is no need to call in any other factor (such as excessive close work, badly illuminated evening schools, etc.), besides the purely racial factor of an excessive incidence of low hypermetropia and a relative absence of high hypermetropia to explain the prevalence of myopia.

SECTION B

An analysis of the refractive errors in relationship to sex

The conclusions reached in Section A might be objected to on the strength that Jewish children and non-Jewish children are not strictly comparable in the one important environmental factor which the figures attempt to prove as being of no importance, namely, the question of close work. To group Jewish boys and girls together is not as justifiable as to group non-Jewish boys and girls together.

The non-Jewish boy does no more close work than the girl, but the Jewish boy does decidedly more than the Jewish girl. Most of the Jewish girls do not attend the Talmud Torahs (evening religion classes), and when they do so it is for decidedly less strenuous learning both in quality and time. The Jewish girl is much more closely allied to the non-Jewish boy and girl than to the Jewish boy in the question of excessive close work. It is, therefore, advisable to analyze the refractive errors in four groups—Jewish boys, Jewish girls, non-Jewish boys and non-Jewish girls, and following the subdivision adopted before, classify each group into the two periods of 5—9 and 10—14.

TABLE VII.

Subdivision of the Jewish section of Table VI according to sex.

<i>Period 1.</i>						
Boys.				Girls.		
23.	25.3%	} 45.0%	Low Hypermetropia	19.	22.1%	} 50.0%
18.	19.7%		Astigmat. c. " "	24.	27.9%	
20.	21.9%	} 34.0%	High Hypermetropia	14.	16.3%	} 31.4%
11.	12.1%		Astigmat. c. " "	13.	15.1%	
8.	8.9%	} 21.0%	Myopia	8.	9.3%	} 18.6%
11.	12.1%		Others	8.	9.3%	
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91				86		

<i>Group 2.</i>						
Boys.				Girls.		
29.	17.4%	} 28.8%	Low Hypermetropia	46.	26.8%	} 42.5%
19.	11.4%		Astigmat. c. " "	27.	15.7%	
17.	10.1%	} 15.5%	High Hypermetropia	16.	9.3%	} 17.9%
9.	5.4%		Astigmat. c. " "	15.	8.6%	
68.	40.7%	} 55.7%	Myopia	46.	26.8%	} 39.6%
25.	15.0%		Others	22.	12.8%	
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167				172		

TABLE VIII.

Subdivision of the non-Jewish section of Table VI according to sex.

<i>Group 1.</i>					
Boys.			Girls.		
30.	20.0%	} 31.7%	30.	18.6%	} 32.2%
18.	11.7%		22.	13.6%	
43.	28.0%	} 54.8%	46.	28.4%	} 47.4%
41.	26.8%		31.	19.0%	
11.	7.0%	} 13.5%	21.	13.0%	} 20.4%
10.	6.5%		12.	7.4%	
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153			162		

<i>Group 2.</i>					
Boys.			Girls.		
43.	15.6%	} 26.9%	67.	22.2%	} 39.7%
31.	11.3%		53.	17.5%	
47.	17.1%	} 32.0%	43.	14.3%	} 25.6%
41.	14.9%		34.	11.3%	
79.	28.7%	} 41.1%	69.	22.8%	} 34.7%
34.	12.4%		36.	11.9%	
<hr/>			<hr/>		
275			302		

Table VII shows that the refractive errors taken in the broad classification of low hypermetropia, high hypermetropia, and myopia, show but little difference in the case of Jewish boys and girls in the first period (5-9), but in the second period (10-14) the myopes among the boys have gone up from 21 per cent. to 55.7 per cent. against only from 18.6 per cent. to 39.6 per cent. in the case of girls. Thus whilst the Jewish boys have an excess of only 3 per cent. of myopes in the first period over the girls, in the second period the excess is 16.1 per cent. and that in spite of the fact that in the first period the boys have fewer low hypermetropes and more high hypermetropes. The case here seems to be absolutely convincing: coming from the same stock the boys doing excessive close work under unhygienic conditions develop an excessive proportion of myopes (an increase of 34.7 per cent. for boys as against 21 per cent. for girls).

But when one comes to examine Table VIII the conclusions drawn from Table VII are seen in a different light. Here in the first period the boys again have a rather smaller percentage of low hypermetropes and a decidedly higher percentage of high hypermetropes than the girls, whilst in contrast to Table VII the boys have a definitely lower incidence of myopia (13.5 per cent. against 20.4 per cent.), and yet in the second group the myopia among boys has increased from 13.5 per cent. to 41.1 per cent. (=27.6 per cent.), whilst the girls have increased their myopia from 20.4 per cent. to 34.7 per cent. (=14.3 per cent.); the boys, therefore, beginning with 6.9 per cent. less myopia and finishing with 6.4 per cent. more than the girls.

The increase in the percentage of myopes (Period II compared to Period I) is therefore as follows:

					<i>Boys.</i>	<i>Girls.</i>
Jewish	...	...	...	...	34.7%	21.0%
Non-Jewish	...	...	...	...	27.6%	14.3%

The difference in the greater incidence of myopia among Jewish boys as compared to Jewish girls (34.7 per cent. - 21 per cent. = 13.7 per cent.) is fully met by a similar difference among the non-Jewish children (27.6 per cent. - 14.3 per cent. = 13.3 per cent.). Or to put it otherwise, the difference in the rate of increase in the case of the two groups of boys is 7.1 per cent. more myopes for the Jewish boys, but this is countered by the difference of 6.7 per cent. more myopes in the case of Jewish girls as compared to the non-Jewish.

From Section A we have seen that the higher incidence of myopia in the second period in the case of Jews is fully explained by the existence of more low hypermetropes among them and a comparison between Table VII and Table VIII would seem to

seem to be dealing here with a sex factor in the growth of the eye. This conclusion is recorded here because it is difficult to see how it could be avoided. But the possible fallacy due to small numbers must be considered.

Much more work is necessary in relation to this sex factor. The whole problem of the growth of the eye requires investigation. What is suggested here is no more than this: that there is no necessity for extraneous factors such as close work to explain the excessive incidence of myopia among a group of people who happen to do much close work. Simpler and more tangible factors would seem to explain the production of the myopia in question. The arguments for the hot-bed theory of the production of myopia are too much of the nature of *post hoc ergo propter hoc*.

It will be the object of a later paper to discuss more fully the part sex plays in the production of anomalies of refraction.

Summarizing, we find that Jewish boys show a heavy percentage of myopes, but we see no reason for ascribing this to the excessive close work done by them. The evidence submitted would tend to show that the racial factor of Jewish children having a low reserve of hypermetropia to start with and the sex determined (and non-racial) factor which allows in the case of boys for a more rapid or more prolonged growth of the eye (we cannot at this juncture say which) fully explains this occurrence.

Summary

(1) The incidence of visual defects among Jewish boys in the East End is over 40 per cent.—double that of the non-Jewish boys.

(2) This heavy incidence of defect among Jewish boys is stationary all through their school life; it is practically no heavier at the age of 14 than it is at 7.

(3) The incidence of the defects is, therefore, not increased with school life, and apparently not produced by the excessive amount of close work done by Jewish boys.

(4) Comparative analysis of the refractive errors seen among the defectives of the Jewish and non-Jewish children reveals but little difference in the distribution of errors apart from a rather higher incidence of myopia and of low hypermetropia among the Jewish children.

(5) There is but little difference in the percentage of myopes in the early years of school life (5-9) in the two groups. The greater incidence of myopia among Jewish children becomes marked in the later years (10-14).

(6) It is argued that the greater increase of myopia in the later years among Jewish children is not the result of excessive close work, but of the greater incidence of low hypermetropia among the young Jewish children.

(7) An attempt is made to establish this contention mathematically.

(8) When the analyses are carried further to bring out any distinction in the increase of the number of myopes among Jewish boys as compared with girls, it is found that the increase is decidedly greater among the boys (who do much more close work).

(9) However, the same is seen to be true of the non-Jewish boys (who do not do an excessive amount of close work) as compared with the non-Jewish girls.

(10) It is, therefore, suggested that there is a sex-determined factor which controls the growth of the eye.

(11) The excessive incidence of myopia among Jewish boys is explained by the racial factor of the great prevalence of low hypermetropia and the sex-determined (and non-racial) factor which allows for a greater or longer development of the length of the eye.

In conclusion I wish to express my indebtedness to Mr. W. J. Lindsay for permission to utilize the records of the Royal Eye Hospital and to Mr. D. Tscherniakoff, the secretary of the Jewish Health Organization of Great Britain for arranging many of the facilities which made the work possible.

To Mr. A. H. Levy I am indebted for suggesting the necessity of the inquiry, for his kindly interest, and the placing at my disposal his great experience and helpful advice.

ANNOTATIONS

The Illuminating Engineer

A special number of *The Illuminating Engineer* was issued in January to celebrate its twentieth anniversary. It is deeply to be regretted that this anniversary also saw the early death of its founder, to whose work so much of its success was due, Mr. Leon Gaster (*v. Brit. Jl. of Ophthal.*, p. 111, 1928). A number of congratulatory messages from the Presidents and Past-presidents of Illuminating Engineering Societies in this country and abroad are published in this issue. The Society is the oldest of its kind in Europe; the only other Society in existence in 1908 was that of the United States, founded in 1906. Twenty years ago the science of illumination was in its infancy, and the conditions in large factories, schools, and public buildings were guided by no