COMMUNICATIONS

FOVEAL VISION IN AMBLYOPIA*

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THE reduced visual acuity in amblyopic eyes has presented a problem ever since the condition was recognized. Most of the evidence so far favours the cortex as the site of inhibition (Vogt, 1939; Wald and Burian, 1944; Dyer and Bierman, 1952). Clarke (1941) thought that the cause might be an atrophy from disuse affecting the cells of the lateral geniculate body which rely for their vitality on the linkage between cortical and retinal activity. Harms (1949) studied the lowered pupillary response to light in amblyopic eyes and thought that the activity of the retina was suppressed.

Although cortical inhibition undoubtedly plays a large part in inhibiting the response of an amblyopic eye, the photoreceptors in the retina are displaced in relation to the line of vision when the eye deviates, and this constant displacement over many years may lead to local adjustments and abnormalities within the retina itself.

In an amblyopic eye, as the power of fixation weakens, so the visual acuity is reduced. Brock and Givner (1952), working on the fixation anomalies in amblyopia, using a modified after-image test, record that only 20 per cent. of subjects with amblyopia (ex anopsia) fixate along the central-foveal axis of the poor eye on occlusion of the good eye. The great majority fixate eccentrically, the shift from the centre being greater the more profound the amblyopia. Jones and Higgins (1947) investigated the acuity gradient within 1° of the central fovea, and reported that the highest visual acuity was confined to the small region of 7' of arc and that there was a diminution of acuity at even 10' from the fovea, which region would be still within the slender cone area (Polyak, 1941).

In the present series of cases, the resolving power of the fovea and the accuracy of fixation in amblyopic eyes have been investigated.

Investigations

Method.—A series of 150 patients with amblyopia was investigated. The vision in the weaker eye ranged from hand movements to 6/12. The patients' ages varied from 10 to 55 years. For the initial examinations there was no selection. As the tests became more difficult the cases had to be selected according to the time which could be spared for investigations, and to the patient's accuracy of observation.

The initial investigations were concerned with the age of onset of the condition, refractive error, amount and direction of deviation, retinal correspondence, and binocular vision

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(Table 1). These were followed by repeated detailed examinations of many of the patients over a period of 1 to 2 years. Monocularly, the visual acuity was analysed both with Snellen types and with small composite targets, and at the same time the type of fixation was noted by direct observation. Using binocular function, the types and degree of suppression were graded. The diminution of the illumination of the dominant eye required to lift the suppression of the other (*binocular light balance adaptability*) was measured in each case.

TABLE I
PARTICULARS OF 150 UNSELECTED CASES

		Percentage of Total	
Age of Onset	Unnoticed	21·3	
	Before 9 mths	14·6	
	9 mths to 4 yrs	46·6	
	Later than 4 yrs	4·6	
	Did not know	12·6	
Visual Acuity	H.M. to 2/60	20·6	
	3/60 to 5/60	9·3	
	6/60 to 6/36	38	
	6/24 to 6/12	32	
Refractive Errors	Anisometropia	} more than 1 D sph. or cyl.	43·3
	Hypermetropia		44
	Myopia		1·3
	Small or no error		11·3
Degree of Deviation	0 to 5°d	} convergent or divergent	44
	5 to 10°d		27·3
	Above 10°d		28·6
	1° or more (vertical)		11·0
Direction of Deviation	Convergence	66	
	Divergence	7·3	
	Varying from esotropia to exotropia	26·6	

Apparatus.—For the more detailed part of the examination 100 patients were examined on the orthoptoscope. The slides were seen by transmitted light which was so balanced that they were equal in luminance (Pugh, 1951).

Calibration of Light.—The amount of light presented to each retina was adjusted by the use of Ilford's neutral density filters. These filters were cut to the size of the lens and slotted into the lens-holders in the eye-pieces of the orthoptoscope. They were used in several series:

- (a) of 1 per cent. differences from neutral density 2.0 to density 1.0 (allowing 1 per cent., 2 per cent., 3 per cent., up to 10 per cent., transmitted light);
- (b) of 5 per cent. differences from neutral density 1.0 (10 per cent.) to density 0.52 (30 per cent.);
- (c) in 10 per cent. differences to density 0.30 (50 per cent.);
- (d) in 20 per cent. differences to density 0.05 (90 per cent.).

By a combination of filters the light in the good eye could be reduced to 1/10,000 if necessary.

Procedure.—The measurements were taken in a dimly lit room. The "retinal rivalry" slides of Chavasse Nos. 7 and 8 were used (Figs 1, 2, 3, 4). One slide showed rings composed of eight dots, the rings varying in size so that the largest subtended an angle of 5° and the smallest one of 50'. The next slide gave rings subtending 50' down to 5'. The companion slides had a central dot with two vertical dots and two lateral dots in the form of a cross, the central dot acting as a fixation spot when the peripheral dot coincided

1(a)

2(a)

1(b)

2(b)

FIG. 1 (*a* and *b*).—Rings graded in size. Largest subtends angle 5° , smallest angle $50'$.

FIG. 2 (*a* and *b*).—Crosses subtend same angles as rings in Fig. 1. Central control dots graded in size. Largest subtends angle $1^\circ 24'$, second angle $20'$, smallest angle $10'$.

3(a)

4(a)

3(b)

4(b)

FIG. 3 (*a* and *b*).—Rings graded in size. Largest subtends angle $10'$, smallest angle $5'$.

FIG. 4 (*a* and *b*).—Crosses subtend same angles as rings in Fig. 3. Central control dots graded in size. Largest subtends angle $10'$, smallest angle $1'$.

with the four dots in the opposite rings. The central dots varied in size, the largest subtending an angle of $1^\circ 24'$, and the smallest $1'$. One set of slides had black dots on a white background, the other white dots on a black background.

At each examination the good eye was padded and the weaker was shown the first slide of crosses, first, the black dots on the white background, and second, the white dots on the black background. The patient was asked to count the dots in the large design (which was equivalent to a 1/60 Snellen letter), and to describe whether they were seen equally clearly and equally brightly. If he were successful in this, he went on to the cross equivalent to 3/60 Snellen type, and then to the 6/60. The second slide showed crosses equivalent to Snellen types 6/60 down to 6/6. When the monocular tests had been completed, the pad was removed from the good eye and time given for both eyes to adjust themselves normally to light. The eyes were then examined binocularly to find out what difference occurred in the acuity of the amblyopic eye when the dominant eye was looking at the companion slide. The reduction in acuity, which was very marked, was then measured by reducing the light transmitted through the slide seen by the stronger eye until the stimulus was low enough to allow the vision of the bad eye to return to its previous

optimum degree of resolution. In some cases this was not possible because a point was reached when the good eye began to suppress when the light was very reduced. In the patients who had a great enough degree of acuity in the poor eye, a further test was made to find the reduction of light needed in the good eye to balance the stereograms.

The stereograms represent a tunnel or a cone so drawn that when the outside rings are fused, the inside dots or rings should be seen centrally on a nearer or more distant plane than the outside ring. The reduction in light balance needed in the dominant eye to centralize the near part of the diagram was then correlated with the filter necessary to prevent suppression of the small dots on the Chavasse slides.

Results

It soon became evident that in order to get any consistent evidence, the good eye must be padded and not covered. This was because small gleams of peripheral stray light entering around the cover could alter the results obtained, whereas when the eye was padded no light could enter even through the closed lid and the results were much more consistent. All monocular tests were therefore carried out with the good eye padded. The results are summarized in Table II, where the findings in 100 patients examined in detail are given.

Monocular Tests

Visual Acuity.—Of the total of 150 cases, 31 had visual acuity between hand movements and 2/60, 14 between 3/60 and 5/60, 57 between 6/60 and 6/36, and 48 between 6/24 and 6/12.

With repeated careful examination of the visual acuity it was noticed that a considerable number of the patients could read part of the line only and that this increase was always in the same direction. The first letter of, say, the 6/36 line would be seen but not the second, or perhaps the first one or two letters of 6/24 line was seen but not the third. When the patients were tested on various charts with different letters and in different rooms, it became evident that there was no doubt that some amblyopic eyes could see better when the visual axis was adducted to fixate than when it was abducted; other eyes had the reverse directional preference, and would see the end of the line when the eye was abducted but failed on the same letter when the eye was adducted. This directional difference was lessened but not removed when the letters were covered leaving only one visible at a time. In this way a blurred letter seen with the eye in the position of abduction would become clear enough to recognize, but still not as clear as the letter at the other end of the line when that was seen separately. Improvement was gained by putting a pin-hole in front of the amblyopic eye; the directional difference was again lessened but not removed.

Patients who experienced this alteration in acuity according to the direction of regard tended to move the head from side to side in an effort to see, and the more intelligent felt frustrated and annoyed at the inability of the same eye to see the same letter as clearly on, say, the right side of the board as on the left side, when both letters were of the same size and there was no hindrance to prevent his seeing it.

When details of the usual acuity were examined in the orthoptoscope with Chavasse slides, it was possible to find out which part of the corresponding Snellen letter was seen faultily, since each cross consisting of five dots subtended the same angle as the corresponding test type letter. Thus the 3/60 cross made up of five dots

TABLE II
RESULTS IN 100 CASES

Visual Acuity	Retinal Correspondence		
	Abnormal	Transitory Normal—Abnormal	Normal
HM to $\frac{3}{80}$	15	2	3
$\frac{3}{80}$ to $\frac{5}{80}$	3	2	6
$\frac{6}{80}$ to $\frac{6}{36}$	7	8	16
$\frac{6}{24}$ to $\frac{6}{12}$	4	1	25
Totals	8 Eccentric Fixation + 29 = 37	13	50

Directional Difference in Acuity

	Abduc-tion	Central	Adduc-tion	Abduc-tion	Central	Adduc-tion	Abduc-tion	Central	Adduc-tion
HM to $\frac{3}{80}$			15	1		1*	1*	1	1
$\frac{3}{80}$ to $\frac{5}{80}$			3		2			6	
$\frac{6}{80}$ to $\frac{6}{36}$	1*		6	1* 2		5	1	13	2
$\frac{6}{24}$ to $\frac{6}{12}$	1*		3			1		24	1
Total	2		27	4	2	7	2	44	4

Degree of Deviation

	0-5	5-10	10+	0-5	5-10	10+	0-5	5-10	10+
HM to $\frac{3}{80}$	3	8	4	1	0	1	0	1	2
$\frac{3}{80}$ to $\frac{5}{80}$	0	1	2	2	0	0	6	0	0
$\frac{6}{80}$ to $\frac{6}{36}$	2	3	2	6	2	0	14	2	0
$\frac{6}{24}$ to $\frac{6}{12}$	2	1	1	0	1	0	18	7	0
Total Percent-ages	24	44.8	31	69	23	8	76	20	4

*Directional preference in acuity against the direction of deviation. All others with the direction of deviation—lateral and/or vertical.

subtended an angle of $1^{\circ} 40'$, but the centre dot subtended an angle of $20'$ and would, if its image fell on the centre of the fovea, just cover the slender central cones. As the 6/24 letter also subtends $20'$ and would cover the same area, it was not surprising to find that difficulty in resolution of a target of this size was present in about 66 per cent. of all the cases in the present series.

There was also present a directional difference which was similar to that found in the usual test with the Snellen letters. For this test the crosses were of white dots lit by transmitted light on a black background. The patient was asked to

count the number of dots in each cross and then to look at each dot in turn and say whether each one was equally sharp and clear. Some patients had difficulty with the central dot only, others said that the 3 or 9 o'clock dot was much duller, even to disappearing, whereas its opposite lateral dot was correspondingly brighter than either the 12 or 6 o'clock dot. Several patients with a marked vertical deviation saw the top or bottom dot clearest with a corresponding blurring of the opposite top or bottom one. These differences were consistent through the months and quite definite.

The blurring sometimes appeared to be graded across from the one side dot through the centre to the other side dot and it remained so however much the patient looked at each in turn.

Fixation.—Some indication of the degree of amblyopia was given by fixation on the letter of the Snellen type. An eye which failed to direct its visual axis towards the target but always took up the same deviated position in the effort to see it, could be said to have Eccentric Fixation. A less poor eye was able to look straight in the direction of the letter but made small searching or scanning movements around it in an effort to distinguish the shape. These searching movements were less as the acuity improved until finally an eye with acuity as high as 6/24 fixed apparently steadily, although when examined on targets subtending small angles the power of fixation was seen to be not quite normal.

When fixation was tested in an orthoptoscope, the good eye was padded and slides with varying size targets were put in front of the amblyopic eye. As the patient fixed the target, the eye was very carefully watched and the smallest movement was noted. Targets were used which subtended angles of 20' down to 1' in consecutively diminishing angles (Figs 1-4 show Chavasse slides in which the centre dots subtend 1° 25', 20', 10', 6', 4', 3', 2', 1.5' and 1').

Relatively few eyes had a definite eccentric fixation, and only 8 per cent. turned the eye in an attempt to fix with an indefinite region of the peripheral retina. The acuity was between hand movements and 2/60.

The next group showed asymmetrical foveal searching movements, a rather rapid lateral scanning of small excursion, but with slight asymmetry of movement as if one side of the fovea was dominant to the other. The rapidity of the movement made measurement of the amount difficult but it was assessed at 30' to 60' of arc; 29 per cent. of patients had this type of fixation, all had directional preference in acuity, 24 preferred the direction of deviation, and 5 were against the direction of the deviation.

An indefinite group of 16 per cent. of patients had a searching movement which sometimes appeared to be central and other times asymmetrical; they all showed a slight directional preference.

In the last group, symmetrical foveal searching movements were to be seen. The movement was more hesitant and not the same sort of lateral scanning as in the previous group; 22 per cent. had a coarse central movement which became more wandering the poorer the vision. The loss of acuity was found to be greater in the centre; 25 per cent. of cases with 6/24 or higher acuity had nearly steady central fixation; only one had any directional acuity in fixation.

Binocular Tests

3A) *Suppression.*—This was found to fall into four groups: "major suppression",

"constant deep central suppression", "'on' and 'off' foveal suppression", and "marked suppression" in definite areas of the peripheral retina.

(i) The first occurred readily and lasted for short or long periods, during which the eye ceased to register any form vision or colour vision. However not one of the 150 cases had anything approaching a constant suppression on targets the angle of which were large enough to include some of the peripheral retina.

(ii) In the second, the part of the target subtending an angle covering approximately 20' at the fovea and falling on the slender central cones was not seen at all, although controls stimulating an area around the centre subtending an angle of 1° 40' remained visible.

(iii) The third, found in the lighter amblyopes, was a rhythmical form of suppression affecting the slender central cones, the rhythm varying according to the degree of amblyopia and also altering with treatment. At first, for instance, a dot subtending an angle of 10' at the fovea would be "off" for say 5" and "on" for 2"; as the vision improved the dot would be seen for say 5" and disappear for 2" until it ceased to disappear.

(iv) The fourth appeared to occur mainly in the peripheral retina and much less at the fovea. This is difficult to explain when the fovea is incapable of resolving small details. If the eye is watched very carefully, the moment the dot has reached the visual axis where the image should fall on to the fovea, a very tiny sharp flick of the eye occurs. Sometimes even a good observer cannot persuade himself that he loses sight of the target, or at most that perhaps it disappeared for a split second. The fovea in such a case has no better power of resolution than the fovea of a correspondingly amblyopic eye with central suppression and yet subjectively the patient will not admit to any form of real central suppression. This last type of peripheral suppression occurs without exception in all cases showing definite abnormal retinal correspondence, the scotoma always being approximately in that part of the retina facing the same direction as the fixing macula in the good eye.

(B) *Light Balance Adaptability*.—These showed the strength of the inhibiting effect of the good eye on the bad eye.

In the amblyoscope, the Chavasse slides were arranged so that the crosses were aligned along the visual axis of the bad eye and the corresponding circles along the visual axis of the good eye. When the retinal correspondence was normal, fusion of the outside dots was usual and the behaviour of the central dot which was seen by the poor eye only, was noted. An eye which could see a dot subtending an angle of 4' or 6' when used monocularly might be unable to see it binocularly. A dot subtending an angle of 20' until the light intensity of the slide seen by the good eye was reduced. In some cases no amount of reduction of light brought back the acuity of the amblyopic eye; but more often the reduction of light transmitted to the good eye to 1/100 or perhaps even to as little as 1/10,000, would restore the resolving power of the amblyopic eye to its monocular standard.

When abnormal correspondence was present, a different kind of response occurred. The slides were placed along the visual axes and were seen simultaneously but were not accepted as coincident. The resolving power of the amblyopic eye was little influenced by the use or non-use of the good eye. Padding of the good eye might increase the resolving power very slightly. The acuity was noted first with the good eye padded, then with the pad off and full light to the good eye, and finally with the companion slide. The difference, if any, was very slight in most of

the cases. A reduction of light to 1/100 to the good eye "perhaps helped", but not enough to matter. When the vision was very low a central scotoma was present, and this was demonstrated by shutting the dominant eye. Such a case seemed to be developing into a true eccentric fixation.

Discussion

Visual acuity on Snellen type and the resolution of the dots making up diagrams of similar size

On this examination the patients' answers were divided into two definite groups, those with directional difference for acuity and those with none.

In the first group the eye has different degrees of difficulty according to the direction along which the visual axis is aligned on to the letter; the eye is able to see a letter when it is fixed in one direction but sees the same letter only as a blur and can not resolve it into its shape when the eye fixes in the opposite direction. To take, for example, a right eye with an adduction preference trying to read a line P N T D: the first letter P was clearly seen but as the eye fixed each letter in turn the difficulty increased, the T being doubtful and the D blurred beyond recognition; this was true whichever letters of the alphabet were chosen. If the letters P N T were covered, an immediate improvement in acuity occurred and the single letter D might become clear enough to be seen. Improvement was also obtained by using a pin-hole in a black shield. However, the difference between the resolving power in adduction and abduction was not completely eliminated, because having achieved each letter of 6/18 by taking each separately, the eye might distinguish the first letter (*i.e.* adduction position) of 6/12 but could see no more even when each separate letter was covered.

The directional difference evident on the Snellen type is again shown consistently on the Chavasse slides in the orthoptoscope. To take a right eye with adduction directional preference, the picture which should be seen as Figs 1 (a) and 1 (b) with all dots equally clear, appears to the patient as shown in 5 (a and b), the dots shading in sharpness and brightness from the right side to the left. As the eye moves its fixation from the position of slight adduction through an arc of 5° to a position of slight abduction, the fovea loses its power of resolution. The dots are

FIG. 5 (a and b).—Chavasse slides (each taken separately) as seen by patients' right eye (left eye padded) showing adduction directional preference.

of equal size and the top dots subtend an arc of 1° 24' so that the image of each dot falls well within the fovea although including some of the wider cones. The same effect is noticed if the dots are smaller and subtend 20', and are within the arc of the slender cones. This "shaded"

acuity is the same kind of difference as occurs when the eye is reading the letters of the Snellen type. The right hand letter of the line is seen correctly, but the left hand letters are too blurred and are described as "ghostly" or "unreal".

When the cases were analysed, it was found that in the group with lowest vision the percentage of cases with abnormal correspondence was highest and that in the group with highest vision the percentage of similar cases was lowest. The next point of interest was that the angle of deviation was greater in the cases with abnormal correspondence; 31 per cent. had more than 10° of deviation and only 24 per cent. had less than 5° . In the cases with normal correspondence 76 per cent. were less than 5° and only 2 per cent. over 10° . This suggested that the higher the deviation the more likely it was that the retinal correspondence would be abnormal and therefore that the visual acuity would have directional preference.

These findings were then correlated with the binocular light balance (Table III, overleaf). Of patients with directional preference and abnormal retinal correspondence, 44.8 per cent. had an amblyopic eye in which the foveal vision was apparently unaffected by the activity of the good eye, in 27.6 per cent. the amblyopic eye was inhibited by the activity of the good eye, the necessary light reduction being of the order of $1/5,000$, and 27.6 per cent. were moderately affected, the balance being about $1/500$.

With mixed correspondence the inhibitory effect of the dominant eye through the cortex is much more often present—the nearer to constant normal correspondence the more marked the inhibitory effect of the good eye.

In the second group (with normal correspondence and no directional preference), there is plenty of evidence that the suppression of the image of an amblyopic eye is controlled to a considerable extent by central inhibition. The chief type, causing sudden and complete temporary loss of all form and colour vision, can easily be demonstrated in a stereoscope or amblyoscope; it must be of central origin since it does not occur if the good eye is padded. The second is the intractable type, occurring at the fovea and appearing to affect the central cones only, since objects subtending an angle of $20'$ or even up to $1^\circ 24'$ are not visible, although the surroundings or extension of the object beyond this area can be seen. This is true as long as the good eye is uncovered, but when it is shut the whole of the centre of the picture is immediately seen by the poor eye within its limits of its acuity. Also if the light transmitted to the good eye is reduced by filters the suppression in the bad eye becomes less, and progressively smaller targets can be seen until the inhibiting effect of the dominant eye is cancelled by the diminished stimulus to it. This balance must be controlled through the cortex.

The third type, which is perhaps only an early stage of the second type, occurred in the higher acuity groups. The suppression is still foveal and only occurs on targets subtending an arc of 1° or less. Moreover, the suppression is less constant and occurs at seconds' intervals. This suppression

TABLE III

DEGREE OF REDUCTION OF LIGHT TO GOOD EYE NEEDED TO RESTORE RESOLUTION OF AMBLYOPIC EYE TO MONOCULAR STANDARD (100 CASES)

Monocular Visual Acuity	Degree of Reduction of Light to Good Eye	Retinal Correspondence		
		Abnormal	Transitory Normal—Abnormal	Normal
HM to $\frac{2}{80}$	None	11	1	0
	Up to $\frac{1}{900}$			
	$\frac{1}{1000}$ to $\frac{1}{10000}$	4	1	3
$\frac{3}{80}$ to $\frac{5}{80}$	None	2		
	Up to $\frac{1}{900}$			
	$\frac{1}{1000}$ to $\frac{1}{10000}$	1	2	6
$\frac{6}{80}$ to $\frac{6}{36}$	None			
	Up to $\frac{1}{900}$	4	3	
	$\frac{1}{1000}$ to $\frac{1}{10000}$	3	5	16
$\frac{6}{24}$ to $\frac{6}{12}$	None			
	Up to $\frac{1}{900}$	4	1	10
	$\frac{1}{1000}$ to $\frac{1}{10000}$			15
Total (includes 8 Eccentric Fixation with Foveal Loss)		29	13	50
Total Percentages	None	44·8	7·7	0
	Moderate	27·6	30·8	20
	Much	27·6	61·5	80

also can be controlled binocularly by altering the relative light intensities transmitted to the two eyes. Table III shows that 80 per cent. of the patients with normal retinal correspondence had an amblyopic eye which suppressed very readily as soon as the good eye was used. The filters needed to prevent this inhibitory effect were of such strength as to reduce the light transmitted to the good eye to less than 1/1,000 and often to as little as 1/10,000 before the vision of the amblyopic eye returned to its monocular standard. No case in this group was entirely unaffected by the activity of the good eye, but 20 per cent. of cases could balance a light value of over 1/1,000. Even so, this reduction of light to the good eye was much greater than was found to be necessary in the cases with abnormal retinal correspondence.

Summary

The aim of the investigation was to obtain further evidence which might assist in the localization of the site or sites of inhibition which lead to the

reduced visual acuity found to be present in amblyopia. Foveal vision was examined in detail in 100 cases, which were selected as being good observers out of the 150 unselected cases examined in the initial stages.

Most of the previous evidence has favoured the cortex as the site of inhibition. The results of this series showed that cortical inhibition could be readily demonstrated as the probable main site of inhibition in only about 50 per cent. of the cases. Further study showed that it was when the eyes were approximately straight that the cortex was more likely to be the main site of inhibition; 76 per cent. of the patients had an eye which deviated only 5 degrees or less, and only 4 per cent. had a deviation of more than 10 degrees. All the cases in this group had normal correspondence, although 12 per cent. had also directional preference in visual tests.

In the remaining 50 per cent. of cases cortical inhibition could be demonstrated in 52 per cent. of the patients who had definite abnormal correspondence, and also in 92 per cent. of those with an indefinite retinal correspondence. The activity of the good eye influenced the visual acuity but much less than in the first group and less consistently. In 48 per cent. of the patients with marked abnormal retinal correspondence any inhibition through the cortex brought about by the stimulus of the good eye was so slight that it could not be readily demonstrated. In all these cases anomalies of foveal vision were manifest in the alteration of acuity according to the direction of fixation.

When this second group was analysed further, 76 per cent. of the patients with marked abnormal retinal correspondence were found to have a deviation of more than 5 degrees. Directional anomalies were present in all these cases so that it would appear that the greater the deviation the higher the chance that directional preference would develop.

This linkage between the angle of deviation, retinal correspondence, and cortical suppression suggests the probability of some local change in the photo-receptors of the fovea which thus appears to be an important site of defective foveal vision. One type of inhibition did not exclude the other, and both types appeared to be inter-related. When the foveal cells seem to have adjusted abnormally, central inhibition is less easily demonstrated and *vice versa*.

The correlation between the amount of deviation and the anomalies of foveal response is difficult to explain, but nevertheless the possibility of local changes in the fovea due to continued and constant deviation of the visual axis appears to be worth further investigation.

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