markedly, whereas depressives even where some anxiety background had been revealed, seemed capable of making a reasonable effort.

Although the tests for dark adaptation do not involve the same mental judgment as night vision tests—it was considered interesting in the case of miners to compare the threshold values obtained by Dr. Sharpley with the psychological tests made by Dr. Stern. The results are recorded in Table 1.

It will be seen that for the total 65 miners tested, the average threshold values in the cases of hysterics, anxiety neurosis and malingerers are the same as for normal mentality, whereas it is higher in manic depressives and in the dull and backward.

In the group of control miners, the psychologically abnormal had a lower threshold than the normal, while in the certified cases the rise in threshold in hysteria and anxiety neurosis was more marked in those without nystagmus than in those with active oscillations.

Conclusion

The evidence such as it is points to the fact that among miners there is no significant relationship between the psychological state and the threshold of dark adaptation. It would be interesting to compare them with a group of ordinary workmen in this respect.

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BINOCULAR VISION IN MINERS

BY

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THESE preliminary investigations were made in the hope that a minute study of the behaviour of the eyes under conditions of low illumination might reveal the mode of onset of nystagmus.

The binocular vision of miners was compared with that of a large group of normal subjects of the same age groups:—

- (a) in full light adaptation.
- (b) in full dark adaptation (after 45 minutes in the dark).

The tests were made on the synoptophore, using test slides calibrated for known illuminations. For tests (a) the illumination

varied from 0.025-0.37 F.C. and for tests (b) from 0.0025-0.18 F.C. Thus in dark adaptation the subject was exposed to a range of illumination comparable to that found at the coal face, but not so low as to exclude foveal vision, except for the stereoscopic test at 1/10 illumination.

Range of illumination

	Full Illumination	Grades		
		1/10	1/4	1/2
For Stereoscopic Vision	0.025 F.C.	0.0025	0.006	0.012
Fusion and Ductions	0.22	0.02	0.05	0.11
Simultaneous Perception	0.37	0.04	0.09	0.18
	Light adapted eye	Dark	adapted eye	

Black and white slides were used for the tests, and the calibrations were made photometrically with the slides in position. The illumination recorded was that which fell upon the eye at the synoptophore. The recording scales on the synoptophore were made visible with luminous paint and only a small red torch was used to help the patient get into position after he had completed his time of dark adaptation.

Each subject was tested for stereoscopic vision, fusion, ductions and simultaneous perception—in this order—and was made familiar with the tests in light adaptation before proceeding to full dark adaptation.

Subjects with strabismus were not included in these comparative figures. We were interested to find that quite a number of miners are working happily on the coal face with strabismus but they had no binocular vision, and were presumably free from any mental effort in this respect. There were also men with high degrees of hypermetropia but low visual acuity, also with no binocular vision.

The tests used were suitable for subjects who could see 6/24

and over. A detailed record of the visual acuity has not been made in this report since it was amply proved by Llewellyn in his earlier report on Miners' Nystagmus that the disease does not run concurrently with the error of refraction.

(1) *Observations on Subjects able to perform Binocular Vision Tests.*—(1) It was noticed that in all subjects the subjective angle tends to become convergent when they are dark adapted.

Miners suffering from nystagmus—did not show this phenomenon so markedly, see Table I.

TABLE I. *Variation of subjective angle*

Subjects	No. examined	Light adapted eye			Dark adapted eye		
		Simultaneous Perception (0.37 FC.)	Fusion (0.22 FC.)	Stereoscopic (0.025 FC.)	SP2 (0.04 FC.)	F. (0.02 FC.)	SV. (0.002 FC.)
Normals	72	1.5°	1.4°	0.2°	2.6	3.2	1.5
Miners from Coal Face	32	0.6	0.8	0.9	1.8	2.0	1.5
Miner's Nystagmus	36	1.0	1.0	1.2	0.9	1.5	2.0

As will be seen the subjective angle did not vary directly with the illumination but appeared to depend on the state of the eye—and with the type of visual test.

The majority of miners showed an abnormal fixation—i.e., their eyes tended to look upwards. The older men—experienced giddiness following upon their tests in the dark.

(2) *Stereoscopic vision.*—We were agreeably surprised to find that the majority of the normal population has good stereoscopic vision. Thus in 200 normals—of both sexes, the incidence of subjects with poor stereoscopic vision in ordinary illumination was only about 5 per cent. The incidence was higher than this in the group of controls tested in these experiments, and tended to increase with increasing age—and under conditions of dark adaptation. This variation occurred more in miners, and most markedly in those suffering from nystagmus. (See Table II.)

TABLE II. *A comparison of Stereoscopic Vision at different Illuminations*

Shewing percentage of individuals found to have good stereoscopic vision

1—Age Group 25-44

	Total No. tested	Illumination			
		'0025 FC.	'006 FC.	'012 FC.	'025 FC.
Normals	(30)	87%	90%	87%	83%
Control Miners	(16)	50	50	81	75
Miners with Nystagmus	(12)	33	8	17	33

2—Age Group 45-54

Normals	(30)	67	70	70	80
Control Miners	(10)	33	50	60	70
Miners with Nystagmus	(17)	32	32	25	32

3—Age Group 55-70

Normals	(30)	53	63	70	63
Control Miners	(10)	40	40	40	50
Miners with Nystagmus	(8)	11	22	22	44
		Dark adapted eye			Light adapted eye

(3) *Comparison of Stereoscopic Vision with Adduction.*—In the synoptophore tests performed as for distance vision it was evident (see Table III) that :—

TABLE III. *Comparison of Adduction (average angle) in subjects of all ages (25-70)*

With good stereoscopic vision

	Illumination			
	0.025 FC.	0.05	0.11	0.22
Normals	18°	16°	16°	17°
Control Miners	21°	20°	21°	19°
Miners $\bar{c}$ Nystagmus	18°	18°	19°	13°

With poor stereoscopic vision

Normals	14°	14°	12°	13°
Control Miners	10°	7°	5°	8°
Miners $\bar{c}$ Nystagmus	4°	5°	4°	4°
	Dark adapted eye			Light adapted eye

- (a) The power of adduction is normal—subjects did not vary with illumination.
 - (b) Subjects having poor stereoscopic vision had practically the same power of adduction as those possessing good stereoscopic vision.
 - (c) Miners (both nystagmus subjects and “control” miners from the coal face) who had good stereoscopic vision, had a noticeably greater power of adduction than normals.
 - (d) Miners of both types—with poor stereoscopic vision, had hardly any power of adduction at all.
- (4) *Nystagmus*.—It is known that certification for miner's nystagmus on clinical grounds does not rest on the existence of actual nystagmus. Indeed, in long-standing cases, particularly in those subjects who have been off work for a long period—no actual nystagmus can be elicited—and the outstanding features are photophobia, blepharospasm and a psychological abnormality which obviate the performance of any binocular vision test.

In the intermediate stage where bilateral nystagmus is present, any attempt at macular fixation results usually in macular suppression, though some degree of fusion, duction and stereoscopic vision are present.

In the early stages of the disease, nystagmus can be unilateral and is usually vertical. Some show vertical nystagmus in one eye and horizontal in the other—while one interesting individual showed alternating macular suppression of great rapidity, while he still possessed good duction, fusion and stereoscopic vision, and developed no actual nystagmus. He was unable to continue his work but improved rapidly with rehabilitation.

Quite a number of miners have been seen who complained of headache and giddiness and occasional oscillations. They showed no nystagmus either by clinical tests or on the synoptophore, but had some degree of suppression in one eye—and poor duction. Their symptoms were improved by orthoptic training.

Conclusions

Up to the present time cases of miners' nystagmus have not been seen by ophthalmic surgeons—until their symptoms are long-standing. They have then developed so marked a psycho-neurosis, that the secondary symptoms far outweigh the original nystagmus. The patients frequently find it impossible even to read 6/60 on account of blepharospasm—and the ophthalmic surgeon has dubbed them hopeless from the point of view of any treatment which he could give them. He has been inclined to suggest that the nystagmus arises from voluntary convergence.

It must not be forgotten that the evidence of previous observers is that defective illumination is the primary cause of miners' nystagmus. My observations during the past three years point to a breakdown in binocular vision under conditions of low illumination. It is only by a minute analysis of the various processes involved that any theory of the origin of nystagmus can be promulgated. It would appear that macular vision is a separate entity—which proceeds independently of the more primitive functions—of fusion, of fusion with duction, and of stereoscopic vision. The latter can certainly be maintained even in low degrees of visual acuity—and is I think (Campbell, 1947) much more likely to depend on the rapid alternation of monocular impressions, brought about by small fusional movements of the eyes (see Clark, 1936), than by summation of stimuli from the two eyes. Burian (1939), (1941) has in fact shown that any disturbance of fusion in the paramacular area will distract macular vision and cause a separation of foveal images. If this is true for the light adapted eye one wonders what occurs in conditions of low illumination.

Many other points require explanation, *e.g.*, as to why nystagmus usually gives rise to intolerable symptoms about the age of presbyopia, and (*b*) as to the effects of posture on the function of the extra-ocular muscles. These are to be the subject of later experiments together with an analysis of the binocular vision under such low illumination that the fovea cannot respond.

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SLIT-LAMP MICROSCOPY*

BY

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LONDON

IN the years that immediately followed the first world war, a great deal of enthusiasm was aroused in these islands by the work of Vogt and others with what was then a novelty—the slit-lamp and corneal microscope. A number of British ophthalmologists went on pilgrimages to Switzerland, fired by ambition to equip themselves with knowledge of the new weapon. It was perhaps only natural that these crusaders should become intoxicated by the thrilling new world of phenomena unfolded before their eyes, and we need feel no surprise that some of them launched into extravagant claims. They even suggested—greatly to the consternation of the non-crusaders—that evidence given in a Court of Law by ophthalmic surgeons could not thenceforth be regarded as expert unless it included facts derived from slit-lamp observation. Here was a chance for the enemies of the new toy, as they derisively dubbed the slit-lamp. “What is the use,” they asked, “of all this pampering and bottle-feeding? You will only succeed in producing a generation of ophthalmologists unable to see anything without the help of intricate and costly devices.” Another upholder of traditional methods was heard to say: “Show me

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