without sutures. The operation with a round pupil is quite free from danger when performed according to my method. I wish to emphasise that this operation may be done even in cases upon which we would not have dared to operate formerly.

This is proved by the fact that among the operations mentioned in my statistics there were 25 cases of patients with impaired hearing, 4 cases of stone-deafness, 6 cases of high myopia, 1 case of advanced Graves' disease, 2 patients suffering from emphysema and severe attacks of dyspnoea, 2 cases of nystagmus—even during the operation—2 cases of deaf and dumb persons, 1 epileptic patient and one with senile tremor of the head. In all these cases I performed successful operations with round pupils, and the state of the patients had not the slightest influence either upon the operation or upon the healing of the wound.

I must mention, however, that operations with a round pupil should be performed by skilful and experienced eye surgeons only. Beginners should practice the flap operation with a complete iridectomy and perform this technically more difficult operation only after considerable experience.

LITERATURE

1. MENDOZA, R. (1892).—*Bull. et Mém. Soc. Franç. d'Ophtal.*, 10, 63.
2. LIÉGARD, H. (1913).—*Ann. d'Ocul.*, 149, 110.
3. HORVÁTH, B. (1939).—*Klin. Monatsbl. f. Augenheilk.*, 102, 473.
4. McLEAN, J. M. (1940).—A new corneo-scleral suture. *Arch. Ophthalm.*, 23, 554.
5. PAPOLCZY, F. (1942).—*Klin. Monatsbl. f. Augenheilk.*, 108, 567.

THE ILLUMINATION OF THE SNELLEN CHART*

BY

M. GILBERT and R. G. HOPKINSON

THE problem of adequate lighting in schools, homes, offices and buildings in general has given rise to a study of the effect of illumination and contrast on visual performance. The programme of work has been carried out in close collaboration with Mr. H. C. Weston, of the Medical Research Council, to whom the authors' thanks for the benefit of valuable discussions are due, and under the aegis of the Joint Committee on Lighting and Vision of the Building Research Board and the Medical Research Council.

It was thought that clinicians would be interested in particular in the effect of illumination level on the visual acuity of observers as assessed by the standard Snellen chart.

The subjects of the experiment were 15 adults from the staff of the Building Research Station, in the age group 20-40. They

* Crown copyright reserved.

TABLE I—*Classification of Subjects Employed on Visual Acuity Tests*

GROUP 1—*Subjects with Normal Acuity*

Subject	Binocular Acuity on Snellen Chart at 30 f.c. (M.R.C.)	Refraction		
			R.E.	L.E.
1. A.B.	6/4.5	Emmetrope.	—	—
2. C.M.P.	6/4.5	Myope, corrected.	—2.0	—2.75
3. *H.M.	6/4.5	Hypermetrope, corrected.	+4.5, —0.5 ax. 30°	+4.5, —0.5 ax. 130°
4. W.H.W.	6/4.5	Uncorrected.	+0.25, —0.75 ax. 180°	+0.25, —0.75 ax. 160°
5. *M.G.	6/4.5	Myope, corrected.	—3.25, —1.75 ax. 180°	—2.75, —2.5 ax. 180°
6. *C.P.	6/6	Astigmat, corrected	—1.0 ax. 155°	—1.5, ax. 20°
7. *E.S.J.S.	6/6	Hypermetrope, corrected.	+4.0, —0.5 ax. 180°	+3.75, —0.5 ax. 180°
3. *H.M.	6/6	Hypermetrope, uncorrected.	see 3 above	
8. *P.M.	6/6	Hypermetrope, corrected.	+3.0	+3.0, —1.0 ax. 120°
6. *C.P.	6/7.5	Astigmat, uncorrected.	see 6 above	

GROUP 2—*Subjects with Moderate Acuity*

9. W.E.S.	6/9	Myope, uncorrected.	—0.75, —0.5 ax. 180°	—0.5
10. G.M.	6/9	Astigmat, uncorrected.	—1.75 ax. 5°	+0.5, —1.75 ax. 175°
5. *M.G.	6/12	Myope, partial correction.	Full cyl. correction, (see 5 above) partial sph. correction (—1.0 sph.)	
11. G.B.	6/18	Astigmat, uncorrected.	—2.5 ax. 90°	—2.5 ax. 95°
12. H.My.	6/24	Myope, uncorrected.	—1.75	—2.0
13. *M.L.	6/24	Myope, partial correction (for full correction see 13 below).	—2.75, —1.0 ax. 90°	—3.5, —1.25 ax. 95°
14. J.F.	6/36	Hypermetrope, uncorrected.	+1.75, —0.25 ax. 180°	+1.5, —0.5 ax. 65°
15. J.P.	6/36	Myope, uncorrected.	—2.0, —1.0 ax. 180°	—1.0, —1.0 ax. 160°

GROUP 3—*Subjects with Poor Acuity*

8. *P.M.	6/36	Hypermetrope, uncorrected.	see 8 above	
7. *E.S.J.S.	6/60	Hypermetrope, uncorrected.	see 7 above	
5. *M.G.	6/60	Myope, uncorrected.	see 5 above	
2. *C.M.P.	6/60	Myope, uncorrected.	see 2 above	
13. *M.L.	6/60	Myope, uncorrected.	—4.5, —0.75 ax. 120°	—5.5, —0.5 ax. 110°

* Subjects marked thus made observations with and without their correction.

varied from emmetropes of 6/4.5 vision to ametropes of 6/60 vision. Various refractive errors were included in the sample. Some of the observers who habitually wore a correction made observations with and without their correction, and in addition two subjects (both myopes) made observations with a partial correction with which they were familiar. Table I summarises the refractive defects of these observers, which were measured by Mr. J. L. H. Moss, of the Medical Research Council, who also assessed the visual acuity on a Snellen Chart illuminated to 30 ft. candles by fluorescent ("daylight") lamps.

For the observations, the subject sat 6 metres from a white wall on which the Snellen chart was displayed. The whole wall as well as the chart itself was illuminated by screened incandescent light sources. Additional room lighting produced a brightness of the surroundings of the same order as, but lower than, the brightness of the chart.

After an initial period of adaptation, the observer was asked to read the letters on the Snellen chart with an illumination of only 0.1 ft. candles. When he had read as far as possible, the illumination was slowly raised to 3 ft. candles (a change of 30:1) and the chart was again read as far as possible. Finally the illumination was raised to 100 ft. candles (a further change of approximately 30:1). It was felt that familiarity would not influence the reading of the chart at the higher levels of illumination, since the smaller letters became visible only at these higher levels, and were not recognised at the lower levels. There was in addition a considerable time interval between the successive showings of the chart, so that it was unlikely that the subject would retain any clear memory of the chart, as a number of other charts (with different contrasts, etc.) were also read at each level of illumination. It should also be mentioned that a magnified chart was produced photographically to enable a complete line of letters of the 6/60, 6/36 and 6/24 size to be available for those subjects with poor vision.

The results obtained were plotted in the form of a relationship between illumination (log. scale) on the chart, and line acuity (inverse log. scale of angular subtense of critical detail) for each of the 15 subjects. The subjects were then grouped in accordance with the Snellen acuities measured by the refractionist, and the observations in each group were averaged. The purpose of this grouping was to show whether the effect of illumination on acuity was the same or different for observers with normal or with sub-normal vision.

The results are shown on Figs. 1A and 1B. It can be seen from the averaged curves that an increase in illumination of the

FIG. 1 B. ILLUMINATION $\times$ ACUITY FOR STANDARD SNELLEN CHART.
(AVERAGES FOR OBSERVERS WITH SIMILAR ACUTIES).

order of 10:1 improves the acuity by one line on the Snellen chart. The effect is rather less for observers with good vision than for those with poor vision, especially for high levels of illumination. However, the result is probably a useful working rule. There were some deviations from the general rule by some subjects, which are not shown by the averaged curves, but there is evidence that the errors were probably experimental and not systematic.

The data would suggest that it is necessary to set some standard of illumination of the Snellen chart, especially when this is used as a pass test of visual acuity for entrants to a trade or profession. The investigation was not, of course, concerned with the optimum level of illumination for clinical practice, although it would be of interest to know the range of illumination levels within which clinicians would normally work. A survey of clinical practice was made in 1928 in the U.S.A.,* but no recent surveys appear to have been made in this country. It is realised that for visual examinations conducted under unfavourable conditions of working, the clinician often finds it impossible to obtain the desired standard of lighting. The results of this study will, however, indicate to him the allowance which should be made for such deficiencies in illumination.

The investigation is part of the research programme of the Building Research Board of the Department of Scientific and Industrial Research, and this note is published by permission of the Director of Building Research. The authors would like to acknowledge the help of their colleagues who assisted in the experimental work.

THE FORMATION OF THE INTRA-OCULAR FLUIDS. STUDIES OF THE UREA COMPONENT OF THE AQUEOUS HUMOUR

BY

E. J. ROSS

*From the Department of Physiology, University College, and the
Ophthalmological Research Unit M.R.C., Institute of Ophthalmology, London*

It has long been established that the concentration of urea in the aqueous humour is less than that in the blood plasma. After making allowance for the 7 per cent. difference in protein content between aqueous humour and plasma, the ratio of the urea concentrations of these two fluids has been determined by various workers using different chemical methods as follows:—

* R. S. BURNAP and E. C. JACKSON (1928). *Trans. I.E.S. (U.S.A.)*, **23**, 1153.