to analyze the conditions for fusional movements. Haploscopic stimulation with low frequency of alternate stimuli gives rise to reaction IV (maximal apparent movement). Increase of frequency results in a combination of reaction IV with reaction II (apparent movement combined with a fusional movement) or in a combination of reaction IV with reaction III (apparent movement together with simultaneous perception). A further increase of frequency causes reaction IV to disappear and fusion (reaction II) or simultaneous perception of two objects (reaction III) results. Reactions II and III occur with the same frequency of alternate stimuli and are brought about by motor impulses of the same quality and quantity. These motor impulses may follow different reflex-paths leading to reaction II or reaction III. Additional circumstances may inhibit one reflex-path and favour the other; *i.e.*, alternate haploscopic stimulation of both retinae in a completely darkened room results in reaction II; if the room is not completely darkened reaction III is favoured.

According to this theory and based on experimental evidence, fusion, localisation and apparent movement are explained as physiological rather than psychological phenomena. They are optical reflexes, of which the physiological correlate is provided by the motor impulses elicited by the retinal stimuli.

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HYALINE MEMBRANES ON THE POSTERIOR CORNEAL SURFACE

BY

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HYALINE membranes attached to the posterior corneal surface and spanning the anterior chamber are striking curiosities. They may arise (1) as persistence of embryonic tissues, (2) as detachments of Descemet's membrane and endothelium, or (3) as sheets of inflammatory exudate; the following three cases illustrate each of these groups, and the aetiology is discussed.

CONGENITAL HYALINE MEMBRANE

Case History. A man, aged 31 years, whose right eye had been divergent and almost blind since infancy, showed the following abnormal signs in that eye.

Behind the axial area of the cornea lay a semilunar transparent membrane, joining the cornea along a line that passed from 11 to 7 o'clock, roughly concentric with the limbus, 1.3 mm. internally, and merging there with the posterior corneal band. The free margin ran vertically to connect either end of the attached margin: in the centre of this free margin, overlying the pupil, was a small area of pigmented tissue, resembling persistent pupillary membrane, and from it a brown cord passed deeply and downwards to reach the lesser circle of the iris at 6 o'clock. There were no keratic precipitates, and the corneal diameter was 12 mm., as compared with 13.5 mm. in the other eye. The pattern of the iris was less well marked than in the other eye, and there were three clumps of axial episcapsular stars on the lens. The eye was highly myopic (-9.0 D.), and even this correction did not improve his vision beyond finger-counting. There was a divergent concomitant strabismus of 20°, rectified by operation, and a coarse latent nystagmus.

His father and grandmother also had divergent squints, but the father's eyes were otherwise normal.

Abcission of the membrane was performed on July 7, 1948; the attached edge was divided by the sweep of a Ziegler's needle-knife, and a few days later the whole membrane was lifted out through a keratome section, the cord to the iris being divided with scissors. It now became possible to see the fundus, which showed extensive myopic choroido-retinal degeneration, and no visual improvement ensued. (See Figs. 1 and 2.)

FIG. 1.

FIG. 2.

DISCUSSION. During development the lens vesicle becomes separated from its parent surface epithelium, and the intervening space is traversed by the protoplasmic threads of the mesostroma or the anterior vitreous body, which is ectodermal in origin. This mesostroma is most evident peripherally, filling the space where the curve of the lens bends away from the surface ectoderm. A directional membrane is formed by a condensation of the mesostroma, whose anterior surface remains in continuity with the epithelium, but whose posterior surface becomes separated from the lens by a space created by atrophy of the cones of the lens epithelium, from which it partly originated. The mesodermal masses lie peripherally, and grow in centripetally both along the posterior surface of the directional membrane as the future endothelium of the cornea; and later, anteriorly to the endothelium, appearing as a wedge of nuclei separating endothelium from epithelium, and ultimately compressing the mesostroma, which it invades, into the condensations of Bowman's and Descemet's membranes. Finally the mesoderm of the iris and pupillary membrane grow in from the post-endothelial mesodermal condensations.

Persistence of the post-endothelial tissues may occur, and thus present as a fluffy mesh occluding the angle and liable to produce glaucoma; the congenital hyaline membranes described in the literature—Mann (3 cases), Ballantyne, Clapp, Hagedoorn—are all of this order, and in all of them the hyaline membranes were present beneath the cornea at its periphery only, and never extended more than a few mm. from the limbus. Only Ballantyne's case (six days old, with lid and iris colobomata), had keratic precipitates. The other patients were more mature, three showing characteristic thickened ridges on the iris, and one a band which passed forwards to the cornea. The post-endothelial tissue is abundant only peripherally, where these anomalies developed, but the foregoing case, where only central anomalies are present and the characteristic iris anomalies are absent, is not easy to explain in this way.

The mesostroma over the centre of the lens is very thin, as the lens remains almost in contact there with the parent ectoderm, separated from it only by the endothelium, and consequently an incomplete separation of the membranous pupillary membrane from the endothelium is likely to occur, with the result that an anterior synechia of pupillary membrane to endothelium, and subsequently of the mesodermal pupillary membrane and secondarily of the iris will result. This would seem to explain the origin of the case I have reported; for it may be surmised that subsequent development of the eye, with deepening of the anterior

chamber, caused the endothelium and Descemet's membrane to be thereby stripped off the cornea by traction of the synechia over the area where the anterior chamber was deepest.

The cornea of the affected eye was significantly smaller than its fellow, in spite of the high myopia, and a similar feature was noted in one of Miss Mann's patients. If it had been unduly large, one might have guessed that the membrane was stripped off like a retinal detachment in an elongating myopic eye, but the small cornea is presumably evidence only of underdevelopment of the anterior segment, as often happens with persistent embryonic tissues. Such congenital membranes might result from an intra-uterine inflammation, with the anterior iris synechia as evidence of this, and the membrane as a secondary detachment through traction; but apart from the synechia (which in both the foregoing case and the case of Miss Mann's in which it was described was large, single, and free from inflammatory irregularities) and the keratic precipitates in the infant described by Ballantyne (which does not fall so readily into this group), there were no signs of inflammation. The membrane reported bore little resemblance to the true inflammatory sheets of interstitial keratitis, etc., as will be evident when this group is discussed.

Divergence of the eye in the above case is probably not due to impaired binocular vision caused by the membrane, but coincidentally to an hereditary monocular myopia, since his father and grandmother had divergent eyes but no membrane.

DETACHMENTS OF DESCMET'S MEMBRANE

Hyaline membranes can be present since birth, not as a congenital defect, but resulting from birth trauma after distortion of the eye with forceps: into this category falls the following case, where a very similar membrane was found behind the centre of the cornea in an eye which had also been divergent and weak-sighted since infancy.

Case History. A man, aged 20 years, with a divergent and partially blind left eye, ascribed his disability to a forceps delivery.

A semilunar transparent membrane lay behind the central area of the cornea, joining it along a line that passed from 10.30 to 5.30 o'clock from the corneal margin at either end, but 3 mm. internal to it laterally; there it merged with the posterior corneal band. The free margin connected the ends of the attached margin, and was curled over on itself, so that it appeared double in the slit-lamp beam. Another line curved nasally from the upper limit of the membrane to just short of the lower limit, and appeared to be a thickening of Descemet, skirting peripherally a similar semilunar area. A dust-like opacity was present in the middle of the corneal thickness over the whole pupillary area; there were no keratic precipitates. A pulverulent opacity was present in the anterior foetal nucleus of the lens. The iris and fundus were normal. The eye

was highly astigmatic (-1.5 D.S., $+5.0$ D.C. at 110°), but this correction did not improve his vision beyond finger-counting.

A 40° divergent concomitant squint was rectified by operation. The right eye was normal and emmetropic, and there was no relevant family history. (See Figs. 3, 4 and 5.)

FIG. 3.

FIG. 4.

FIG. 5.

DISCUSSION. Thomson and Buchanan described three varieties of birth injury to the cornea, in all cases following difficult labour and the use of forceps: (1) A diffuse opacity which is temporary, and due to oedema. (2) A similar diffuse opacity which becomes permanent through superadded inflammation. (3) An opacity which is linear and permanent, and due to rupture of Descemet with or without the posterior corneal lamellae. Subsequently cases were recorded in which tears of Descemet were followed by its detachment over a wide area. This usually produced a series of vertical ribbons between the parallel tears, which were attached only at their upper and lower extremities (Peters, Feingold, Lloyd, Rushton, Perera, Fison): these bands tended to roll up into rods if they were narrow, so that a colonnade seemed to grace the forecourt of the eye. In other cases, as in that described here, a falciform or segmental detachment was present, again with the long axis roughly vertical. (Ballantyne, Fewell.)

All such birth injuries of the cornea are becoming less common as rickety pelves become rarer, and accoucheurs become more deft and less reliant on forceps. These lesions occur predominantly in the left eye, as in the above case and in Lloyd's five cases, since the left occipito-anterior position is commonest, bringing the left eye laterally. The damage is probably caused by pressure directly on the cornea by the long axis of the forceps blade—so everting and vertically splitting the inner layers.

In the above case the nasal edge of the torn Descemet's membrane has remained (as usual) as a small ridge through the greater part of the extent of the original tear, while temporally the membrane has become detached over a wide area. The fine powdery opacity in the *substantia propria* of the area that has been denuded is typical of those cases of more severe damage, where some fibrosis has followed the initial oedema. There is also the characteristic high astigmatic error (5.0 D.C.) in the slightly oblique axis of the tear, such uni-ocular astigmatism being sometimes attributed *per se* to obstetric pressure; and there is characteristically no mesodermal abnormality.

INFLAMMATORY RETROCORNEAL MEMBRANE

Case History. A man, aged 59 years, with a classical history of interstitial keratitis—bilateral "blindness" at the age of 13 years, which after two years cleared gradually in the left eye only, and an acknowledged parental infection with syphilis—showed the following appearance.

The right eye was blind, and directed 15° upwards and 15° convergent. Both corneae were slightly ectatic, with characteristic interstitial nebulae, some deep attenuated blood-vessels, and, in each eye, an eccentric deposit of blood pigment. Over the back of the right cornea stretched a reticulate sheet, the interlacing fibrinous bands being as wide as the holes that separated them. They adhered to the posterior corneal surface except at a very few points, where a gap between

band and Descemet's membrane was discernible; these bands became fainter peripherally, where the cornea was relatively clear.

Over the back of the left cornea were fewer but more discrete interlacing strands, spanning the anterior chamber like a cobweb so that centrally they lay well behind the cornea. Inserted, as they were, into the latter at either end, they seemed to consist of a fine opaque white central filament with a relatively broad translucent sheath.

Both irides were atrophic, especially on the right side, with posterior synechiae also on that side. Exudate on the anterior lens capsule, cortical cataract and a small bound-down pupil prevented a view of the right fundus, and this eye had no perception of light. The left lens was clear except for a few epicapsular stars. The left fundus was normal centrally, but showed extensive peripheral disturbance from old anterior choroiditis. The left vision was improved to 6/18 with -5.5 D.S. correction.

In spite of having had no specific treatment, he was otherwise healthy, except for deafness on one side. His Wassermann reaction was negative. His mother and father had "died of drink" when he was young, but his brother, aged 66 years, was alive and well, and also showed on examination a typical interstitial keratitis, although much less intense, the vision being 6/60 and 6/24 with myopic correction. There were no comparable abnormalities in the brother's eyes, except for a fine translucent strand passing in the right eye across the pupil from one posterior synechia to another, and jutting forward into the anterior chamber, so that it was well clear of the lens capsule. (See Figs. 6, 7, 8, 9.)

FIG. 6.

FIG. 7.

Fig. 8.

FIG. 9.

DISCUSSION. Membranes from inflammatory exudate are considerably less rare than the two varieties already described, and are more frequently recognised in the literature, so that little comment is here required. Typically they are seen as irregular fibrinous laminae, reticulate or stellate, and not as an even and thin semilunar sheet. Commonly they admit the term "glass membrane."

They occur classically in interstitial keratitis, but are occasionally described in tuberculous or other forms of intense uveokeratitis. They lie behind the centre of the cornea, and are necessarily associated with other signs of past inflammation. Initially they were probably wholly in contact with the endothelium, but become detached like the strings of a bow when their fibrin content subsequently retracts. It is of passing interest to note the fibrinous filament in the anterior chamber of the brother's eye, but here passing between two posterior synechiae instead of between two points on the posterior corneal surface.

Perhaps the precipitation of fibrinous shreds depended on an hereditary predisposition or on the particular strain of spirochaete.

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Summary

Three cases are described of hyaline membranes; one of them a consequence of developmental arrest, one due to birth trauma and the third following uveokeratitis. Their aetiology is discussed.

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LOCAL APPLICATION OF UREA FOR THE TREATMENT OF DENDRITIC ULCER*

BY

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LONDON

HYPERTONIC solutions applied in an eye-bath are believed to have a favourable influence on marginal ulcers of the cornea. One obvious advantage of an eye-bath is that the medication is kept in the conjunctival sac. A series of cases of dendritic ulcer was treated with a corneal bath containing a 25 per cent. solution of urea in 1942-44 at the Central London Ophthalmic Hospital and the results in over 30 cases were encouraging.† The same treatment has been carried out in a new series, and the results are reported here. It

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† M. Klein. Results unpublished, as the notes of these cases were lost during the war.