The creatine and creatinine metabolism was not altered by the use of prostigmin: average daily excretion of creatine (Case No. 2) was 0.02 gram per day before the injections and 0.025 gram per day after the injections.

The creatinine excretion was 1 gram per day before the injections, and 0.9 gram per day after the injections. The diet was the same during the observations, and these findings agree with those of Cooke and Passmore.

The injections produced no systemic disturbance and caused no inconvenience to the patients, and the psychological improvement in their outlook was very gratifying. The two cases are being kept under observation, and it is hoped that favourable reports of their progress will be given at some future date.

These observations have been made while holding the appointment of house-physician to Professor A. Ramsbottom in the Royal Infirmary, Manchester. I am indebted to Professor Ramsbottom and Mr. Geoffrey Jefferson for access to their cases and for helpful advice and criticisms; to Dr. G. E. Loveday and the clinical laboratory for the laboratory investigations; and to Dr. Paterson of the x-ray department for his co-operation in regard to the photography.

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A. A. Levi and C. M. Krinsky (*New England Journ. Med.*, February 20th, 1936, p. 362) record an investigation of the effect of administering coramine to post-partum patients under the analgesic influence of some barbituric acid drugs. The series studied consisted of forty consecutively admitted patients who had received nembutal and paraldehyde. To twenty of these patients 5 c.cm. was given intramuscularly after the third stage of delivery had been completed; the average patient had in the meantime come round from the mild degree of ether anaesthesia which had been induced. The remaining twenty served as controls, and significant differences were observed between the two groups. Recovery of consciousness supervened in an average of seven hours and forty-eight minutes in those not so treated, while the time was five hours and forty-five minutes for the coramine group. The average doses of paraldehyde were almost identically the same in all patients—namely, 4.4 grains of nembutal and 5.1 drachms of paraldehyde for the control group, and 4.7 grains and 4.5 drachms respectively for the coramine group. It was also noticed that there were fewer catheterizations necessary in this latter group. One patient, not in this series, who seemed to be dying after exceptionally heavy doses of nembutal and paraldehyde, was restored to consciousness three-quarters of an hour after the administration of coramine, and the pronounced cardiac and respiratory embarrassment passed off. The authors add that coramine is undoubtedly of value when the respiration is so depressed that the patient cannot inspire carbon dioxide and oxygen mixtures.

TREATMENT OF THE AMBLYOPIC EYE

BY

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Von Graefe once described amblyopia as a condition "where the doctor and patient see nothing"; to-day we might quite well add the reproach "and do nothing." Treatment of the virtual blindness of these eyes is almost entirely neglected after early childhood, despite the disability that it undoubtedly involves. This is the outcome of an assumption that the loss of visual acuity is either incurable, or that improvement in function such as can be obtained by treatment is not commensurate with the effort involved.

The object of this paper is to show, first, that this assumption rests on very flimsy pathological evidence, unsupported by the clinical results that can be obtained by treating amblyopia; and, secondly, that these eyes, even when the blindness is unilateral, represent in this mechanical age a grave economic and social disability more than justifying the effort of securing useful function. To assess the value of treatment I have recently treated a group of amblyopic eyes selected at random from hospital and private practice. They exhibited three clinical types of reduced visual acuity:

1. Amblyopia ex anopsia—the legacy of childhood strabismus (Cases 1 to 5).
2. Congenital amblyopia presumed to result from the presence of some developmental defect (Cases 6 and 7).
3. Amblyopia of the type associated with corneal nebulæ, ametropia, or other objective evidence of interference with infantile education in macular perception. The blindness of many eyes damaged in early childhood by disease or trauma is frequently in a greater degree due to an associated amblyopia than to the optical effect of the sequels of the lesion, and their treatment may result in a dramatic increase of visual acuity, despite comparatively gross ophthalmoscopic signs (Case 8).

In my opinion these three forms have a common pathological basis, consisting of an obstruction in the psychological phase of the visual arc. This interference with conscious perception may be a purposive act to avoid the psychic trauma involved by some fusion dysfunction or the passive result of the incomplete conditioning of the pathways which subserve syncritic vision. Anatomical defects in the visual arc play, I believe, a comparatively small part in the pathology of amblyopia.

Toxic and similar forms of amblyopia are not considered, as their connexion with these groups is only an accident of nomenclature.

The Value of Treatment

There are certain unproven assumptions regarding the pathology of the amblyopic eye which have tended to discourage efforts at treatment. It has been assumed that a progressive and irreversible deterioration from disuse takes place somewhere in the visual arc of the "lazy" eye. Certainly, as the suppression becomes more habitual the residual function tends to get less until only perception of light with no power of central fixation may remain. This does not necessarily mean, however, that any concurrent organic change in the eye or central pathways has taken place. In fact, careful histological examination has failed to demonstrate any secondary change.

There is, therefore, no *a priori* justification for presuming that, if the suppression habit is overcome, a return of visual function might not be expected. The results

of my treatment, quoted later, show this to be the case. Even without treatment cases have been reported in which an increase of visual acuity has spontaneously occurred in amblyopic eyes, due to the psychological urge following the loss of the good eye. A recent example was reported in the *British Medical Journal* (1935, ii, 113) by Mr. A. W. Green. The patient at the age of 35 had a right vision of less than 6/60. Following the loss of sight of the left eye due to optic atrophy the vision in the amblyopic eye gradually improved to 6/6 and J1. Such cases show that a secondary organic and irreversible deterioration in the visual arc is not an inevitable sequel to amblyopic suppression, if in fact it ever occurs.

The presence of some form of macular developmental defect is presumed to be responsible for "congenital" amblyopia. Such lesions would, of course, make a high degree of macular perception impossible, and the assumption that they are of frequent occurrence has further tended to discourage efforts at treatment. Such congenital lesions do exist, but histologists have failed to find any such defects in the majority of amblyopic eyes submitted for examination (Friedenwald, Heine, Lehrmann). In addition, the clinical history of an amblyopia due to such a lesion would be different from that associated with congenital amblyopia, for nystagmus or "wandering" movements would replace the usual concomitancy.

Statistical evidence is insufficient to enable one to estimate the incidence of congenital aberrations, but I believe that most of these eyes are in reality the result of some transient infantile interference with macular education. The essential pathological lesion is in fact central, not peripheral. Certainly I have never treated an amblyopic eye the visual acuity of which in the absence of nystagmus could not be improved to better than 6/60, the threshold for extra-macular perception. The number of such cases treated so far is, however, too small to enable me to draw any final conclusions.

The indifferent results obtained in the past by the treatment of established amblyopia have also tended to confirm the assumption that either a causative or a secondary organic lesion is present in the visual arc. In addition, the prolonged and tedious methods employed may have justified a certain hesitation in even making the attempt.

The following notes are therefore of interest to show the results that can be obtained by treatments given once or twice a week over a comparatively short period. They represent a series of ten cases which have been given six to ten weeks' treatment at the Royal Eye Hospital and in private practice. They were originally selected without regard to age or degree of visual acuity. Of these, eight have secured a return of useful visual function in the amblyopic eye, and have acquired binocular vision. The other two patients (men aged 47 and 27) have secured central fixation and an increase of visual acuity, but their progress has been much slower and they are still under treatment.

The following table shows the ages and the visual acuity obtained by the eight successful cases.

All the strabismus cleared up during treatment, except in the case of No. 5, who had had a tenotomy of the left internal rectus at the age of 16. He secured central fixation, and after a secondary advancement should secure full binocular control and a further increase of vision. Simultaneous perception and some amplitude of fusion were obtained by every patient. My experience of examining some old cases suggests that the latter increases with use.

Examination of these results shows that there is no justification for neglecting the treatment of an amblyopic

Group I: Amblyopia ex anopsia

Case	Sex	Age	Condition	Vision Before Treatment	After Treatment
1	F.	7½	Left convergent strabismus 20°	Left eye, 6/60	6/6
2	F.	15	Right convergent strabismus 3° since 5 years	Right eye, 6/24	partly 6/6
3	M.	17	Right convergent strabismus at 3 years	Right eye, 6/60	6/9
4	M.	37	Left divergent strabismus 15°	Left eye, count fingers only	6/9
5	M.	38	Left divergent strabismus 45°	Left eye, 6/36	partly 6/12

Group II: "Congenital" Amblyopia

6	F.	18	—	Left eye, 6/60	6/6
7	F.	22	Left eye, lost fixation	Right eye, 6/60 Left eye, hand movements only seen	6/5 6/6

Group III: Sequels

8	M.	27	Corneal nebulae since infancy	Left eye 6/36	6/9 partly
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eye on the grounds of its presumed incurability. It remains, however, to examine the advantages gained by substituting binocular vision for the monocular function, for the final criterion of the value of any treatment lies obviously in the benefits it gives to the patient.

Disabilities of the Amblyopic Eye

The value of useful vision to a bilateral amblyope is too obvious to require stressing. Bilateral amblyopia may follow, *inter alia*, any form of prolonged occlusion during early childhood, or even the relative occlusion of uncorrected ametropia. Moulton recorded two cases (*Ophthalm. Record*, 1903), and H. Herbert (*Cataract Extraction*) reports that following successful operations on neglected congenital cataracts in India "some of our patients could see only moving bodies" owing to "amblyopia from disuse." A case of amblyopia associated with ametropia was reported (*New England Ophthalm. Soc.*, 1929) with eight dioptries of hypermetropic astigmatism, the vision being little more than perception of light.

The intrinsic desire to see more will lead to a spontaneous improvement in many cases, but in others this does not occur. In Case 7, for instance, the patient had been virtually blind since birth. Until the age of 14 she had been continually under treatment for corneal ulcers. This had involved long periods of complete or relative ocular occlusion. Since it had been considered advisable to rest her eyes, her refractive errors were not corrected until the age of 17. The errors were high (at present: right eye — 0.25 D.S. and + 1.50 D.C. vert.; left eye + 4.00 D.S. and + 3.00 D.C. Ax. 80), and the combined effect of the keratitis, therapeutic occlusion, and dioptric distortion was a vision at the age of 22 of right eye 6/60, left eye hand movements only, despite correction. During her childhood her vision had been little better than that described above by H. Herbert. As a child she thought all faces were black. After refraction her vision had improved, but she was still unable to read or to follow any occupation requiring even fair visual acuity. She was under the impression that during the past year her vision had got somewhat worse again, but this belief was probably the effect of a not unnatural anxiety regarding her condition. Examination revealed corneal nebulae in both eyes too fine to affect vision to any serious extent. The media, fundi, and general condition showed no abnormality. Binocular movements were normal, but on occlusion of the right eye the left eye "wandered" in its attempt to secure fixation. An eccentric fixation by an area in the temporal retina was favoured, but the patient had little power of maintaining it.

I have recently seen two further examples of this condition. Each patient had high errors of refraction, especially astigmatic, which were not corrected until comparatively late in life (38 years and 21 years).

The genesis of this amblyopia is the imperfect facilitation in childhood of the central pathways which subserve macular perception. It is more likely to occur if the ametropia is associated with any other ocular lesion, such as nebulae and subnormal pigmentation. In the absence of treatment the low visual acuity of these cases bars them from a full enjoyment of life, and keeps them in a condition of perpetual economic dependence, or, at the best, in the ranks of unskilled labour.

The visual handicaps entailed by unilateral amblyopia, while not so obvious, are nevertheless very real. These people rarely practise simultaneous perception, even when they have a fair degree of visual acuity in the amblyopic eye. They are therefore functionally monocular. This involves a reduction of their field of vision and the loss of the advantages inherent in the possession of a common field.

Field of Vision

Increasing traffic congestion and the mechanical complexity of modern life have tended to focus attention on the minimum visual requirements of drivers and others with similar responsibilities. The binocular field normally covers slightly over 180 degrees, of which 120 degrees is common field in which the benefits of binocular fusion should be enjoyed. Outside this, in the unocular fields, one should be aware of any untoward happening. The normal motor car driver should therefore have warning of the approach of a pedestrian or a car cutting in from any point in front of the level of his driving seat.

The driver with an amblyopic eye, however, has no functioning common field, and no unocular field on the blind side. The effect of this, with a left amblyopic eye, would be to prevent his being aware of a pedestrian leaving the curb at any point within twenty feet ahead when his car is about four feet from the pavement. If the right eye is amblyopic the limit of his field would meet the pavement some twenty yards ahead in a street of average width, and consequently he has no warning of danger coming from this blind area.

The regulations in Great Britain at present permit driving without reference to the visual fields. In America, however, certain States (Ohio, Minnesota, and Delaware) have already prohibited monocular drivers, and Maryland demands the possession of binocular vision. Other States have varying requirements based on the extent of the fields. R. E. Mason (Missouri) has recently published some interesting observations on this subject.

Visual Acuity

Under the usual conditions of his normal life the amblyope may not experience much handicap from the loss of the macular perception of his blind eye. He has generally adapted, consciously or unconsciously, his occupation and recreations to his visual limitations. Such theoretical benefits as increased luminosity and power of discrimination conferred by fusion have not been experienced by him, and in normal circumstances are not missed. Under unusual conditions, however—for instance driving in a fog, or a sudden change of occupation—he will find that he is much less adaptable than his binocular brother, and his accident proneness is correspondingly greater.

The danger of virtual blindness owing to disease or trauma affecting the vision of the good eye is an ever-present menace. Such cases are not uncommon. Unfortunately, a spontaneous increase of vision in the amblyopic eye under these circumstances is too rare to be taken for granted.

The exclusion of the amblyope from many private and public services may interfere with his entry to his chosen career or jeopardize his advancement. In Case 3, for instance, the patient has been specially trained for a service into which the presence of his amblyopic eye would have prevented his entrance.

Perception of Depth

Our judgement of distances with our appreciation of stereoscopic effect is to a large extent a function of binocular vision. As with the functions already dealt with, the amblyope has usually adapted himself to its absence at the expense of sacrificing sports and occupations which he might otherwise have enjoyed. Nevertheless, under unusual conditions, his adaptation is liable to break down and expose him to dangers which, with binocular vision, he might have avoided.

Strabismus

The psychological effect of the squint, so frequently associated with an amblyopic eye, is insufficiently appreciated. The outspoken comments of school companions may have an important and permanent effect on a child's character. Operative adjustment of the deviation is of no functional value, and even the cosmetic improvement is frequently disappointing. Later in life, with the gradual loss of central fixation, a disfiguring divergent strabismus frequently develops, to add a further social handicap to the amblyope.

Conclusions

1. The virtual blindness of the amblyopic eye is a symptom of a psychological inhibition. The presence of any causative or secondary anatomical lesion is largely conjectural.
2. The disability involved by the loss of binocular vision and the risk of total blindness, should their only functioning eye become damaged, makes a return of vision, to even the unilateral cases, of the highest importance.
3. There is no justification for regarding these eyes as incurable after early childhood, and consequently abandoning any effort at treatment.
4. Both in childhood and in adult life a useful degree of visual acuity and simultaneous perception can usually be restored, and with these the disappearance of any associated squint.

On May 25th representatives of local authorities and other organizations co-operating with the Department of Scientific and Industrial Research in the investigation of atmospheric pollution met in conference. Dr. H. A. Des Voeux, a past chairman, presided. A report was received from Dr. G. M. B. Dobson, F.R.S., chairman of the Atmospheric Pollution Research Committee, on the progress of the researches carried out under the committee. He announced that the committee had decided to undertake an intensive survey of the pollution in and around an industrial centre, and had chosen Leicester, whose geographical position in relation to the surrounding country and neighbouring centres of population appeared to render it particularly suitable. This proposal had been cordially received by the authorities of the city, who offered full co-operation. The conference noted with interest that the London County Council had intimated that it was extending its investigations and observations in various directions, and that it was, in particular, arranging for observations at a rural institution and a seaside institution belonging to it. Reports from Glasgow and from Sheffield and Rotherham were presented on comparative determinations of sulphur in filtered and unfiltered air. Measures were discussed for reducing pollution due to the emission of ash and grit from chimneys.