Wintersteiner mentions a case in his book (*Das Neuro-epithelioma Retinae*, 1897) cited by Pepper, No. 194, p. 348, in which the patient was 17 years of age, and the duration seven months.

The patient has not had a recurrence in the orbit or metastasis elsewhere, so far as is known at this period, although thirteen months have elapsed since the second eye was excised.

I am indebted to Mr. J. Herbert Fisher for permission to publish the case.

THE MONTGOMERY LECTURE, 1917-18*

A survey of cases of concomitant squint in the practice of the late Mr. P. W. Maxwell.

BY

EUPHAN M. MAXWELL, M.B.,

DUBLIN.

AN article entitled "Precision in Squint operation" was published by Mr. Maxwell in the *Lancet*, 1896. The conclusions arrived at were based on a survey of two hundred cases. The author described a "muscle tucker" of his own design, but his practical experience of the instrument was then limited to three cases.

In 1908, he published an article "Internal Squint" in the *Medical Press and Circular*. This paper dealt mainly with Donder's theory of the aetiology of concomitant convergent squint, and contained no statistics of cases. No further record of his work was published, but up to the time of his death in 1917, the subject received his closest attention, and he was indefatigable in his efforts to perfect his operative technique.

There already exists a copious literature on concomitant squint; my excuse for adding to it is that a survey such as the following, though it embraces no new conceptions, may prove of value if it but strengthens existing theories and acknowledged lines of treatment.

Since 1896, 1,201 cases of concomitant squint are recorded amongst Mr. Maxwell's private and hospital patients. Of these, 1,121 were convergent, 179 divergent, and one an upward squint unaccompanied by lateral deviations. Fortunately I have been able to follow up several of these cases, and thus to complete their records.

I.—*Convergent concomitant squint*

An estimation of the average age of commencement showed: Constant and unilateral, 3.6 years; alternating, 3.4 years; periodic, 2.8 years; periodic becoming permanent, 4.5 years.

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*Delivered in the School of Physic, Trinity College, Dublin, on Friday, Nov. 8, 1918.

An estimation of the average refraction of all the cases examined within a year or two of the commencement of the squint, excluding myopes with corneal nebulae, showed the following amount of hypermetropia in the lower and higher meridians of the squinting and fixing eyes respectively :

	Squinting eye.		Fixing eye.	
	l.mer.	h.mer.	l.mer.	h.mer.
Constant and unilateral	3.5 D.Hy.	4.75 D.Hy.	3.5 D.Hy.	4.25 D.Hy.
Periodic	3.75 D.Hy.	4.5 D.Hy.	3.5 D.Hy.	4.25 D.Hy.

Only five cases examined under puberty showed myopia of both eyes ; in these the convergence commenced within the first six months of life. Worth has noted this development of a convergence rather than a divergence in infantile myopes.¹¹ The average refraction in untreated cases under ten years of age, estimated in respect to the size of the "longe" angle was

	Under 10° L	10°-20° L.	21°-30° L.	Over 30° L.
Constant convergence	4 D.Hy.	4 D.Hy.	4 D.Hy.	4.25 D.Hy.
Periodic convergence	3 D.Hy.	4.5 D.Hy.	5.25 D.Hy.	6.75 D.Hy.

The refraction here noted was that of the fixing eye ; where astigmatism was present the amount was halved and added to the lower meridian.

An increase in the amount of hypermetropia with an increase in the size of the angle was only noted in the case of the periodic squints where the refractive error is theoretically the sole causal agent. In these periodic cases, where the angle was small, or of medium size, 1 D. Hy. corresponded roughly to 3° of squint. That this correspondence ceased in the higher angles, is presumably due to the introduction of the secondary actions of the superior and inferior recti.

In 65 per cent. of cases under ten years of age the "prox" deviation was found greater than the "longe," only 45 per cent. of cases over ten years of age showed this relationship. These figures suggest a decrease, with advancing years, in the neuro-muscular activity associated with convergence.

Numerous instances of an absolute increase in both the "longe" and "prox" deviations up to puberty were noted.

The following were recorded as precipitating agents :—

Fright.	Illness.	Trauma of the eye itself.	Trauma or operation in the neighbourhood of the eye.	The wearing of a bandage for some weeks.
26 cases...	26 cases...	5 cases...	6 cases...	1 case (this occurred in a boy of 9 who had suffered from corneal ulceration).

Two of the cases precipitated by illness were of especial interest in that squints, cured in early youth by glasses and operation respectively, recurred some years later following the onset in one case of peritonitis, in the other of disseminated sclerosis.

The following complications were recorded :—

Nystagmus,	Well-marked vertical deviations,	Congenital ocular defects.	Ptosis,	Mental defects.
22 cases ...	16 cases ...	7 cases ...	5 cases ...	4 cases

The nystagmus was mainly bilateral and horizontal in type. The vertical deviations were upward in 14 cases, downward in two. In one of the former slight paresis of the superior rectus was noted. The congenital defects were cataract (4 cases), bilateral coloboma of iris (1 case), pigmented maculae (1 case), bilateral absence of choroidal pigment (1 case). Four of the 5 cases accompanied by ptosis showed the defect in the squinting eye only.

II.—*Divergent concomitant squint*

An estimation of the age of commencement in the cases of constant concomitant divergence, irrespective of the associated type of refraction, showed $7\frac{1}{2}$ years. Where the divergence was only periodic in type, the age at which the defect became noted appeared to vary with the type of refraction, where accompanied by a bilateral hypermetropia being noted at an earlier age than where accompanied by a bilateral myopia.

Eighty-three cases, where the type of refraction was the same in both eyes, showed :

Myopia, 48 cases ; hypermetropia, 28 cases ; mixed astigmatism, 7 cases.

An estimation of the amount of the refractive error, irrespective of age, in the lower and higher meridians of the squinting and fixing eyes respectively, showed :—

	Squinting eye.		Fixing eye.	
Constant divergence	1. Mer.	h. mer.	1. mer.	h. mer.
assoc. with myopia	8	D.My. 10·75D.My.	5	D.My. 7·75D.My.
both eyes				
Periodic divergence	7	D.My. 9·25D.My.	5·25D.My.	6·75D.My.
ditto				
Constant divergence	1·75D.Hy.	2·75D.Hy.	1·75D.Hy.	2·75D.Hy.
assoc. with hy.				
both eyes				
Periodic divergence	1·25D.Hy.	2	D.Hy. 1·25D.Hy.	1·75D.Hy.
ditto				

An estimation of the refraction in relation to the size of the

angle in the myopic cases suggested that the larger angle was associated with the greater anisometropia. No relationship between the size of the angle and the amount of the refractive error was noted in the hypermetropic cases.

An estimation of the type of refraction in relation to the respective sizes of the "longe" and "prox" angles showed :

	Hy. both eyes.	My. both eyes.
"Longe" greater than "prox" ...	20 cases ...	5 cases
"Longe" less than "prox" ...	4 cases ...	14 cases

This preponderance of hypermetropes in cases of "divergence excess" and of myopes in cases of "convergence insufficiency" agrees with the findings of Wootton of New York.¹⁰

As regards precipitating agents several cases were recorded where illness acted directly as such. Fright was recorded in 4 cases. Two cases of "consecutive divergence" were noted. In both these cases an eye, previously convergent, became divergent about the age of 7 years.

As regards complications 4 cases with marked vertical deviations were noted, 3 showed an upward and 1 a downward deviation. In the latter was noted slight paresis of the superior rectus. Two instances of divergence occurring in imbeciles, and one in an epileptic, were recorded.

III. The following is a brief outline of *the methods of examination and lines of treatment* adopted, where feasible, in the cases of *concomitant convergent squint* :

(1) The deviation and fixation angle were measured at the perimeter. Gross defects in outward mobility, and any complications present, were recorded.

(2) After an instillation of 1 per cent. atropin into both eyes for ten days, the deviation was again measured and retinoscopy done.

(3) Glasses were then ordered, the spherical correction being 0.5 D. less than, the astigmatic correction being exactly that of, retinoscopy. Where the hypermetropic error was high, atropin was continued in both eyes until the glasses had been worn for about a fortnight.

(4) Where fixation was faulty, or vision defective, despite optical correction in the squinting eye, atropin in, and occlusion of, the fixing eye was continued for some weeks. Occlusion, in the very young, was only practised during part of the day, preferably at meal-times.

(5) Where the squint still persisted after some months of above treatment, operative measures were introduced.

(6) Orthoptic exercises were mainly employed as a post-operative measure.

Certain points of interest elicited in the examination of these cases are here recorded:

(1) The average reduction of the "longe" angle by atropin, estimated in respect to the age of the patient, and the length of time of dosage, and in comparison with the reduction effected by glasses, was as follows:

Average reduction under 10 years, 6°			10-15 years, 4·6°	over 15 years, 2°
Average reduction, irrespective of age, when given from 1-3 days, 2°			4-7 days, 2·5°	over 7 days, 11·6°
Average reduction, irrespective of age or dosage, with atropin			under 10 years, 6·8°	over 10 years, 5·7°
Average reduction with glasses			15·9°	8·6°

The decreasing effect of age is presumably the result of decreasing hypermetropia.

In estimating the result of dosage, several instances of an increase in convergence and a decrease in divergence, where atropin had only been instilled two or three times, were noted. This was presumably the result of an increased accommodative activity called into play on account of faintly responsive muscles. That the reduction with glasses was greater than with atropin may be largely explained by the fact that many of my figures were taken from patients who had been wearing glasses for some months. Mr. Maxwell has estimated the immediate and remote effects of glasses as being in a ratio of 3:5·5.⁶ The still greater relative increase with glasses in children under 10 years, may have been partly due to the added effect of occlusion of the fixing eye, recorded in many instances, this effect being apparently more marked in younger children. I noted eight cases which were recorded as "straight" under atropin. Seven of these became cured with glasses, the eighth, examined some months later, still showed a slight convergence for "prox."

(2) The average fixation angle was 3° out in the squinting, and 4°, in the fixing eye.

Amblyopic vision in the squinting eye was found to exist where the angle was less than 1° or more than 7° out. A vision of "motion of hand" was recorded in one case with marked eccentric fixation. Where fixation was faulty, the average age of commencement of the squint was found to be 1½ years; this agrees with Priestley Smith's view, as quoted by de Schweinitz, that all infants are amblyopic, and that an early developing squint may readily hinder the further progress of the eye.⁷

Several instances of a travelling inwards of the fixation point

after treatment, even where some convergence still persisted, were noted. This has been explained as showing an attempt on the part of the squinting eye to co-operate better with its fellow.⁶

3. Binocular vision was found present in every case of periodic squint, where looked for. In the cases of constant squint its presence or absence was usually recorded after treatment. The following table shows the average ages at which treatment was undertaken, in the cases where a complete, partial, or absent binocular vision was noted :

Complete binocular vision.	Partial binocular vision.	Binocular vision absent.
4½ years. ...	7½ years. ...	8½ years.

Guided by Worth's experience¹¹ we may assume that the majority of cases recording partial binocular vision after 7 years of age had had a fusion sense before treatment, but in too weak a degree to prevent the squint. Eight of these cases with partial binocular vision still showed slight convergence when tested. In one or two instances where a sense of perspective was wanting, bar-reading and accuracy with the Hering drop test were noted. One case of a boy of 16 years of age who showed complete binocular vision after a successful operation, was presumably an illustration of fusion memory, as in early life his squint had been cured with glasses but had recurred a year or two later on discarding the latter.

About 40 per cent. of cases showing binocular vision after treatment, optical or operative, became straight without glasses at an early age. In no instance where complete binocular vision was noted, did the corrected vision of the squinting eye fall below 6/12.

4. Diplopia as a symptom was only recorded in 1.5 per cent. of cases. The average age of commencement of the squint in these cases was 11 years.

In 36 per cent. of cases in which binocular vision was noted absent, diplopia was recorded as having been readily elicited. I had several opportunities during such examinations of noting the power of the vertical prism to overcome suppression, over coloured glasses.

In 87 per cent. of cases where diplopia was recorded either as a symptom, or as having been artificially produced, the corrected vision of the squinting eye was above $\frac{5}{8}$. Several instances were noted of the post-operative development of crossed diplopia, in cases where the eyes were straight, or where some convergence still persisted. These cases have been explained as demonstrating the existence of a new fovea, or, in the absence of co-ordinating points in the retinae, of the power of each eye to localize for itself more or less correctly.⁷

In some few cases with homonymous diplopia in which I was

able to measure the distance between the images, I found an average equalling roughly one-third of the deviation.

Certain points of interest in connection with the results of optical treatment are here recorded :

	Under 10 years of age.	Over 10.
Average reduction "longe" with glasses	12.5°	6.9°
Average refraction of fixing eye ...	4.25 D. Hy.	2.75 D. Hy.

This averages a reduction of about 3° of squint by every corrected dioptré of hypermetropia. The figures were taken from cases which had only been wearing glasses for a few weeks. Where astigmatism was present the amount was halved and added to the lower meridian.

In the following tables "cosmetic cure" implies a remaining convergence of less than 3°, including the fixation angle; under this heading are also included cases which became straight "longe" but remained convergent "prox."

	Perfect cure.	Cosmetic cure.	Not cured by glasses.
Average age of treatment	5½ years.	8 years.	9 years.
Percentage of results	30 per cent.	20 per cent.	50 per cent.
Spherical correction given to within 1 D. of retinoscopy.	100 per cent.	100 per cent.	88 per cent.
Astigmatic correction ditto	75 per cent.	75 per cent.	64 per cent.
Occlusion recorded as supplementary treatment.	25 per cent.	18 per cent.	12 per cent.
Binocular vision present, in cases where looked for, after treatment.	100 per cent.	56 per cent.	70 per cent.
Faulty fixation before treatment ...	20 per cent.	25 per cent.	35 per cent.
Squint amblyopia	25 per cent.	45 per cent.	45 per cent.

These figures were taken from cases which had been given a genuine trial, for several months, with glasses. Two or three cases were recorded in which, showing little improvement with an under-correction of their refraction, they became straight or very much reduced, on being given an accurate correction. 30 per cent. of the "perfect cures" were periodic in type. 18 per cent. of the constant cases noted "perfect cures" became straight without glasses, within a year or two of wearing them.

The high percentage of cases showing binocular vision amongst the "non-cures" may be accounted for by the fact that many of

these cases later underwent, and were cured by, operation, the fusion sense being looked for at the completion of treatment.

In the following table are recorded certain points of interest in connection with the results of optical, combined with operative, treatment:

	Perfect cure.	Cosmetic cure.	Still converging.	Diverging.
Average age of treatment.	Gl.: 7 years Op.: $8\frac{1}{2}$ „	Gl.: $7\frac{1}{2}$ years Op.: $10\frac{1}{2}$ „	Gl.: 7 years. Op.: $9\frac{1}{2}$ „	Op.: 11 years.
Percentage of results.	36 per cent.	26 per cent.	29 per cent.	9 per cent.
Alternating squint.	12 per cent.	13 per cent.	28 per cent.	
Occlusion recorded as supplementary treatment.	35 per cent.	14 per cent.	12 per cent.	
Binocular vision present in cases where looked for, after treatment.	84 per cent.	42 per cent.	0 per cent.	50 per cent.
Of the cases presenting diplopia as a pre-operative symptom.	85 per cent.	15 per cent.		
Diplopia as a post-operative symptom.	36 per cent.	40 per cent.	12 per cent.	12 per cent.
Faulty fixation before treatment.	8 per cent.	25 per cent.	70 per cent.	20 per cent.
Squint amblyopia.	12 per cent.	50 per cent.	46 per cent.	55 per cent.

These figures were taken from cases, seen during a period of four years on an average, after the last performed operation.

Only 20 per cent. of the "perfect cures" required a second operation. 35 per cent. of the "perfect cures" were found straight without glasses within two or three years of the operation, that is, on an average, about puberty.

None of the "divergences" with binocular vision had a sense of perspective.

Amongst the cases marked "still converging" were noted one mentally defective, three accompanied by nystagmus, several accompanied by marked altitudinal displacements, and three which showed considerable variation in the size of the angle, examined on different days. These last-mentioned cases had presumably a marked neurotic element, rendering successful treatment more difficult.

IV.—*The methods of examination and lines of treatment* adopted in the cases of *divergent squint*, accompanied by myopia, were

roughly those outlined under convergent squint. When accompanied by emmetropia or hypermetropia, there were no general lines of treatment which could be recorded.

Certain points of interest elicited in the examination of divergent squints are here noted :

(1) The average fixation angle was 4.25° out in the squinting, and 5° out in the fixing eye.

Amblyopic vision in the squinting eye was found to exist in every case where the angle was less than 2° , and in the one case where it was more than 10° out.

Not very many instances of faulty fixation were noted, presumably owing to the usually late development of divergent squint. A travelling inwards of the fixation point after operation was recorded in four cases.

(2) Binocular vision, in some degree, was found present in most of the cases where looked for. This may partly account for the fact that more complete and rapid results with orthoptic exercises and occlusion of the fixing eye, appear to have occurred in divergent than in convergent squints. In one case of alternating divergence, a well-developed sense of perspective was recorded. No case with a fusion sense had a corrected vision below 6/24.

(3) Diplopia as a symptom was recorded in 12 per cent. of cases ; most of these were associated with bilateral myopia.

In 85 per cent. of cases where diplopia was recorded either as a symptom or as having been artificially produced, the corrected vision of the squinting eye was above 6/24.

In 65 per cent. of cases which became straight after operation, and in which diplopia was noted as a post-operative symptom, the diplopia was homonymous in character.

In the cases with crossed diplopia, where the distance between the images was measured, it was found to equal roughly, on an average, half of the deviation.

In regard to the general results of treatment the following points are of interest :

The few cases which were recorded as cured or improved with glasses showed myopia in both eyes with a convergence insufficiency.

In all of them good fixation and corrected vision were noted. Diplopia was recorded as a symptom in the majority of these cases.

One instance was noted where a divergence, but little affected by under-correcting concave glasses, became straight, when the patient was given the full correction.

In the following table, in connection with operative results, "cosmetic cure" implies a remaining divergence of less than 10° , including the fixation angle.

	Perfect cure.	Cosmetic cure.	Still diverging.	Converging.
Average age of treatment ...	24 years.	11 years.	17 years.	
Percentage of results ...	36 per cent.	30 per cent.	17 per cent.	17 per cent.
Binocular vision [*] present, in cases where looked for, after treatment ...	100 per cent.	—	100 per cent.	50 per cent.
Diplopia as pre-operative symptom ...	68 per cent.	0 per cent.	32 per cent.	25 per cent.
Diplopia as post-operative symptom ...	40 per cent.	60 per cent.	—	100 per cent.
Faulty fixation before treatment ...	0 per cent.	25 per cent.	35 per cent.	25 per cent.
Squint amblyopia ...	25 per cent.	25 per cent.	75 per cent.	0 per cent.

These figures were taken from cases seen during a period of three years, on an average, after the last operation.

Only 25 per cent. of "perfect cures" needed a second operation. All the cases marked "still diverging" were operated on more than once.

(To be concluded)

THE VISUAL PERCEPTION OF SOLID FORM*

BY

E. M. EATON.

It is almost universally accepted that the binocular element is the essential factor in stereoscopic vision. Several of the attributes of uniocular vision have long been recognized as contributing to the impression of relief, or to the sense of depth, but it is generally considered that the vision obtainable by such means differs in a peculiar essential from that which has the quality described by Sir Charles Wheatstone as stereoscopic. I am convinced that this view is erroneous, and in the following paper I hope to satisfy you that it has no justifiable foundation.

What is the essential quality? It is difficult to obtain agreement on this question, for it concerns a subtlety of personal experience that

* Read before the Ophthalmological Section of the Royal Society of Medicine on June 4, 1919.