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FURTHER INVESTIGATIONS ON ACCOMMODATION.

THE SO-CALLED SANSON-PURKINJE REFLEX IMAGE OF THE ANTERIOR LENS SURFACE.

Being Papers read in the Section of Physiology at the Annual Meeting of the British Medical Association, Oxford, 1904.

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FURTHER INVESTIGATIONS ON ACCOMMODATION.

SINCE I gave a report of my investigations on accommodation at the annual meeting of the British Medical Association [1] in July, 1903, I have subjected the result to a careful re-examination, and can uphold my statements in every particular.

These investigations were at the time prompted by the examination of a case of total congenital aniridia duplex with good range of accommodation, and gave as their result the following changes during accommodation: (1) The diameter of the lens equator becomes smaller; (2) the antero-posterior (axial) diameter of the lens increases; (3) the anterior pole of the lens moves forward (towards the cornea), the posterior pole of the lens moves backwards; (4) by means of retinoscopy, a ring-shaped shadow zone becomes visible between the centre and the equator of the lens, as an expression of the occurring refractive changes—of the formation of a lenticonus accommodativus; (5) it was proved by means of the Sanson-Purkinje reflex images that the posterior surface of the lens also forms a lenticonus; (6) the lens *in toto* moves upwards and inwards.

Besides this was noticed, though only at the height of eserinization, the appearance of the ciliary processes, and their centripetal moving inwards (towards the axis of the eye); and the tremor of the lens, first observed by Hess, was also seen very distinctly.

The results of these different points, of which the first six have now for the first time been demonstrated as established facts and not as hypotheses, have not been refuted by any one, and have been universally accepted with the one exception of Dr. Tscherning. Now, after the traction theory has been deprived of one support after another, Dr. Tscherning tries to replace missing facts by a highly imaginative hypothesis. At the end of this paper I shall disprove also this latest hypothesis.

The observation No. 6, that the lens moved upwards and inwards during accommodation, seemed as unexpected as difficult to explain. The movement took place and could be observed during voluntary effort of accommodation, although not in such a high degree as after eserine. As I had already remarked at Swansea, this movement more than counterbalanced the slight sinking of the lens due to gravitation which took place at the height of eserinization. Although it is so much greater, it cannot be proved entoptically, because in a normal eye it is accompanied by a simultaneous and analogous movement of the contracting pupil, which is also dislocated upwards and inwards.

Meanwhile it has been observed again this year in another case of congenital absence of iris. Mr. Story, in Dublin, to whom the patient went, informed me by letter that for the present he had not been able to conduct a more minute examination, but could observe "an indefinite decrease of the equatorial diameter of the lens, with apparent dislocation upwards and inwards. The lenses stand normally in the young girl a little upwards and inwards, and this dislocation was more accentuated by eserine." We may without doubt look forward to a detailed account of the case from Mr. Story.

The observations made on my case of aniridia gave me an explanation for the following case, which is so interesting that I give it somewhat fully here :

Mr. B., aged 37, came to me in October, 1903. Besides some other symptoms of a conjunctivitic nature, I noticed in both eyes a pronounced and symmetrical displacement of the pupils upwards and inwards. Their function was otherwise quite normal (Figs. 1, 2, and 3). Both corneae are of normal size and shape, and are about 11 millimetres in diameter. In medium light the pupils have a diameter of 3 millimetres, and are situated as indicated by the accompanying diagrams (Figs. 4 and 5) where the sizes of both pupil and iris in the two principal directions are given in millimetres. The centre of the pupil does not coincide with the centre of the iris, and the line passing both these centres I will call here the principal axis. In the right eye the principal axis (marked -------- in Figs. 4 and 5) was inclined with its upper end 40 degrees towards the nose, in the left 10 degrees. In the direction of these axes both pupils show a slight tendency to be oval.

Vision for distance was: S R = $\frac{30}{30}$ with cyl. − 1.75, deviation from the vertical of the upper end of the cylinder axis 40 degrees (towards the nose); S L = $\frac{30}{30}$ with − 3.0 sph. ◯ cyl. − 1.75, deviation from the vertical of the upper end of the cylinder axis 10 degrees (towards the nose).

When examined for short-range vision, it was found that very small print, lines, dots, etc., can be made out much better when the axis of the right glass is turned more horizontally by 17 degrees, and for the left eye by 10 degrees, as shown in Fig. 6.

Glasses for near work were, therefore, prescribed in which the cylinder axes have the corresponding position differing from that in his distance glasses.

From the first there was hardly any chance of a mistake, the patient being very precise and clear in all his answers; and a series of re-examinations excluded the possibility of any error. The explanation for this unusual condition suggested itself to me from observation No. 6 on the irisless eye; it is due to a dislocation of the lens inwards and upwards during accommodation. I was in the fortunate position of being able to examine most carefully the corneae of the patient, with the help of the Oxford Helmholtz ophthalmometer, which Professor Gotch had kindly lent me for my investigations. No trace of corneal astigmatism was present; both corneae, however, had almost exactly in their respective centres an apex of a curvature a very little stronger than the rest. It followed that both lenses were suspended slightly excentrically, which accounted for the astigmatism. During any accommodative effort an additional movement of the lenses upwards and inwards took place. For the right eye the inward component of this movement was larger than for the left eye, quite in harmony with the excentricity of both pupils, as already existing for the state of rest; and thereby it was effected that, with the corneal apex remaining in its place, the axis of the astigmatism—namely, its upper end—moved towards the nose, and more so in the right than in the left eye.

This observation has since then been corroborated by two further cases of a similar nature, though not quite as pronounced as the one given here *in extenso*. In my opinion it furnishes the explanation of a somewhat rare and obscure condition, namely, a temporary alteration, improvement, or even disappearance, during accommodation of the astigmatism found to exist for distance, or vice versâ. Such an occurrence has hitherto often been explained by a thoroughly hypothetical partial contraction of the ciliary muscle; it now finds a simple explanation by a lateral displacement of the lens during accommodation. I have been fortunate in being able to observe this accommodative movement of the lens, and also to demonstrate it here in Oxford last year, but although I have no doubt that its existence is the rule, it will be possible only under exceptional conditions to prove its occurrence.

This change of axis of the astigmatism having once been ascertained, it was found much easier for the patient himself to recognize it whenever the pupils had been slightly dilated by a quantity of cocain small enough not to interfere with the accommodation. This suggested another question, namely, whether an improvement of vision was brought about by the narrowing of the pupil alone, or also by its concomitant dislocation upwards and inwards, assisted by its simultaneously increasing oval shape.

For the solution of this question, it appeared desirable to examine the mechanism of accommodation in an eye with a pupil of a pronounced oval shape. For various reasons, investigations on ruminants could not be undertaken, and I therefore decided to select an eye in which the oval type of pupil had developed to its extreme, namely, to a slit-shaped pupil, of which we have the most pronounced and familiar example in the eye of the cat.

I did not approach the subject with very sanguine hopes, remembering what an observer generally so reliable as Professor Hess, partly alone, partly in conjunction with Dr. Heine, had stated with regard to the range of accommodation in various animals, of which dog, cat, and rabbit are specially mentioned. In all of them, the range of accommodation was asserted to be extremely limited, so that only the eye of the monkey could be compared with the human eye in this respect. My investigations on the eye of the cat, however, have shown that Professor Hess's assertions are wrong.

It became necessary to examine the facts concerning the accommodation of the eye of the cat both anatomically and physiologically. The difficulty—hitherto unsurmountable—of determining anatomically the shape of the lens during accommodation, consists in the circumstance that up to now no unexceptionable method of fixing the shape of the lens was known. I tried osmic acid in different concentrations, pure and with chromic acid, Fleming's solutions, but found that in a series of experiments with the unopened eyeball action took place neither evenly nor deeply enough, while in the opened eyeball the additional grave objection existed of the disturbed intraocular pressure. Moreover, I have sometimes observed very marked distortions through swelling and other uneven action. In fact these methods proved quite unreliable.

Should it become possible to fix the lens in its shape and place, it would then be desirable to introduce some staining method in order to differentiate the lens clearly from its surroundings. An observation which I had made some time previously came to my help and led to a method of examination which combines both fixation and staining of the lens in a thoroughly satisfactory manner.

When examining bullocks' eyes for other purposes I had noticed that on freezing the eyes the lens had become chalky white, while the surrounding parts, aqueous and vitreous, were semi-transparent and of a dark colour. It was thus possible to fix the lens in its position without any disturbance and to make topographical transverse sections in which the lens stood out in a sharply-defined hard white outline from the dark grey of the surroundings. Different formulae were employed for freezing mixtures, but as it was advisable to freeze the eyes as rapidly as possible, I resorted, on the suggestion of Dr. Mann, of Oxford, to solidified CO_2. Liquid CO_2 is commercially obtainable: by vaporizing part of it a snow of solid CO_2 can be obtained which is used to cool alcohol. Such low temperatures can thereby be produced that small objects, such as an eyeball, when dropped into the alcohol, freeze almost instantly.

The frozen eye is then taken out and sawed in the direction marked beforehand. The technique is not without trouble and requires some practice, but it yields exquisite pictures. On the other hand it is not easy, and requires a good deal of patience, to obtain good photographs of the frozen sections; the surfaces are rather apt to melt during the slow process of focussing such small objects with an ordinary camera. Nevertheless I have been able to take a series of photographs which, even in the less sharp specimens, give some idea of the surprising clearness of the originals.

For the purpose of examination the atropinized or eserinized eyes of freshly killed animals were frozen and opened with a fine saw through the vertical meridian, marked previously with a coloured thread. The following differences were found :

In the atropine lens the anterior surface is more strongly curved than the posterior surface, and is of a regular, spherical shape ; the posterior surface, always curved in a smaller degree, showed in many cases a pronounced central flattening. (Figs. 7, 8, 9, 14)

In the eserine lens the anterior surface is scarcely different from that of the atropine lens ; the curvature appears the same in the centre and the surrounding zone, only towards the periphery there is often a stronger curvature present. (Figs. 11, 12, 13.) The posterior lens surface, however, showed a change in form as marked as it was unexpected ; a pronounced lenticonus has appeared, the apex of which is situated above the axis of lens centre, at a height which corresponds approximately to half the distance between the centre of the lens and its upper margin (Figs. 11, 12). The equatorial diameter of the eserine lens is scarcely any smaller than that of the atropine lens.

The figures (Figs. 8, 9, 10, 11, 12, 14) represent the "vertical" meridians, in which we find the extremes of the differences between the eserine and atropine lens. The meridians are not absolutely vertical, but correspond to the direction of the slit of the contracted pupils ; their upper ends are slightly divergent (inclined towards the temple). Intermediate figures are found in the intermediate meridians.

It is clear that we have here to deal with a phenomenon which, though new, is indisputable, and on it—as upon a solid foundation—we can build further conclusions. The principal one of these is that there must exist in the eye of the cat not only a very considerable amount of accommodation, but also that this accommodation must be accompanied by a high degree of astigmatism. In other words, the effect of the accommodation will consist in an increase of the refraction, principally in the direction of the vertical meridian.

And if we consider how such an astigmatism could be corrected we find that two ways would be open to us to effect this —namely, either by a concave cylinder lens placed with its axis in the vertical meridian, or else by stenopoeic slit put in the same direction. *In the eye of the cat we find the second alternative employed : the pupil contracts to a slit, the direction of which corresponds with the principal axis of the astigmatism, and corrects it more or less completely.*

If this explanation of the above-stated anatomical differences between the atropine lens and the eserine lens is correct, it should be possible to demonstrate physiologically that during accommodation a fair amount of astigmatism occurs with its principal axis in the direction of the slit of the pupil. From the very beginning I had strong misgivings with regard to the already mentioned assertion of Hess—expressed as recently as February, 1904, in the *Clinica Oculistica*—that the amount of accommodation in the eye of the cat is very small. Apart from the seemingly excellent vision of the cat for near objects, the large extent of the field of binocular vision[2] spoke in favour of a highly developed vision for near objects.

In order to clear up this point, iridectomy was performed on the cat's eye, which is a more complicated operation than in man, as, in consequence of the larger size of the blood vessels of the iris, the anterior chamber at once fills with blood. It takes months and months before its absorption admits of a reliable examination of the refraction. This latter requires some practice before one becomes accustomed to determine the refraction for a definite part of the fundus. It will be found that the portion which approximates in position to our yellow spot has, in the atropinized eye, a fairly high degree of hypermetropia. After eserinization, however, I found in the iridectomized eye myopia, and for the vertical meridian a well-marked myopic astigmatism. The amount of accommodation measured was, on an average, equal to 9 dioptrics, with the addition of 5 dioptrics more for the vertical meridian. Allowing for the original hypermetropia, this would correspond to a near point of about 5 in., and would, with the help of the slit-shaped pupil, admit of a sharp focussing for the distance of the fore-paws—analogous to our short-range working distance—and would be called into use when a cat was playing with a mouse, etc.

After these results it appeared desirable to see whether the accommodative dislocation of the lens observed in the human eye was also accompanied by a noticeable, if small, excentricity of the posterior lenticonus. My patient with aniridia and the Helmholtz ophthalmometer were happily accessible. The reflex images were produced by a naked arc light doubled by prisms. The posterior lens pole, to all appearance situated exactly in the centre of the posterior lens surface, was unsuited for the measurement of the reflex images, owing to the small white opacity (polar cataract), but careful measurements carried out in the circumpolar zone showed that after eserine actually a slightly stronger curve existed upwards and inwards from the posterior pole than downwards and outwards. The difference in the size of the reflex images was, however, very small, and would probably not have been detected with a less accurate instrument.

The establishment of these facts is of great importance, as they indicate a decided analogy between the mechanism of accommodation in man and in certain other animals, not necessarily anthropoids. It will therefore be admissible, though of course with due reserve, to apply certain conclusions obtained from investigations on animals to the human eye.

The question then arose how to explain the excentricity of the lenticonus, and why when I observed the lenticonus first in the aniridic human eye I was wrong in assuming it to be correctly centred, and its apex coinciding with the posterior pole of the lens. I think the answer will be found most easily by studying the surrounding anatomical conditions prevailing in eyes with oval or slit-shaped pupils. We find that the ciliary body forms a ring which, in the eye of the cat, is narrower at the upper than at the lower end of the vertical meridian. Between the two extremes there are gradual transitions which are symmetrical in the nasal and temporal half. The size of the ciliary muscle, and therewith the possible amount of its contraction, is greater at the lower than at the upper end of the vertical meridian, while the temporal and nasal halves are symmetrically arranged, and hold each other in equilibrium. It results from this anatomical condition that by the contraction of the ciliary muscle during accommodation, a greater amount of relaxation of the zonula occurs in the lower than in the upper part, and therefore the conditions are given for an accommodative deformation of the lens with a pronounced asymmetry in the vertical meridian.

In animals with a more horizontal pupil we find an analogous asymmetry of the ciliary body in the direction of the horizontal diameter. In man the pupil and likewise the ciliary body is approximately circular, but still we find that the ciliary body is broader outwards and downwards than inwards and upwards, which equally holds good for the iris. The amount of asymmetry is here very small, and not generally noticed except in such extreme cases as described above.

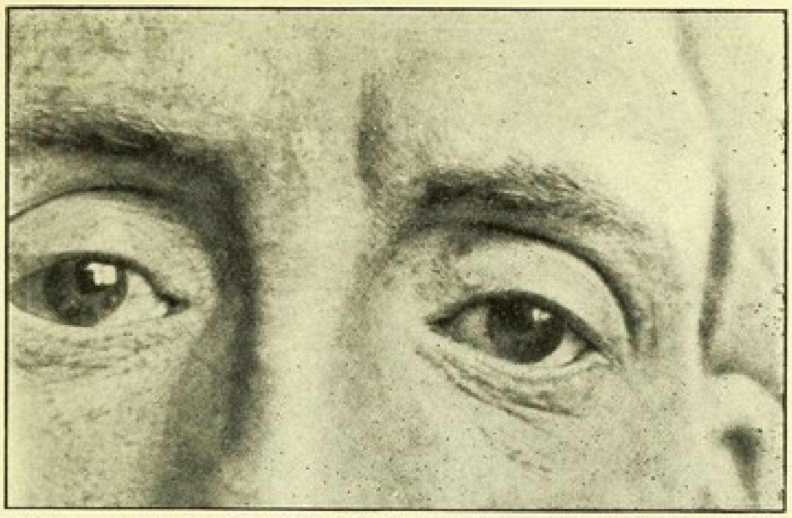

Fig. 1.—Showing position of pupils (upwards and inwards).

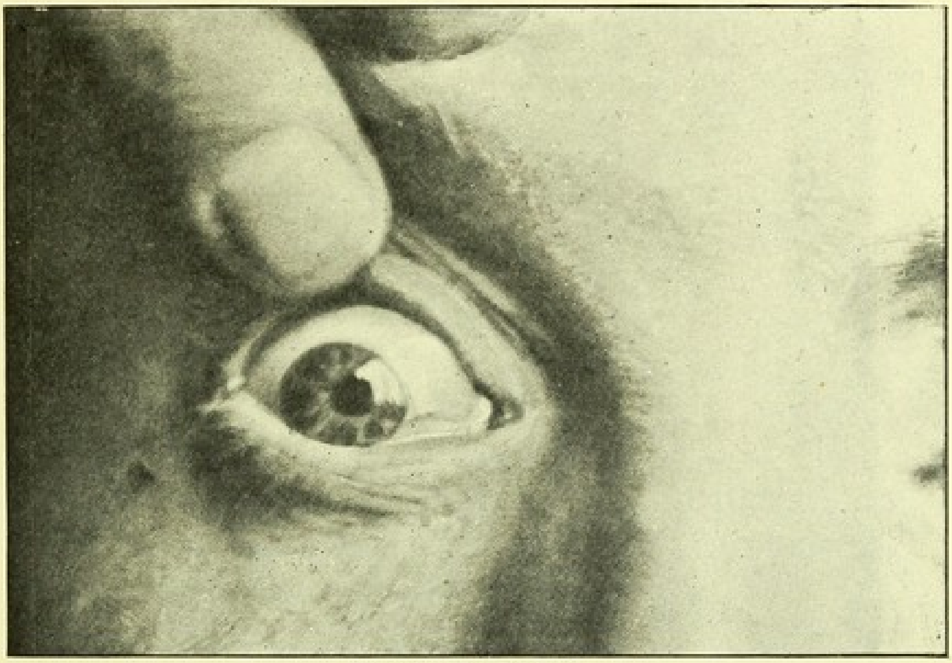

Fig. 2.—Right eye.

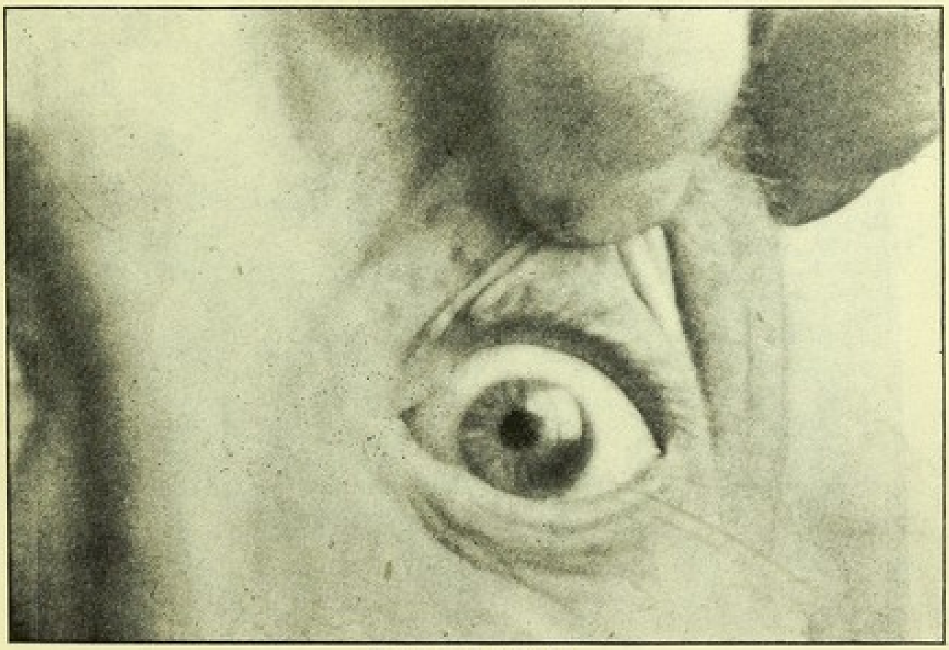

Fig. 3.—Left eye.

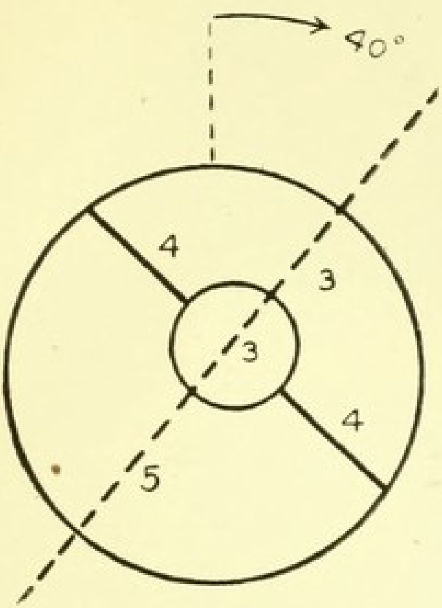

Fig. 4.—Diagram of iris and pupil of right eye.

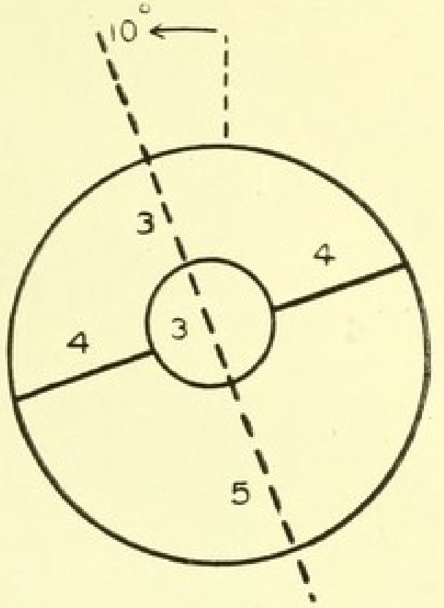

Fig. 5.—Diagram of iris and pupil of left eye.

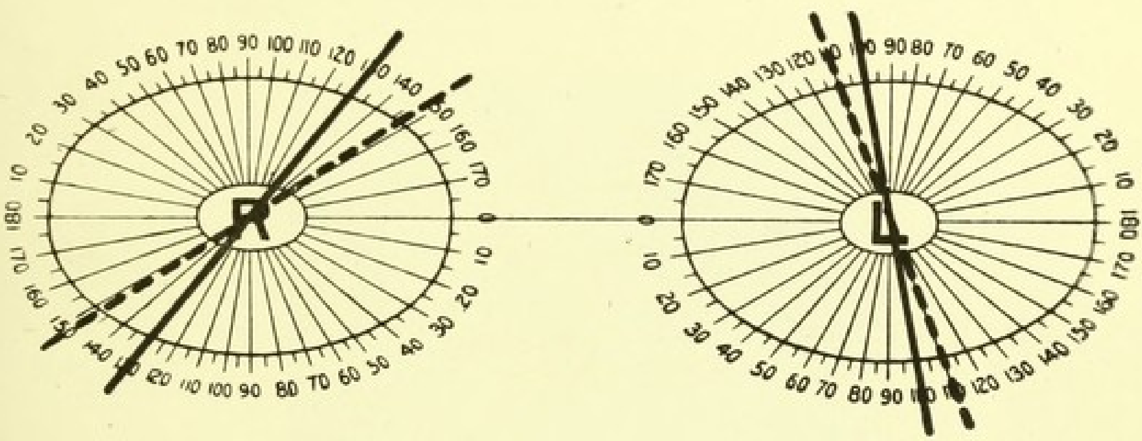

Fig. 6.

——— Axis of cylinder during rest (distance).

-------- ,, ,, ,, accommodation (reading, etc.).

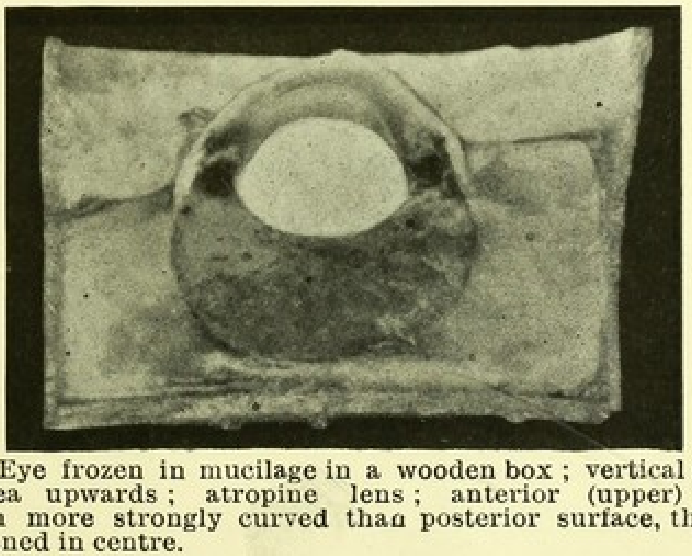

Fig. 7.—Eye frozen in mucilage in a wooden box ; vertical section ; cornea upwards ; atropine lens ; anterior (upper) surface much more strongly curved than posterior surface, the latter flattened in centre.

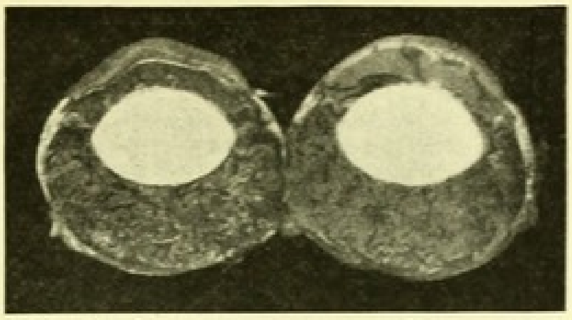

Fig. 8.—Atropine lens ; cornea upwards ; vertical section.

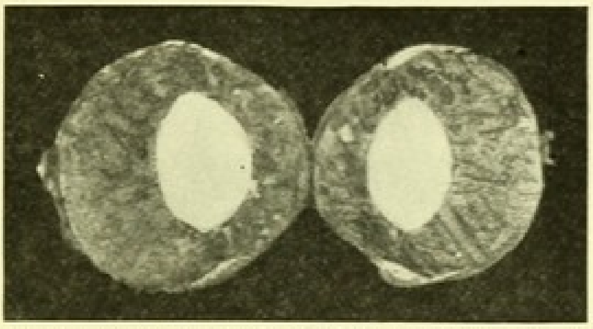

Fig. 9.—Atropine lens ; vertical section ; cornea inwards, touching that of the other half.

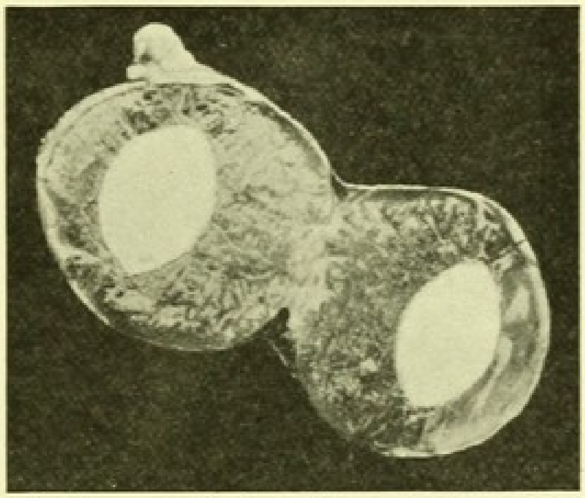

Fig. 10.—Atropine lens ; vertical section ; cornea outwards. The left (upper) half a little distorted in the photograph by being nearest and slanting towards the camera.

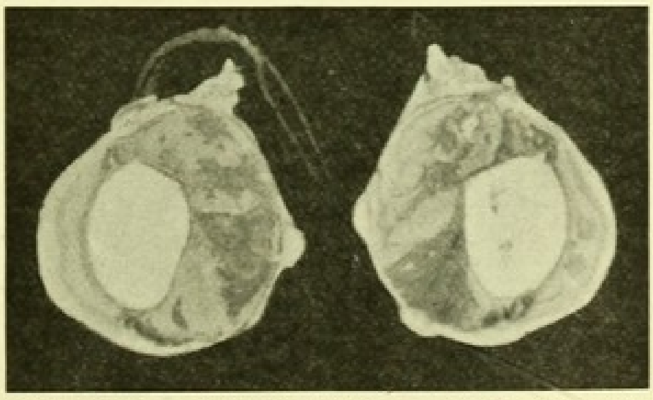

Fig. 11.—Eserine lens ; vertical section ; corneae outwards ; anterior lens surface not noticeably different from atropine lens ; posterior surface shows marked lenticonus with excentric apex turned upwards.

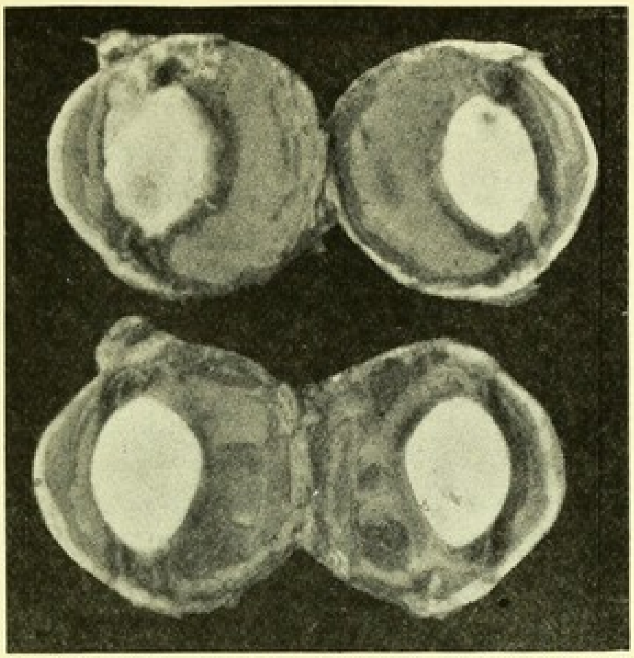

Fig. 12.—Above section through atropine lens and below section through eserine lens of same cat; corneae outwards; vertical sections; the left upper half damaged; right half clear; lenticonus and excentricity in lower lenses well marked.

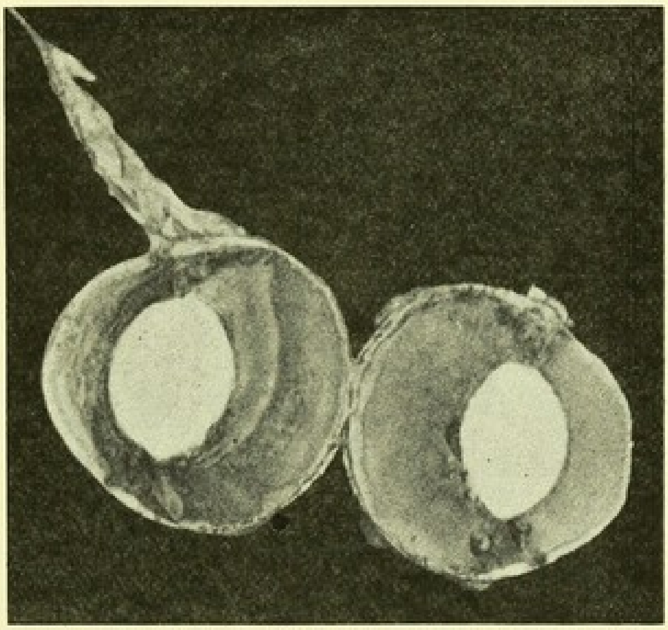

Fig. 13.—Eserine lens; horizontal section; corneae outwards; lenticonus in that particular meridian barely recognizable.

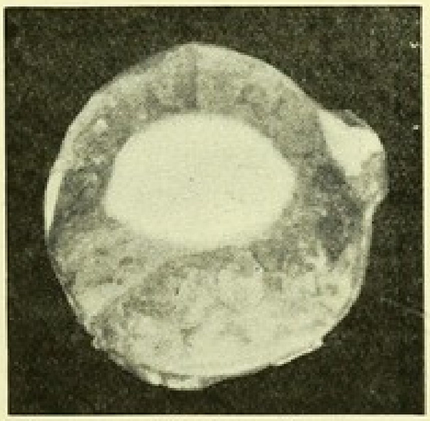

Fig 14.—Atropine lens; vertical section; cornea upwards; not sharply focussed, but flattening of posterior lens surface well recognizable.

Evidently a certain correlation exists between the size of the ciliary muscle and the sphincter of the iris. While the iris in the atropinized eye of the cat forms a narrow ring of equal width all round, the narrow slit of the eserinized pupil leaves the iris at its upper end much narrower than at its lower end. An analogous condition, though more horizontally situated, occurs in the eye of the ruminants.

These observations help to demonstrate the preponderating importance of the one function of the iris, namely, that of acting as a correcting diaphragm for the purpose of eliminating as much as possible the effects of aberration. We notice an inter-dependence between the muscular apparatus of accommodation and that of its diaphragm. The ciliary body not being equal all round, the lens moves in one direction during accommodation, while the diaphragm contracts in such a manner as not only to shift the position of the narrowed pupil with the optical axis, but also to adapt its very shape to the optical requirements.

That this function of correcting aberration is more important than that of regulating the amount of infalling light, is generally shown by physiological and pathological observations. Physiologically the pupil of youth is wide. The lens is bounded by approximately spherical surfaces These surfaces become more parabolic or hyperbolic during accommodation, and the pupil narrows accordingly with it. In age the lens fibres become sclerosed, the cortical layers lose their jelly-like softness. The elasticity of the capsule gradually loses its power of altering the shape of the lens, and the latter becomes more permanently hyperboloid, with a marked anterior and posterior lenticonus, such as we find transitorily in the youthful lens during accommodation. Likewise, we find that the pupil of age contracts gradually more and more until we often see in old age the pinhole pupil, which is, however, easily dilatable with mydriatics.

With regard to the regulation of light, on the other hand, the amount of light that reaches the retina is, *ceteris paribus*, owing to the decreasing transparency of the optic media, smaller in age than in youth. Nevertheless, in age the pupil is narrower, producing sharper images.

It will be interesting to see whether the eye of the cat shows an analogous slit-shaped contraction with advancing age. Observations in this direction do not exist to my knowledge, and it will, of course, take some years before I can report any observations on this point.

Pathologically, too, we see that the light-regulating function of the iris may long have been destroyed—for example, in locomotor ataxy—while the synergetic contraction of the pupil still accompanies accommodation.

In conclusion, I wish to touch on some points in the reply to my previous paper which Dr. Tscherning has just published.[3] The publications of Dr. Besio,[4] made under the auspices of Dr. Tscherning, were, as he rightly assumes, unknown to me. I should otherwise have commented at the time on some of the conclusions set forth there, to which I can only refer very briefly here, namely:

The flattening of the periphery of the lens during accommodation is in itself of no importance, it is simply an accessory to the increased curvature of the centre, which is the essential point for the accommodation. The dead and excised lens does not admit of any unmodified conclusions as to the behaviour of the lens in the living eye. Both Crzellitzer's and Tscherning's experiments have been disproved since by other experiments of Hess.[5]

The quantities calculated (not measured) by Dr. Besio for the increase of the diameter of the lens are far too small (fractions of a millimetre) to admit of any conclusions as to the alteration of the equatorial diameter of the lens. My own direct measurements gave an apparent difference of $1\frac{1}{2}$ mm., but I already mentioned at the time that this amount is too small, because it represents only the distance of the optical images of the anterior and posterior lens pole. After reduction the real distance is found to be nearer 3 mm. than 2 mm. The transverse section of the lens focussed for distance as represented by Tscherning is wrong, even if the curves of the anterior and posterior surfaces are sketched only diagrammatically. The lens is not rounded at the equator but sharp-edged. If Dr. Tscherning says: "It is asserted that the lens trembles owing to relaxation of the zonula as assumed by Helmholtz, but no one has, to my knowledge, seen that the reflex image of the anterior lens surface ever trembles," I here state again and distinctly that in my case of aniridia the lens moved *in toto;* the tremor was observed in the sharp equatorial margin, in the posterior and in the anterior polar cataract. In order to obviate the possible objection that after all the tremor may be confined to the intracapsular mass of the lens, I have to record an observation made since in a case of iridectomy performed some time ago for a corneal opacity. Within the area of the artificial iris coloboma a small deposit of uveal pigment was visible on the anterior surface of the anterior lens capsule. During eserinization this pigment mark trembled with the lens. Thereby proof is given that also Tscherning's latest hypothesis—according to which during accommodation the anterior lens capsule becomes taut and fixed through increased tension of the zonula, while simultaneously the posterior capsule becomes relaxed—is wrong and contradicts the actual facts.

With regard to the possibility of a greater amount of relaxation of the posterior as compared with the anterior lens capsule, time does not allow me to enter into particulars here; I am therefore glad to be able to refer in this respect to a paper just published in the *Journal of Physiology*, vol. xxxi, p. 1, by Professor J. P. Anderson Stuart, who comes to conclusions diametrically opposed to those of Tscherning.

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[1] BRITISH MEDICAL JOURNAL, September 26th, 1903; and *Ophthalmic Review*, January, 1904. [2] *V. Graefe's Arch.*, xxiii, 3, p. 127. [3] *La Clinica Oculistica*, November, 1903; and *Ophthalmic Review*, April, 1904. [4] *Journ. de Physiologie et de Pathologie Générale*, June and September, 1901. [5] *La Clinica Oculistica*, February, 1904.

THE SO-CALLED SANSON-PURKINJE REFLEX IMAGE OF THE ANTERIOR LENS SURFACE.

In my paper on the Mechanism of Accommodation[1] I mentioned that the reflexion from the anterior lens surface could not be used for the purpose of demonstrating any changes of curvature that might take place in the anterior lens surface during accommodation. I have been informed from various sides that this has been understood to mean that in my case of aniridia the anterior surface did not change its curvature at all, or not sufficiently to be observed, during accommodation. This is altogether a misunderstanding; no reflexion from the anterior capsule could be obtained at all in its centre, neither during rest nor during accommodation, while in the circumpolar and peripheral parts they could be easily produced. If we wish to observe the reflected image of an ordinary flame—for example, of an Argand gas-burner—on the anterior lens surface, we shall find that the angle of 30 degrees selected by Helmholtz for his ophthalmometric observations is much less suitable for easy recognition than an angle of double the size—namely, 60 degrees. The incident ray should thus form with the reflected ray (visual line of the observer) an angle of 120 degrees, in order to give the best conditions for observation. With this angle it is easy to let the reflex image of the flame travel over every part of the pupillary area. It very soon becomes clear that in the overwhelming majority of cases the anterior lens surface in the living human eye is not spherical, but more curved in the centre than towards the periphery. This also holds good not only for distant vision (for rest), but is even more easily observed after atropinization than with a normal, and therefore narrower, pupil. I have found this increased central curvature of the anterior lens surface at all ages, in children as well as in old people, though generally more marked in the latter.

As soon as one has gained some experience in the observation of these reflex images, and especially after having learnt to interpret correctly the shadows thrown by the lashes, particularly those of the upper lid, it is a surprise to find the reflex image of the flame interrupted in some parts by black lines which in the beginning, if observed at all, were also put down as the shadows of the lashes. Following them up more closely, one finds that they form the figure of a six or seven rayed star (Fig. 1), which corresponds to the architecture of the lens. From this it follows at once that the image on the anterior lens surface cannot be produced by the anterior surface of the anterior lens capsule, but by a deeper lying surface.

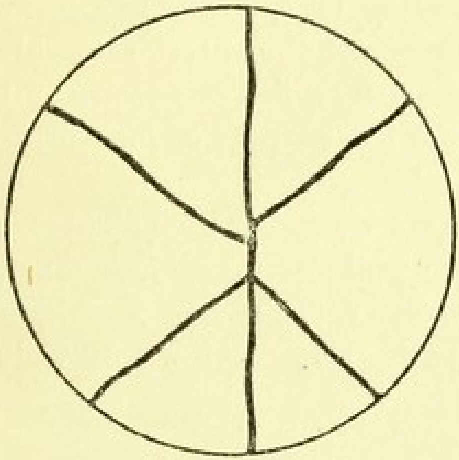

Fig. 1.

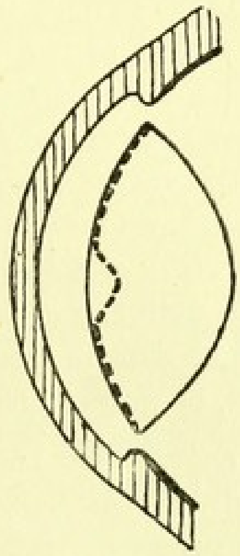

Fig. 2.—The dotted line indicates the reflex producing surface (very diagrammatic).

The epithelium of the anterior lens capsule does not take part in the radiate arrangement of the mass of the lens fibres, but coats the inner surface of the anterior capsule in a continuous layer without any break; the visibility of the radiate figure suffices, therefore, to show that the reflecting surface is situated underneath the capsular epithelium. Sometimes it is possible to see that the reflex image is produced not by a mathematical surface (a boundary surface between two media of different refractive index) but by a layer of a certain thickness. This has become evident in a few cases where the reflex images of the flame showed a striking iridescence, which latter can be produced only by an actual layer of a certain depth, not by a mere mathematical surface. In examining this reflex image in lenses with commencing cataract, we often find interesting occurrences, which will be described elsewhere. Here I will recur only to the point mentioned at the beginning of this note. When I examined the anterior lens surface of the aniridia case with this reflex image, I found that no reflex image at all was visible at the anterior pole. With focal illumination it was possible to see that the anterior surface was of quite normal shape. When, however, the reflex image was brought from the periphery towards the anterior pole, it turned inwards at the margin of the small cataractous opacity towards the centre of the lens, bending off gently behind the opacity and soon vanishing there. (Fig. 2.)

We know that the anterior polar cataract belongs histogenetically to the capsular epithelium. The difference in the refractive index of aqueous, anterior capsule and epithelium is evidently very small compared with that of epithelium and lens fibres, or of the thin layer of substance sometimes observed between both. Thus it came that, notwithstanding the normal curvature and smoothness of the anterior capsule within the area of the polar cataract, no reflex was seen at all and could therefore not be used for the purpose of measuring the curvature of that region.

The phenomena described here are visible to the naked eye, and do not require the help of a corneal microscope. It must, however, be pointed out that their easy observability without the help of a magnifying glass varies very much within wide individual limits.

REFERENCE.

[1] BRITISH MEDICAL JOURNAL, September 26th, 1903.