May 1935 Issue
Vol. 3, No. 2

THE DIOPTRIC EFFECT OF μυ

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My skepticism regarding Syntonics received its initial jolt when for the first time I encountered that effect of μυ which expresses itself in terms of dioptric value. It was my first case of lenticular opacities, a woman of seventy, wearing a correction of 3 D. plus which had presumably yielded normal vision when prescribed five years previously. The vision had now receded to 10/150, but a reduction from +3 to +1 immediately gave her vision of 20/40. Five Syntonizations of μυ changed this refractive picture to an easy acceptance of +2, which remained constant until the patient was dismissed. The final outcome was a corrected vision of 20/25, scant. It will be noted that in this case a vision of 10/150 or 10 per cent was improved to 20/40 or 85 per cent simply by restoring a harmony between a lens correction and a pair of eyes which during a period of several years had increased in dioptric power approximately 2 D. A subsequent acceptance of +2. D. representing an additional one diopter after five syntonizations, therefore, connotes a lowering of the total refraction of this pair of eyes 1 D, or 50 percent of that morbid increase which had ensued over a period of several years.

When the full import of what had taken place in this case was made apparent to me, my mind harbored no further doubt as to the work doing power of selected frequencies of the visible spectrum.

I have brought this case history, in approximate terms only into the first paragraph of this paper, first because syntonically it has, may I say, a historical significance with me. To me the change that had been wrought was profound. As far as I was concerned for the first time, a morbid retrogression in a pair of eyes had been stopped and a benevolent reversal of process had taken place. Within one week a pair of eyes had retraced toward a normal status, ground which had been slowly yielded over a period of several years.

In the second place this case history serves to make clear the nature of the problem and the investigation which this paper will attempt to discuss and recite.

Since Dr. Spitler assigned this problem to me I have had reason to recall to my mind individual in attacking the many research problems which lay before us. I have also had occasion to appreciate the full significances of his warning to the effect the problems begot problems. And so at the outset I wish to make it very clear that this paper is merely a progress report. At this time I can only endeavor to act out, first, the nature and some of the ramifications of the problem, second, the manner in which we have so far approached it, and, third, the results of the inquiry to date.

This paper is primarily concerned with the "How" and "Why" of μυ in its role as a dynamic instrumentality in influencing the refraction of the eye. One type of case, which you have all met with, has been set out. There is another type of case with which you are likewise familiar and which comes within the purview of this discussion. This is the pattern which has probably brought more sorrow and grief to the observant and conscientious refractionist then all others. I refer to the myope who has no business being a myope. By all the rules he should be a happy hyperope, but he refuses so to be and what is worse he won't even be a contend myope. And then there is the hyperope who accept the correction most gratefully for a brief period and then gradually in the wrong direction, pulls away from it visually. Such cases constitute a portion of the so-called problem cases which previously have not responded to our best efforts. The reason for this is now clear for as syntonists, under Spitler, we have learned that normal ocular function is dependent on normal supportive function. Yes, perhaps we have in a general way known this before, but since there wasn't much we could do about it there wasn't much point to the knowing.

The cases which I have attempted to bring in review before you represent without doubt real personalities with names and addresses in your files. They are, of course, susceptible to sub-classification in relation to their particular departures from normal. But among them are these which should respond logically to μυ and therefore come within the scope of this discussion.

It can be stated I think without fear of contradiction that any substantial increase in the refraction of the eye is morbid and points to some actual pathosis or mal-function. It will be argued by some that a myopia which gradually develops in children of grade and high school myopia is strongly indicative of some present or hereditary tendency toward mal-function of some sort.

It is apparent that any increase in the eyes refraction must arise from one of the following changes:

a. An increase in the anterio-posterior diameter of the globe.
b. An increase in the convexity of the crystaline lens.
c. An increase in the refractive index of the cornea, lens or both.
d. A decrease in the index of the aqueous humor.

Since these are the sources of change, obviously a dioptic change brought about by μυ must be sought therein.

Our efforts to date have been largely confined to a determination of the effect of μυ on index of the aqueous.

For measuring the index of refraction a Total Reflection Refractometer was constructed. This is a very simple device consisting of a plain parallel glass plate, six to eight millimeters thick, the undersurface of which is painted white A tube lined with black velvet in which is arranged an auto headlight bulb and a lens to form a point image of the filament on the lower surface of the glass plate is provided. This device utilizes the principle involved in the relationship between index of refraction of a reflecting surface and the critical angle or angle of total reflection. The point image on the lower painted surface of the plate becomes a new source of light from which rays proceed in all directions. At those angles of emergence which are equal to and greater than the critical angle, all rays are returned to the lower white surface Those rays at angles of emergence less than the critical angle past out without reflection thus leaving a relatively black disc surrounded with a relatively bright border. If a film of liquid is spread over the upper face a second larger ring appears due to total reflection at the glass-water interface. The diameter of the large ring is dependent on the index of the liquid.

From the thickness of the plate and the diameter of the central black ring the index of the plate may be determined and with this and the diameter of the outside ring, formed by the liquid film, the data is complete from which to calculate the index of the liquid.

Since our investigation is to determine the influence of μυ relative findings only are of importance. But since Optometry is getting the itch for research and much fear has been evidenced then we are not quite equal to the task, as a meticulous gesture to those who “view with alarm”, we decided to check the accuracy of our tools. The following chemicals were measured on our apparatus and the findings checked against the known indices: Acetone, amyl-alcohol, chloroform and glycerol. The discrepancies between the book value and the results obtained on the refractometer varied between .042 and .049. The variation in these discrepancies being attributed to lack of strict chemical purity.

Beef eyes were used in our experiments. They were procured from animals immediately after being butchered and the tests made as soon thereafter as possible. The interval between butchering and tests was never over three hours during which time the eyes were in a normal salt solution. In all about fifty eyes were used in repeated tests involving about 65 c.c. of aqueous. The ring diameters were measured independently by two people with a micrometer caliper. The tests were also made with photographic plates substituted for the painted white surface. The rings were thus photographed ad could be measured at leisure.

The first series of tests covered four samples separated into samples marked a, B, C-1, and C-2. All samples were taken from a common lot of aqueous. Sample a was not irradiated. Sample B was irradiated with μυ twenty minutes. Sample C-1 was irradiated with μυ forty minutes. After measurement was taken C-1 was set aside to stand for sixty minutes. It then became sample C-2 and was again measured for index. The following results were obtained:

Sample A	Ring diameter 53.5 m/m	Index 1.378
Sample B	Ring diameter 55 m/m	Index 1.387
Sample C-1	Ring diameter 56.5 m/m	Index 1.395
Sample C-2	Ring diameter 54 m/m	Index 1.381

It will be noted that the index of the aqueous before irradiation is 1.378 which is a figure in excess of the index usually given for the human eye, namely, 1.336.

Your attention is called to the difference between the indices of the aqueous B and C-1. The former after twenty minutes irradiation and the latter after a forty minute irradiation. In order to eliminate the possibility of time or temperature as a factor, another sample from the same lot of non-irradiated aqueous was measured after standing forty minutes. This showed no change in index.

Sample C-2 which as above as the original C-1 after standing sixty minutes on re-measurement showed a lowering of index from 1.395 to 1.381.

In order to translate these results into dioptric values the figures for the human eye as given by Gauss, for curvature and indices of refraction have been used. To the figure for index of the human aqueous, namely, 1.336 has been added, the increase caused by a twenty minute irradiation of μυ in our experiments, namely, .009. Our theoretical, modified aqueous now becomes 1.345. The Gauss figure for the human crystalline lens index is 1.43. Our theoretical relative index between lens and aqueous has now been changed, due to μυ, from .094 to .085. Taking the Gauss figures for the radii of cornea and lens we have the following dioptric values: Cornea 44 D., anterior surface of lenses 8.5- D., posterior surface of 14. or a total of 66.666 D. This is subject to a reduction of about 12 D. due to separation of refracting surfaces and slight minus value for inside of cornea giving a net figure of 54.666 D. Contrasting this figure with total net dioptric value calculated from the same data except using the aqueous index figure of Gauss, namely, 1.336 we have a difference of 2.4 D. The total dioptric value without a modified index yielding a not figure of 57.56 D.

From the foregoing the following hypothetical statement may be made: Were it possible to irradiate the human eye with μυ thus as effectively, and there were no physiological stabilizing or neutralizing influences the relative index between lens and aqueous would be lowered and a reduction of refraction would be brought about in the approximate ratio of 2 D. in 50 D.

A further series of experiments was made where beef eye aqueous was irradiated with different frequencies. The point might be made that light from the visible spectrum regardless of wave length, might cause an increase in refractive index. To arrive at a definite conclusion on this point a quantity of aqueous was divided into three adequate samples of about 1 ½ cc. Sample D was irradiated forty-five minutes with μδ. Sample E forty-five minutes with αδ, and Sample F forty-five minutes with αυ. The results from these irradiations were as follows: The index of Sample D was raised from 1.378 to 1.381; Sample E was lowered from 1.378 to 1.355; Sample F was raised from 1.378 to 1.379. A further experiment was tied on sample D which had already been irradiated with forty-five minutes of μδ. To this sample was added an equal amount of unirradiated aqueous and this was now subjected to an irradiation of thirty minutes of μυ. The index of this was now found to be 1.383 or .002 higher than was the resultant μδ irradiation on one-half of this specimen. The findings from this last series of experiments are in perfect harmony with the law of quantum mechanics, namely, that work doing power is a function of frequency.

The next phase of our laboratory investigation will be directed to: The influence of μυ on the index of the crystalline lens. So far only one attempt has been made in this direction. The results are not considered accurate and this experiment would not be mentioned were it not considered for the interest provoking nature of the readings so far made.

The reflecting refractometer is not adapted for measuring the index of solids or semi-solids, although for liquids it does quite well. Until more suitable equipment is available, no definite conclusions can be had. An attempt, however, was made to make tests by first freezing the lenses and preparing specimens with a microtome as in slides using irradiated lenses, and for control, lenses not irradiated. This did not prove successful as the specimens would curl. Placing them in water to flatten them out as is the practice in slide making would again affect the reading. An attempt was then made to make a smear on the parallel glass plate and smooth it out with anther glass plate. Three readings were made, one on the control lens unirradiated with a ring diameter of 77.5 and an index of 1.473. Sample 2 irradiated while still within the eye giving a ring diameter of 72 and an index of 1.458. Sample 3, irradiated after removal from the eye, giving a ring diameter of 70.7 and an index 1.454. Samples 2 and 3 were subjected to thirty minutes of μυ. Since it was not possible to get a perfectly smooth surface to the layer of lens substance, the definition of the ring was not good. It was immediately noted also that the ring was not a perfect circle. After a moment's consideration the reason for this was clear for the lens we know is not constant throughout; the nucleus having a higher index. Although I am attaching no importance to this testimony it is still very interesting since the tentative finding is that μυ reduces the refractive index of the lens while increasing the refractive index of the aqueous. This, of course, is in harmony with the clinical results, but seems strange withal.

In pursuing an inquiry of this kind whether confined strictly to laboratory investigation or permitted wider range of speculative reasoning it leads inevitably to other problems for which we still lack adequate and convincing explanation.

I refer in particular first to the mechanism of accommodation itself and the corollary phenomenon, so-called sectional accommodation. To these unanswered questions I will make further reference shortly.

It would be very simple to assume from the laboratory findings that the lowering of relative index between lens and aqueous, as a result of the raising of the aqueous index gave a complete answer to the question, but this conclusion would without doubt be in error. It is necessary to recognize that physical and chemical changes in an organ removed from its normal living physiological environment is quite apart from such changes that might result under conditions of life. Further, it is necessary to square the laboratory findings with the results and at this point there are definite evidences that such effect as μυ has an index is only a part of the story. We can also state that its influence on ocular dioptrics is apparently not operative when the refracting media are in a normal state. A reduced ocular refraction has not been noted when μυ was applied for the relief of other conditions and no morbid increase in ocular refraction present.

That the effect of μυ on the eyes refraction can be accounted for only in part through its influence on index seems apparent from the following clinical evidence: In the cases of lenticular opacities that have come under my observation and Syntonic handling approximately one of every three showed a reduction of dioptric power. In the cases the average change as evidenced by an acceptance of an increased plus correction has been that amount as expressed by the prescription +0.51 s ≈ -0.48 cyl. These changes have varied from additions as little as +.25 a s. ≈ -.25 cyl. and as much as +1.00 a s ≈ -1.50 cyl. In only one out of twelve has the change been spherical in plus acceptances, over ninety percent of these cases showing any change have revealed an increased astigmatism. Since careful ophthalmometer readings show no changes in cornea the presumption is that some physical modification takes place in the lens. It is also noted that practically all of these cases show an increase in so-called astigmatism against the rule, a further fact developed from my own case histories is that the greatest amount of refractive change takes place in these opacity cases where the greatest improvement in vision resulted from syntonizing with μυ.

The tentative conclusions that may be drawn from this inquiry at this time are:

1st That μυ increases the refractive index of the aqueous.

2nd That such change is a factor in decreasing the refractive power in those cases where a morbid increase of ocular dioptrism has developed.

3rd That a lowered aqueous index co-exist with a morbidly increased ocular refraction. At least this is deductively plausible.

4th That μυ also causes some physical alteration in the lens, whereby a change in astigmatism is brought about.

Although not much that is conclusive has been developed in this investigation so far – at least certain problems that have a bearing on the inquiry, have been drawn to our attention.

May I give a few thumbnail notes in reference thereto? We all recognize that anomalies in ocular behavior have long constituted a challenge to refractionists, anatomists, physiologists and physicists. Each day we come face to face with them in one form or another. For example: In a recent issue of an optometric paper a controversial editorial appeared. From it I quote "When Tait states that myopes usually, if not always, develop from hyperopes and in many cases the cramp seems to continue throughout the change, one naturally infers that the cramp constitute the myopia and that usually there is no other factor that causes the myopia".

I presume that every thoughtful refractionist has at some time harbored such hypothesis – that ciliary cramp was the causative factor in myopia. It has been a speculative fantasy for a great many years, and certainly, I am not going to dispute it for I can't prove that it isn't so. But, how easy it might be – if we had a true picture of the accommodative act – to either offer supporting evidence to such a theory or consign it forever to oblivion.

Again we meet with patients frequently, who show a high corneal astigmatism, but have in spite of it a normal uncorrected vision – explained by so called sectional accommodation.

And yet again the significant circumstance that the majority of people in the younger brackets show astigmatism with the rule and in later life the majority show an astigmatism against the rule.

One of the results of attacking a problem of this nature is an emphasized realization of our lack of knowledge on the subject about which we are supposed to informed. The most sanguine prospect for a solution of the many vexing questions is, I believe, through Syntonics and I am hopefully persuaded to prophesy that some of the answers will issue from this College of Syntonic Optometry.

In our work to this end may we always submerge the desire to believe and make the demand for proof preeminent, thus keeping Syntonics on the high scientific level established for it by Dr. Spitler.

In closing I wish to make grateful acknowledgment to Dr. J. F. Goggin and Prof. Howard Urie of the Chemistry Department of St. Ambrose College for their kind assistance and cooperation.

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