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Practical techniques in the functional approach to optometric handling of visual problems of patients at all age levels—analysis, correction, future protection, visual enhancement, programmed vision care through life

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Optometry is a remedial profession. This must always be borne in mind. The profession of optometry contains both a discipline and a practice. The discipline of optometry is the searching out of information. The practice of optometry is the application of the knowledge that has been developed for practical use in the profession. The discipline and practice of optometry allow it to grow and develop as a remedial profession.

In a recent conference of optometrists, the statement was made that we are investigating the operation of the total organism when we apply our optometric procedures. In a sense, this would appear to be a truism. However, it does appear to need continued emphasis. Inevitably, professional activities begin with an examination of the operational aspects of vision. In the standard language, this is "making an examination." In times past, this was known as "making a refraction." In 1959, because of the elaboration of information sought, it is called a primary case study. In any event, certain test situations are set up and the responses of the patient recorded.

The fundamental starting point of any such appraisal is the subjective finding. This is not because it is the basic error, and most decidedly not because it is a fixed and changeless quantity. Probably, the subjective finding is considered the fundamental starting point because by this very nature of the learned visual process, it provides a basis for the evaluation of other measurements.

Optometric research has brought forth a great many important understandings relative to the operation of that extremely complex process known as vision. Probably the most fundamental of all these ideas, and the one that brought the greatest revolution in the whole field of remedial vision, was the concept that hyperopia was not originally and basically a defect of the eye, but was a range in the organismic operation of interpreting the visual space world.

Lest this repel the student, let him recall that long ago, the refractionists accepted what was called "latent hyperopia." Part of an "error" was covered up, so to speak, by some process. It was rationalized under the term "accommodative spasm" with a cavalier disregard of the improbabilities of such a notion. Even then, the idea was entertained of some sort of absorption of hyperopia.

The development of the techniques of "book retinoscopy" (Getman) has brought further elaborations to the understanding of the mechanics of operation of the visual mechanism. The concept of hyperopia as a range and the development of various "book retinoscope" techniques have given great impetus to the functional approach to vision.

In the light of these developments, the need arises for a re-evaluation of the methodology and understanding of the significance of the operations that are measured in the investigation and appraisal that have been labelled the Analytical Examination. This is the same as any other examination except for the interpretations that have been brought to bear on the significance of the findings. It must be recalled that this examination is by method and intent a psychometric examination. It is not intended to follow the psychophysical methodology. The method of limits is not necessarily utilized. What is being sought is a knowledge of the freedoms in spatial manipulation available to that person.

Observed Retinoscopy Changes

Three important developments taking place this past year make it quite necessary to examine closely some of the long-established methods and concepts. One was the formal presentation before the Invitational Conference on Vision of the retinoscopic investigation of the sightless man by Dr. G.N. Getman. Briefly stated, Dr. Getman detailed the alterations in the retinoscope findings under varying magnitudes of problem solving. The retinoscope findings shifted from a habitual +2.25 to -0.75 to -1.25 when the problem solving was particularly difficult. The emphasis, for the moment, is on the important facet of this investigation,

that this man was sightless. These retinoscope changes were not due to adjustments to facilitate seeing. They would appear to be part and parcel of an elaborate biochemical and biophysical change taking place within the organism when there is a problem-solving task.

Optimal Lens Power

The motion picture film produced in the neurological laboratories in Austin, Texas and supervised by Dr. Darell Boyd Harmon on the effect of a convex lens was presented at the same Invitational Conference. To summate, the subject had a quantitatively measured "refractive error" of some slight hyperopia (around +0.25 to -0.25 sphere), with a net at near of less than +0.25. It was photographically demonstrated that with a critical +0.62, there was an optimal posture for learning and a minimal tension in the muscles of the back. There was an optimal blood pressure with that lens power. The adverse effects of either "undercorrection" or "overcorrection" with convex lenses were demonstrated. The significantly adverse effects of applying prisms were also shown, as well as of wrongly determined anisometropic differences in the two eyes, and the effects of spatial distortion when there is adverse posture. Of all these, the most significant to the optometrist is the demonstration that the optimal lens power bears no quantitative relation to the "refractive error" measurements.

"Transient Meridional Differences"

The third development is the expanded use and interpretation of the retinoscope in the realm of observation. The responses shown with the retinoscope have been studied by many men working somewhat independently and yet also in tenuous collaboration, among them Drs. John Streff, W.R. Henry, Richard J. Apell, and Victor Glover (to name only a few). The "transient differences in meridians" observed originally by Dr. Getman is extending to adults. It is being realized that these informative responses have been there all the while. They have hitherto been ignored.

The student of these papers and the study group would stop and review the foregoing three developments. Consideration should be given to just what is happening within the envelope of the skin of the sightless man that causes him to alter the retinoscope findings. Of a certainty, it cannot be passed over by the light statement that all convex lens systems have a depth of focus. They have. However, the important point is the covariance of the employment of that depth of field with the magnitude of problem solving, and the immediate release to the habitual +2.25 when the problem is solved!

In the mind of the solitary reader, or vocalized in group discussion, the related problem of "book retinoscopy" should be introduced. The student must somehow entertain the idea that the changes in the sightless man and the changes in "book retinoscopy" have the same originating source within the organism. Granting that probability, there should be some new consideration of what has been known as "static" retinoscopy and of dynamic retinoscopy findings. Certainly, new thought should be given to the methods of arriving at the lens acceptability at near. Likewise, that finding long considered stable and completely reliable, the subjective, demands some renewed consideration.

A matter for group discussion is the question as to just what is being measured in that almost universally employed procedure known as the "subjective finding." It seems needless to revert to the ancient and—it might be said—classical concept and definition. It may be true, as one authority said, that "the principles of refraction have been established for over a century." Not until 1959 were the demonstrations brought forth that cause closer scrutiny of these long-established concepts.

The day after the explosion of the atom bomb in Hiroshima, every chemistry professor in the world faced a bewildered class. The "invisible atom" had been fissioned—divided! The student who participated in the demonstrations with the convex lens and the retinoscope outlined earlier in this paper would have embarrassing questions to ask. They could not be shrugged off with the professorial dictum, "It can't happen." It did! It was photographed!

It would be fruitful to consider the method of taking the subjective finding before embarking on any further discussion of whys and wherefores. The subjective is the one common denominator of a refraction. Yet there is no more controversial situation in the whole gamut of procedure. Perhaps that is due to the fact that there has not yet been reconciliation of the ideas that once persisted and those which have emerged in the past few years of investigation and observations.

The Subjective Procedure

Consideration may be given to the fairly standardized procedure. The patient will be assumed to possess the ability to read the standard Snellen type graded for twenty feet, at a distance of twenty feet. The instructions usually run to "fog" or blur the patient

to worse than 20/50. This is the sort of instruction that would be given the "rating" from the ranks who is to be taught to do refraction. The optometrist who is seriously concerned with the visual abilities of his patients immediately raises the question of what constitutes a blur.

Refractive Status Changes

There has been much talk in the past— and even in the present—about the matter of "blur circles." Operationally, there is no question that sufficient convex lens powers will bring about an inability to distinguish the letters or whatever discriminations of contour are needed for the target presented. In 1890, Gullstrand received the Nobel Prize for proving that the old theory based on the "narrowest cross section of the bundle" cannot possibly be correct. What then constitutes a blur? Just what this blur actually is within the organism becomes increasingly important in the light of the investigations cited at the opening of this paper. The presentation of the Bell Telephone Company film, "Gateways to the Mind," brought to the American public and professions alike the investigations of Lord Adrian and Professor Hartline.

Adrian showed that a series of "on and off" impulses passes along a nerve. Professor Samuel Renshaw has called this a "slow ionic volley." The men whose minds run in the analogues of modern mechanics call it a "digital input." In any event, there certainly is nothing resembling a picture, clear or blurred, traveling along that amazing anatomical structure known as the "optic nerve."

The sightless man could shift the retinoscope findings from +2.25 to -1.00 (and more). The seeing person can do the same thing. Without a change in acuity, as determined by the ability to discriminate contours on a presented target, large changes in the refractive status eventuate. A study of the series of investigations carried on at Ohio State University each summer by optometrists working in the laboratory of Dr. Renshaw shows that without any diminution of reported acuity, there were changes in the measurable physiological optics system of the eye that far exceeded the measurements accorded the reduced eye of Gullstrand.

One fundamental principle emerges from all the foregoing information. The organism operates as a unity. The "Harmon film" along with the retinoscope-kymographic studies and motion pictures made by Skeffington and co-workers at Ohio State University illustrates this point. Herrick, Dewey, Renshaw, to name but a few, seem to present a similar thesis.

The "Basic Set"

It would seem that in the examination procedure known as the "subjective," the examiner is exploring the basic set of the person in relation to how much acuity is significant to him. Further, this "set" is positioned within a significant series of range measurements. It is interesting to note, as a sort of out-of-sequence statement, that the retinoscopic changes observable in the measurements made on the sightless man were always those having to do with problem solving, and the frequency and degree of those changes were covariant with the intellectual demand. This is significant in that most of those seeking the assistance of the optometrist live and operate in a world demanding the ability to solve problems, the most significant of which may be that contained in the printed symbols of the language. It is this kind of task that has been labelled in optometric thinking as "near-point."

The subjective, however, is taken at a "far-point." At present, there would seem to be only one end of a range of operation under investigation. Only in recent years has there been a serious investigation of the other part of this range. The subjective is characteristically taken only with the maximum plus end of the range. There is also the ability, in most patients, to maintain contour discrimination (acuity) unchanged when some magnitude of concave lenses is placed before the eyes. This "other side of the coin" should be a part of the investigation made by every optometrist. Without it, one might have difficulty in determining the "basic set."

The evidence of the sightless man, of the "transient differences in meridians," and of the motion picture of Harmon showing tensions in the back of the subject, all bring vivid realization of the seemingly inescapable conclusion that the subjective, as is true of every other finding, measures a dynamic, alterable process that is being operated by the organism for the preservation of that organism. It may seem a far cry from the problem of the hunter and the hunted to that of the student and the machine operator, but the same mechanisms are found in both. In the light of the work of such men as Herrick, the "mind-body" problem ceases to exist, and one is concerned with the total organism.

A "Base Line"

The subjective, then, taken at a far point, would seem to be a measurement that could be used as a "base line," so to speak, for all subsequent findings in any investigation of the visual behavior of any person. To make any measurement effective, it is necessary

to have a "zero point." The measure of so many units, whether millimeters or miles or diopters, must have a point of departure, a starting point. The subjective, properly taken, would appear to supply this.

It is necessary for the student to bear in mind that the measurement is not of a fixed, inflexible mechanism. Dr. Apell experimentally wore a -2.50 lens for three days. His associate in the experiment at Ohio State University, Dr. Glover, made complete refractions over stated periods of time during and after the experimental wearing period. The changes in all findings were significant, and the subjective changed definition and made some unexpected reversals. The table of findings is attached to this paper. It is worthy of close scrutiny by both the individual student and the entire study group. The subjective finding can no longer be regarded as unalterable and fixed.

In a recent optometric publication, the statement is made that "the study of test findings is made to indicate whether the subjective correction can be worn to give not only clear vision but also comfortable and efficient vision." The author continues, "if the subjective cannot be accepted, then the case analysis should indicate that modification of the prescription needs to be made or whether visual training is advisable." The question to be raised is whether the examination is made to discover whether the subjective can be worn for the objectives named, or whether the subjective is itself a finding that contributes to an understanding of the total visual problem.

What is the value of any lens to a person for whom that lens produces no increase in resolving power? The age-old question was quoted by Dr. Emmett Betts in the magazine EDUCATION, "Why should anybody who can see without glasses find such a wonderful help by wearing them?" The answer would seem to go far beyond the simple problem of whether or not the subjective finding is an acceptable formula. It may require more than even the fullness of an Analytical Examination to answer the question of what visual problem is present in this particular person. It is certain that a part of this answer lies within the province of that field of interest most ably presented by Dr. S. K. Lesser, namely, that of the "ranges" that exist within the good, sound, physiological optics of the visual mechanism, controlled and put into operation by the total person.

The Methodology

The concept of the existence of a "range" gives reason for the methods employed in determining the extent of the ranges in the subjective.

After completing the dynamic retinoscopy, sufficient plus is added to blur to 20/40. Occlude one eye and reduce plus to best acuity. Note whether this equals or exceeds 20/20. Again blur back to 20/40 and present the astigmatic chart. Reduce plus to 20/30 and determine any astigmatic interval. If present, reduce the interval with appropriate cylinders, and note.

Reduce plus to best acuity and recheck with cross cylinders, and if at variance with astigmatic chart, note. Reblur to 20/30. Present a single 20/20 line and record the point of clearing as plus is reduced, and the point of blurring as it is further reduced. Repeat with the other eye. Dissociate the two eyes and balance for equivalence of readability, size of charts and relative distance away of the chart, in that order. Note any difference in color of charts. Reblur binocularly and record the emergence of a good 20/20 and the best acuity.

A "Good" 20/20

There has been a long-term discussion of just what constitutes a "good" 20/20. The contour discrimination values of the letters of the alphabet differ so greatly that no comparison can really be made. However, the standard has long been set that "when the subject can read all the 20/20 line except a few of the difficult letters and can read some of the easier ones in the 20/15 line, it is considered as a "good" 20/20. This may not be the best acuity.

The subjective is essentially a method of locating or determining a base line. This base line, or starting place, serves as the base to which all the measurements made in subsequent findings are related. It is also the measuring point against which all previous quantifications are weighed. The student will note in the various manuals that the dynamic retinoscopy finding is compared to the static, while the static is compared with the subjective. The subjective is the "base line."

The student is reminded, once again, that neither in fact, in fancy, nor in illustrative language is there an "image" that travels along a nerve. It is permissible to say that the blur is not on the retina. The blur is in the interpretation. To avoid the repetitious use of a phrase, let it be said that acuity is the interpretation of a certain pattern of "on and off" signals that travel in a "slow ionic volley" from retina to central nervous system.

Blurring may be said to be the product of unaccustomed photo scatter on the retina with resultant altered interpretation. It could be further hazarded that blur is a product of an altered resonance

within the organismic circuiting and hence an altered spatial interpretation. If that same target is moved to a different place in space, it can be seen clearly or can become more blurred. Yet every practitioner knows that certain patients will come to accept greater amounts of lens powers with no discernable change in the optics of the situation.

The subjective might be said to be a means of measuring the volume of space in which a given magnitude of information can be obtained. The volume of space indicated by 20/20 appears to be related to the survival needs of the species. That magnitude of contour discrimination appears to be common to almost every member of the species when an appropriate target is presented. It is so closely associated with the "patterns of behavior in their anatomical, physiological, biochemical, and pharmacological contents" that when this complex alters, it can be predicted that the quantifiable amount of the "subjective will change."

Three Subjective Measurements

The "subjective" can be one of three things: hyperopia, emmetropia, or myopia. For the moment, astigmatism is not being considered. The hyperope has a large amount of freedom to operate within that total volume of space quantifiable by the amount of convex lens to blur and the amount of concave lens to blur—and to perceived size change. The emmetrope has absorbed one whole dimension of his degrees of freedom to operate within his space volume, without necessarily extending the other area of freedom. The myope has decreased his total area of space in which he can maintain space volume. This is essentially a constricting of the total visual space world.

Acceptance in the subjective of convex lens would appear to be a measurement of the magnitude of operational space volume. When no convex lens is accepted without a reported blur, the whole of that operational space volume has disappeared. When a concave lens is demanded, the space world itself has been diminished, and all remaining operational volume of space is within that restriction.

A Basic Substrate

Acuity is a basic substrate. Its existence allows the construction of a visual space world in which identification is acute within an expanded volume. The visual problem is the inability to organize meaning within that volume. Distorting the volume to enhance organization is measurable as a transformation of the one basic set into another, e.g., myopia, astigmia, adverse hyperopia. Absorption of ranges surrounding that set freezes performances.

The book retinoscope has demonstrated that the amount of operational space volume measurable as hyperopia disappears as quantifiable measurement under stress. It also diminishes when there is demand for finer contour discrimination. The subjective, long held as the one sound, solid immutable and unvarying measurement has been demonstrated to be quite variable, not only from second to second as the biochemical balances alter, but over longer periods of time and at times in quite unpredictable fashion.

In investigating the visual "patterns of behavior," it would seem more informative to consider the measurement classically called "the subjective" as the anchor point, the zero point, the starting point from which all subsequent measurements are made. The fact that people may display a measurement of better acuity than that does not alter the basic approach. The main thesis of this paper is not altered by the fact that many people, having achieved a "20/10," demand it in their applied lenses. The question arises as to "which patients demand the 'best VA,' and which patients fail to thrive under it?" The Navy brass in Canada who flatly stated they intended to bring "ratings" from the ranks and teach them refraction would be justified if the supplying of the "best VA" were the aim and goal of optometry. This is a matter very easily learned and very simply accomplished.

What Lenses Do

A whole new operational area develops when a question is raised as to what constitutes a visual problem and why lenses are required. It can be said of the myope that lenses are needed to "make him see normally," but that statement cannot be said of the hyperope. The hyperope (except the absolute hyperope) already sees "normally." The very real problem arises as to what lenses do for him. It is in this realm of optometric attention that the three investigations outlined in the opening of this paper loom large.

In the case of the sightless man, the retinoscopy findings changed as he changed "problem-solving" demands. The film from the Neurological Institute gave the myographic evidence that convex lens of proper amount releases tension from the muscles of the back, from the heart action, and from respiration, and that the proper lens cannot be determined from the quantitative measurements of the examination. The optimal lens was +0.62, while the refraction was +0.25. However, the Analytical Examination showed

clearly that convex lens above the power indicated by the refractive status was needed. To the pride of all in optometry, the +0.50 had been given two weeks before the myograph demonstrated that +0.62 was optimal.

The subjective, taken with the recorded amount of lens power which allowed 20/20, was the base line. The "best acuity" was with a -0.25. This did not show the true available volume of space. Used as the sole criterion, it would have proved deceptive in the final evaluation.

The third item of evidence concerns the change of the retinoscopy motion from "with" to "against" when there is no change in distance of target or demand, but an alteration in the physiological optics system is produced by the localization of the target. It is unlikely that anyone would seriously question the idea that this observable, transient change demonstrated by retinoscopy would also appear in the hyperopic findings shown by the subjective if a method existed of recording these fleeting changes in the optics of the eye.

The Whole Organism

This gist of this paper and the discussions appearing in it is the one great important lesson of the year. In making a visual examination, one is engaging the operation of the whole organism. To state it another way, optometry is today engaged in a study of the operation of all the processes that take place within the envelope of the skin. Vision is not a limited, segregated process. It appears to be the master mechanism.

Vision is primarily a process of interpretation of space. The measurements made in the Analytical Examination are measurements of the degrees of freedom that exist within that person, to let him continue an adequate and optimal evaluation of the visual space world. This he must do while adapting to and coming to a workable equilibrium with the forces and the energies of the physical world that envelop him.

The subjective finding is a method of obtaining a base line for evaluating the other measurements that must be made in order to ascertain what adaptations this person has made to the forces that affect the organism. From the full set of investigatory findings, it is possible to learn the means, kinds, and degrees of adaptation that have been made. This information indicates the lens powers best suited to restore an operationally effective visual space world. There must be adequate freedoms and sufficient volume to allow the exigencies of the "physiological, biochemical, and pharmacological" alterations to be met without too adversely affecting the operation of the total visual process.

The subjective provides a base line at a distant point in space. A base line is also needed for the near-point in space. This quantitative base line will be discussed in the next paper of this series.