From the OEP Archive • Functional Optometry in Theory and Practice: The Equilibrium Findings

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The definite point is being made in these papers that optometry is interested in the remedial aspects of understanding the visual processes. There is a wide field for exploration into many laboratory and research areas of investigation. Fascinating as these are, they have no place in the profession except as they ultimately yield information to the profession in improved ways of dealing with the visual problems of people.

The previous two papers gave consideration to two important aspects of an investigation of the visual behaviors of the individual. One was classically named the "subjective." It was described as a means of quantitatively measuring one aspect of the individual's existing degrees of freedom to perform within his operational visual space world. The other, explored in the second paper, was the methodology and understanding of those findings known as crossed cylinder findings. The subjective yields a "base line" for the starting point of all further quantifications. The crossed cylinder findings yield knowledge of the operational latitude, or freedom, at the all-important area of space that has long been familiar to the members of the Optometric Extension Program as "near point." Recently, this is more frequently referred to as the area of "near space."

The evidence that a convex lens localizes away in space demands that the optometrist take a long look at what is being done with lenses. The organism was left in tension when the lens powers were significantly less than or more than the amount that proved to be optimal. This tension was quantifiably measurable in the six muscles of the back, blood pressure, respiration, etc. It is worthy of incidental comment that the effect of too little lens power was far less detrimental to the learning process than when too much lens power was employed.

Measurement of Acuity

The criteria of too much or too little had no relation to acuity. That factor remained unchanged so far as the patient was concerned. Acuity, being a learned process, can only be rated by the observer. There is no objective method of measuring acuity. To say it differently, only the observer knows whether the target is clear or blurred, absolutely or relatively. No scale outside the personal, phenomenal observation of the person can give any information as to acuity. When the patient reports no change in acuity, the optometrist can say with perfect assurance that no change in acuity occurred.

This is an important and delicate point. The assumption that there is an objective or absolute measurement of acuity has driven many men to the laboratory to perform questionable experiments on such things as resolving power of the eye and acuity, the discrimination of Landolt's rings, Koenig bars, and other targets with controlled illumination and artificial pupils. Even if the premises upon which they were constructed are in doubt, the results should be convertible into useful information to the men interested in remedial information.

In an article in the March 1959 Texas School Board Journal (reprinted by the Optometric Extension Program), Dr. Wilma R. Baber quotes Professor Ward Halstead:

> Clear and efficient vision is one of the highest functions of the brain; part of what we in psychology have in the past attributed to the individual differences in native endowment of intelligence is probably due to the distortions of the outer world impressed upon the brain, and hence the mind, through neglect of vision or improper correction. It is probably no accident that the English language uses the term 'I see' to mean 'understanding.' Let us make certain that the eye, as the great window of the mind, is properly cared for at all professional levels.

The reason for the quote is to impress the statement made here, unequivocally, that acuity is a function of the mind. It is wise for the reader to stop just a moment and for the study group to give some time in discussion to this matter.

Photon Scatter Concept

Realize this means the practical abandonment, in reality as well as in hypothesis, of the idea that acuity is derived from a "clear round focus on retina." If acuity is

of the mind, it is derived from the information brought to the organism by the "programming" from retina. This in turn is dependent on the photon density scatter on the retina. It is also a seemingly inescapable conclusion that there is a very large change in this photon scatter during which the mind continues to interpret without any phenomenal change in acuity. This photon density scatter involves not only the function of acuity, but also size and form. Ranges measured with lenses involve all three areas of information. Acuity would appear to be the easiest derivative, then size and form last.

Change in photon scatter without a phenomenal change is the constancy or organization, whether in relation to acuity, size, or form. This has been elaborately demonstrated by Hans Wallach in his presentations at the Invitational Conference at Ohio State University. Objects rotated in space so that the resultant photon scatter is radically changed are continuously identified by the observer as the same object. It would appear to be the interaction between these three factors that accounts for the differences in reports, that some see only size changes, some see form, and some retain acuity desperately. The point was made earlier in this paper that this photon scatter was a wholly individual matter. "Blur" is within the person.

This is not to equate the idea of "retinal image" and "photon scatter." No two concepts could be at more nearly opposite poles. Photon scatter is a density distribution. Retinal image is a presumed mirroring activity. It is for this reason that the laboratory experiments to produce a clear retinal image have consistently resulted in frustration. The photon scatter concept allows wide ranges without altered interpretation. The retinal image, carried to its logical conclusion, allows none.

Were this not true, a very small change in photon scatter would produce changes in acuity. In the rare person, this happens. It is, however, not a product of a perfect mechanism. On the contrary, it would seem to be a product of a visual problem that has restricted the usual degrees of freedom with which the organism can operate. For this reason, it happens that small changes in photon scatter do affect acuity, or size, or form.

This can move in several manifestations. One is the "supercritical," restricted, frequently unstable and "tight." The other is the "superable," wherein the same small changes are effective, but the results are far less restricted and lead to better retinal and more complex processing. On the other hand, there can be apparently no recognition of changes in photon scatter when there ought to be.

Quantification of Range

As the knowledge elaborates of how the visual process operates to let man see things as he does, there comes a greater and greater need for more exact knowledge of the magnitudes and scope of the operational ranges within the total visual interpretive sequence. The cross cylinder net permits the quantification of the amount of range that exists within which there can be a localization away without bringing further stress. It must not be overlooked that the organism is interpreting where and what things are in relation to a total terrain. The target is, in the reality of time and space, never a segregated one. It is always a target set in a terrain where the computing is the product of all the energies and the transformation which they undergo.

Thought and Action

Vernon stated that "figure is fabricated out of ground," and that vision develops under the tutelage of the active touch. All this is a part of the infinitely complex deriving of ever more elaborate derivatives from the original simple kinesthetic and proprioceptive patterns. These are integrated into the complexity whose vector is the derivative from the one universal energy, light. They become vision, man's ability to know where things are and where he is, what things are and their significance to him. Fulton J. Sheen, in a recent article, stated that "abstract ideas are often hard to keep in mind, but they become more readily retained when associated with sensible images of physical movements. The relation existing between thought and action is indeed intimate."

In a working model of vision, the student might well keep in mind one of the most helpful statements in the printed literature. Strauss and Lehtinene (Psychology and Education of the Brain-Injured Child, New York, Grune and Stratton, 1948, p.148) observe:

> In time, the concrete perceptual element of the number concept fades and recedes, yielding to the gradual development of a scheme of visual spatial relations, the establishment of which seems essential for operations on an abstract level. However, the perceptual element is still dimly retained in such a visual scheme, while the scheme itself, even in adults, is present as the inner basis for almost all abstract work...the number concept is rooted in the perception of objects in space and grows from the organism's inherent ability to organize...

It may seem like a detour to the reader to go back into these seemingly only slightly related matters. Yet if the concept of an operational range in visual space is to be more than a meaningless phrase that has no relation to the actual writing of an equation for lenses, some of this understanding of the operation of the visual process is essential.

Four Equilibrium Findings

The last paper stated that the cross cylinder net is not necessarily also the prescriptible near net. The prescriptible near net is the part of the cross cylinder net acceptable in the equilibrium findings. This is a statement long made and experientially and clinically well supported. The clinically established procedural rule is that the lenses given shall not reverse the equilibrium findings as they have been developed by the organism. There are four of these findings: prism base-out to blur, prism base-in to blur, minus sphere to blur, and plus sphere to blur. The prism base-out to blur and prism base-in to blur findings are an alignment-centering-identification sequence. The minus sphere to blur and plus sphere to blur are an identification-centering-alignment sequence. All four mark the limitations of an operational range within the total information-getting sequence of the person.

The methodology is so familiar that there seems small purpose in repeating it. However, it will be necessary to consider the methods in order to discuss the significances of the four quantifications. Therefore it will be well to recapitulate.

Characteristically, the findings are taken utilizing a standard phorometer. This is a generic term to cover all apparatus having a complete lens battery and accessories all combined in one holder. There is an eyepiece approximately 1.25 or more inches deep. The aperture size, in millimeters, gives a very limited field. However, the findings are always relative, and the table of means has been constructed, basically, on findings taken in this limiting arrangement. Therefore, there is no impairment of the reliability of the findings.

The subjective finding, if in plus, is in the phorometer. The cross cylinder findings are completed. The resultant phorias have been taken. The gross fused cross cylinder finding is reduced to the amount of the convex lens power of the subjective.

The photographically reduced Snellen target is placed at the determined distance. The patient watches the smallest line of letters, i.e., presumably the reduced 20/20 line. Prism base-out is introduced, with the patient instructed to report when the letters are no longer readable. When this point is reached, the patient is exhorted to tell whether even ONE letter is readable. When there is a definite statement of complete inability to read one single letter, the amount of prim base-out is recorded.

Designation by Number

The finding has many names in optometric circles. To save misunderstanding and controversy, it was labelled #16A by its place in the sequence of the psychometric examination called Analytical. It could have been called delta or theta or gamma or, as originally, positive relative convergence. However, the word "convergence" came into a more restricted meaning. The problem was raised, "relative to what?" A question arose as to why one direction in space was positive and the other negative. The complications of meaning attached to words were avoided by simply calling the "prism base-out to blur-out" the #16A finding.

The opposite finding, #17A, is taken in exactly the same way, with the same instructions and the same speed of insertion of the prism powers, but with prism base-in rather than prism base-out. The two findings are recorded for later comparison.

The identification-centering-alignment investigations are called #20 and #21 in the Analytical for exactly the same reason that the #16A and #17A were labeled by their place in the examination sequence. It has often seemed that they were given wonderful names when someone wanted to confuse or avoid clear explanation. In this series of papers, these four findings, though of great importance, will be called simply "#16A and #17A" and "#20 and #21" findings.

Again, the reduced Snellen target is employed. The patient is again instructed to read the 20/20 line. Minus lenses are inserted while the patient is asked to state when a blur occurs. At that point, the patient is instructed to say when the blurring is sufficient that no letters can be read. Upon that report, the patient is exhorted to tell whether there is just ONE letter that remains readable. When there is not, the amount of minus lens required, over and above the subjective finding, to bring about the blur-out, is recorded as the #20 finding.

Precisely the same procedure is employed with convex lenses. Snellen type is utilized as the target. Convex lenses are added to blur, to complete blur, and then until not ONE letter can be extracted. The amount of plus over and above the plus of the subjective is recorded as the #21 finding.

Theory and Practice

The procedure is simple in theory but complicated to no end in practice. For one thing, it is possible, with some patients, to run the minus to blur-out into high amounts. The target will get smaller and smaller and blacker and blacker until finally the patient assumes that the small black blotch is now blurred out. In actual practice, there is no good diagnostic reason to justify such an experience. Characteristically, the patient who can maintain the minus to blur-out up to 3.50 D has supplied the needed information. The finding can be recorded as +3.50 D. This tells any reader that more would have been accepted.

When the plus to blur-out is higher than the minus to blur-out, and the cross cylinder net would reverse this arrangement, the amount of the cross cylinder net which reversed it is contraindicated. The amount that just equalizes the two would be termed the prescriptible near net. If the minus to blur-out is greater than the plus to blur-out, then no amount of plus will reverse them. The cross cylinder net is therefore the prescriptible near net. When the minus to blur-out is low, with the plus to blur-out high, and the cross cylinder net does not reverse them, that is the prescriptible near net.

Two of the factors that will further affect the dioptric values that can be given were outlined in Volume 31, the 1957-1958 series. These are the adaptation syndrome and the spatial organization syndrome. The student and the study group should review these papers. It is impractical and wasteful to repeat these matters every year. They form a continuum.

The past two years have given in detail the communication with the patient and the syndromes used in optometric practice. This particular volume finds its interest in the matter of the volume of space within which a person operates. The restatement of findings has been a necessary vector for the understanding of what sort of space-volume is employed by the person whose visual processes are being investigated.

The Final Determinant

Nothing more clearly indicates the effector system as the final determinant of vision than does the series of findings discussed in these three papers.

The dynamic process that is the subjective finding. This is far from a static and fixed mechanism, as shown by the three investigations cited: the sightless man; the "dangled bell" retinoscopy in adults; and the three-day wearing experiments of Dr. Richard Apell, whose graph was attached to the first paper of this volume. The subjective is an indication of the moving "in and out" of the volume of that person's visual space world. The control of that system is the "limit of experimental abduction" that has ever been acquired "under the tutelage of the active touch." However, there is an interesting tentative hypothesis that should give any thoughtful study group an interesting hour of exploratory speculation: that the angle kappa and hyperopia are the means whereby the organism is retained in dynamic readiness for immediate activity and so is freed of any interference factor of inertia.

The determined net at near, by equating the relationships within the space-volume or the visual space solid, whichever is the more congenial term, of the alignment-centering-identification sequence and the identification-centering-alignment sequence. The student will note that in this phrasing, the idea is embodied of the dual effector system, with the definite intent of making real the oneness of the total process. It would seem that the energy sequence of centering is unlikely to be significantly changed without some change in the energy sequence of identification. This is probably best illustrated by the visual problem that limits learning ability. The organism exerts all of its survival processes. Contour discrimination or resolving power or acuity, whichever term best suits the student, have remained unchanged. The change has been in the abilities which are the derivatives of the derivatives of these energy sequences.

Edith Meyer (J. Genet. Psychol., Vol. 57, 1st half, September, 1940, p. 150) says, "As might be expected, processes such as those involved in the evolution of notions like time and space are more readily impaired than simple ones." On p. 140, Meyer says, "Whenever the mind encounters problems too difficult to solve with the functional instruments at its disposal, the process of comprehension recurs to the same mechanisms long left behind on other levels." To interpret Dr. Meyer's statement, the "problem solving" may be too difficult for the organism to resolve within the time limits available in the closed energy sequence of the visual circuiting. The survival abilities that were learned first and long ago in the life span of that person are the ones preserved. The original exploratory kinesthetic and proprioceptive patterns form the experimental net from which emerge the more elaborate, the "derivatives of derivatives" of time and space.

The stresses produced by the energies that impose problem solving may cause a warping or altering of the effector processes. This latter is being explored by the optometrist when he takes what are known as *the "equilibrium" findings*.

Interpretation of Space

In the determination of the problem of learning the lens that will be worn, the mechanics of the use of the equilibrium findings is simple. However, over and above this simple use is the problem of the interpretation of space. Something quite different has happened in the total operational sequence when, in the taking of these findings, size changes begin to occur. The "equilibrium findings" operate both ways from the area of demand. The minus to blur-out is an enforced movement in one direction within the space-volume. The plus to blur-out is in the other direction of this same visual space-volume. It becomes important to note whether the size changes occur more or less quickly within one of these volume-areas than the other.

It will be recalled that the acceptable lens is one which does not exceed the operational areas of freedom within the visual process. These operational areas of freedom would appear to be related to the relative volumes of visual space available. To say it better, they appear to have a connection with the relation of space-volume to the area of the demand. When there is a greater area of the space-volume beyond the demand area, more plus can be applied. When there appears to be a smaller space volume beyond the demand area, there would be a lessened plus acceptance.

The prism base-out and prism base-in findings, known in the Analytical sequence as "#16A and #17A," represent the investigation of the centering-alignment-identification space-volume. Every beginner student in optometry being introduced to the dynamics of the Analytical examination is familiar with the observation that "#16A is high and #17A is low" in a "B" type case. This has certain very definite indications for lens application. Considerable time has been devoted in this paper to the discussion of the inadvisability of prescribing a lens that reverses the arrangement of the blur-out findings of #20 and #21 in the Analytical sequence. There are times when this general rule is violable. When applied to the "equilibrium findings" determined by prism, there is far less flexibility in that rule.

Spatial Computing Network

In the Optometric Extension Program many years back, the statement was made that the use of prisms tended to be contraindicated. Prism affects the skeletal alignment mechanism. This latter is intimately related to the kinesthetic and proprioceptive mechanisms of spatial learning by sheer experience in handling. One knows how far a thing is by his experience in reaching and handling, and later by crawling, walking, running, and finally throwing, to it. These comprise much of the experimental network of spatial computing.

The Harmon film brings substantiation to this view. The behavior of the young man under the effect of lenses was photographed. Behind prisms, there is an increase in the tension of the back muscles. Also, there is a thrusting movement of the arm and trunk. In the case of the introduction of sphere, the localization was away, as a change in the identification process. With the prism, the photographed change was in the body musculature.

A relation within the space-volume is indicated by the amount of prism that will change the centering-alignment-identification cycle. When the utmost reaches of that space-volume have been attained, there will be the complete blur-out. In passing, it may be noted that the "blur-out" technique was imposed early in the history of the developing discipline. Men insisted it was easier for the patient to tell when things blurred out completely than when the first blur occurred.

The findings were always compared one with the other, i.e., base-out to blur with base-in to blur, minus to blur with plus to blur. At that time, it did not seem to matter particularly whether a first blur or a blur-out was the measuring point. The requirement was that the same procedure be used in both directions. A far more definite finding is the point at which the patient first experiences the inability to continue decoding the incoming signal as having clear boundaries.

The #9 Finding

One other centering-alignment-identification quantification is the base-out to blur at far-point. In the Analytical sequence, it is the ninth step. Hence, it is called the #9 finding. It is taken with the 20/20 Snellen type as the target, situated at 20 feet. The technique of the subjective has been applied. The subjective finding is in the phorometer. The resultant phoria is taken and recorded.

The Snellen letters are presented. The patient is completely unaware of what the optometrist means by a slight blur. A blur can only be experienced. It cannot be illustrated. A blur IS an experience, something the organism does. It does not happen to the organism. It is a behavior on the part of the organism.

It may seem absurd to belabor this point. Yet it is important. This sort of concept brings the dividing line between those who actually think dynamically and those who either deride such thinking or give lip

service to it. The researchers in child development are as one in declaring that acuity is learned. The student should take that statement and return to the previous statement that a blur can only be experienced. It cannot be illustrated. It cannot be imposed.

Significance of #9

The particular significance of the base-out to blur at far, #9 in the Analytical sequence, is that it seems to be a consistent reflector of the alteration in the energy pattern at the near point. It is one of the first to show significant quantitative loss when there is adaptation to stress at the near-point. It is one of the significant findings when the process of adaptation nears relative completion. In short, the #9 finding tends to be very low when the case is in the earliest stages of its adaptation to whatever stress may exist. It tends to move upwards towards and sometimes beyond its "expected" as the case nears embedding, or relatively complete adaptation.

Near space and far space are more than just names given to the placement of a target. Near space is that area of the environs where there can exist a reinforcement of the visual energy sequence by other modalities, or other sensory input-integration-output sequences.

The so-called equilibrium findings are methods of investigating the shifting of the demand area within the total visual space-volume. They are not alone indicators of gross quantification of lens acceptance. They also give information as to the likelihood of the long-term value of lenses to the patient. When the demand area occupies an equilibrated placement within the space-volume, what Dr. S. K. Lesser calls an "optimum positioning," the visual performance is likely to be efficient. When stress alters the total movement patterns of vision so that the space-volume is warped, lenses that will bring about changes in localization are advantageous if they do not exceed the operational degrees of freedom.

Elaboration of Interpretation

The concept of space-volume being equilibrated with the demand area does not convey the idea that the equilibrium findings should always be made equal with a lens. The lens that would accomplish this may be inadequate for the ultimate purpose, just as the lens that restores best acuity may not be the best lens, operationally, for that person. The elaboration of interpretation that has come into the Analytical examination is intended to allow the optometrist to make just such decisions. The many factors that enter into these decisions are the subject of these papers. As a foundation, it appears necessary to reexamine the familiar procedures in order to convey a complete understanding that all are measurements of an externalizing process. All are measurements indicating how large and how well organized the viewing person's visual space-volume or visual space solid is.

The property of a convex lens is to relocalize away. Sooner or later it is necessary to analyze the property of a concave lens and of a cylinder. To do this understandingly, two other explorations of the manipulation of the space-volume must be considered. These are the groupings of findings known as ductions and phorias. In the next paper of this volume, the role, place, and significance of the duction findings will be considered.

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