Article ▸ A Modern Concept of Vision

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This series of chapters, written by A. M. Skeffington, O.D., some years ago, reviews the behavioral functional theory of vision care, and then the details of lens application for the prevention of certain visual problems, the development of visual performance, and enhancement of vision achievement. Beyond the methods used for making an analytical examination and analysis (explained in detail in the Introduction of Clinical Optometry by Dr. Skeffington, published by the Optometric Extension Program Foundation, 1990), this book is a sequel. Explicit case examples are given for various age levels, from preschool through old age, and specific visual problems identified by traditional labels are explored. Included are case findings, lens applications, and, most importantly, why. When vision therapy is also needed and recommended, the procedures or source chapters are cited.

— Homer Hendrickson, O.D., D.O.S.
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The chapters of this series will consider the entities of the remedial facet of the profession. The concept of emmetropia and other variations from optimal performance need reexamination and redefinition in the light of modern understanding of human performance. It is the fundamental idea that the remedial entities are end products of altered integrative and output operations.

Once understood, in this concept lies the answer to the questions that have plagued the profession from its very beginnings. Why does the person accepting only +.25 spheres often find it more difficult to go without his lenses than does another person who is wearing +2.25 spheres? One person with .37 D astigmatism shows immediate results from the prescribing of that amount of cylinder. Why, then, does another with many times that amount maintain perfectly good acuity without a lens, and reject the cylinder if given as a lens formula? How does it happen that one myope with 20/100 acuity will attain 20/20 with a -.50 and another will require -1.50 before 20/20 is possible? These are the problems which have plagued optometrists. The attempt to solve them by ignoring them, or to avoid them by attributing the reports to a neurosis or psychotic condition, is a failure.

The Nature of Vision

Here also is the answer to the failure in school on the part of children who do not have discomfort nor show significant measurable defects. In fact, the very real problem today is the emmetropic orthophore who is in trouble. The problem is not solved by the classic answer made by one head of a school survey when confronted by the evidence that many of those screened as having visual problems were among the best achievers in school, while those he had passed as having no significant defect were among those failing. The scholarly head of the survey team looked at the evidence and said, loftily, “That is not my problem. I showed you the ocular defects. The scholastic problems are up to you.”

That practitioner, like many others, was concerned with what he thought were “eye” problems. Actually, although he did not know it, he was really faced with the results of a visual problem. What constitutes a visual problem? This whole approach can be summed up in a series of hypotheses:

1. Vision is a process, afferent, integrative, and efferent.
2. The visual problem is not an eye problem but can produce eye problems.
3. Vision is output, and all measurements are measurements of output.
4. Lenses are fitted to enhance performance in output, rather than the correction of structure.
5. The ocular conditions of astigmatism, anisometropia, adverse high hyperopia, myopia, and squint are the end results in structure of adverse changes in process.
6. These manifested ocular states are all varying forms of adaptation to the same fundamental underlying problem.
7. The remedial measures of lenses and optometric vision therapy are designed to bring about unimpaired output with adequate latitudes to meet imposed stresses.

It is interesting the way this idea has penetrated well outside the realms of the profession. Emmett A. Betts, Ed.D., educator, writing in the book, Foundations of Reading Instruction (American Book Company: p.175), says, “Functional difficulties are being corrected by up-to-date vision specialists by means of glasses, visual reeducation, or both.” He continues later in the same paragraph, “False notions were based on statements and diagrams of short and long eyeballs. Such statements are now being vigorously challenged by vision specialists.”

In the very excellent publication by Helen Robinson, Ed.D., educator, Clinical Studies in Reading (University of Chicago Press, 1953), an article by Arnold Gesell, M.D., holds two paragraphs pertinent to this discussion. On page 133 he observes that “The total-action-system factors are so important that the adequacy of child vision cannot be appraised in terms of acuity alone.” Later he states, ...

"paradoxically enough, high acuity is sometimes associated with low reading ability." Then he surmised that perhaps ... "sheer intensity of pinpoint acuteness interfered with that mobile modulation of fixation and peripheral awareness which makes for facile reading perception."

The following paragraph states, "Refractive errors which yield to optical correction are not in themselves likely to cause reading difficulties." This is in accord with the elaborate literature relating to the correlation of refractive errors, muscular anomalies, and so on, with retardation in reading. On page 141 of the same book, in an article by Marguerite Thoma Eberl, O.D., appears the quotation from Dearborn and Leverett, "In fact, there appears to be an excessive conflict of opinion among students and specialists in the field." A number of conflicting statements from various authors are given. As a result, the diversity of thought in matters concerning the relationship between visual defects and reading is now so great that it may have to be described as confusion (Walter F. Dearborn and Hollis M. Leverett, Visual Defects and Reading, Journal of Experimental Education, XIII, III).

It is to be noted that in the description of the problems of the retarded reader there is being rehearsed the story of all visual problems. The discomforts "in and around head and eye regions," as S. Howard Bartley, Ph.D., psychologist (Psychosomatic Medicine, April 1942), described it, have been the basic drive in a population that has brought about the development of optometry. The reason for ocular discomfort has been a baffling search for many optometrists. They sought it in muscle, in anatomical failures, in differences in image size and in a score of anatomical and input hypothesized causes. In all probability, Bartley said it better than it has ever been said before, "Evidence suggests that the localized discomfort is a function of the organism as a whole, becoming thus localized when visual achievement becomes, for any reason, unsatisfactory." This is as historically important as the pronouncement in 1941 by Samuel Renshaw, Ph.D., experimental psychologist, that "seeing is learned" and "seeing is motor." It ranks with the observation of Darell Boyd Harmon, Ph.D., Ed.D., educator, that the development by man of higher faculties does not excuse him from the necessity of maintaining the optimum performance of the supporting mechanisms.

The physiologists inform us that smooth muscle is, in the intact organism, for all practical purposes, unfatigable. The anatomists state that the extrinsic muscles of the eye (striated) are 60 to 100 times as strong as need be, thus providing "a mechanism for prolonged activity without fatigue" (Walter B. Lancaster, M.D., physiologist). The problem of ocular discomfort is then neither neurological nor physiological nor anatomical. It is organismic and as such cannot exclude the operation of what has continued to be called the "higher functions." Actually, these unhappily labeled higher functions are simply the most elaborately organized performances man has acquired in the long history of mutation. The cephalocaudad progression is that of eternally more elaborated organization of protoplasm.

Protoplasm has the properties of metabolism, irritability, and reproducibility. Under the assumption that seeing is organismic, and not a mere camera to photograph the details of our surrounds, these properties should have their weight in the understanding of vision. Records from postwar Europe show that when a mother was deprived of the essential minerals and vitamins and the child was deprived of them in its early months of life, the child operated as a brain-injured child. The ability to acquire knowledge via the visual processes was seriously diminished. The metabolism is a factor in vision not to be ignored. Under the heading of deprivations in the culture, there will later come into the discussion the problem of the child in good socio-economic status, whose loaded food plate does not contain those essentials, simply because the culture has erased them from the proffered foods.

Adaptability is the main thesis in the approach to vision. Reproduction would have its place in the transmission of biophysical and biochemical tendencies that would make certain types of adaptation more readily accessible to the organism than others. Harmon has said that vision will never be understood until those three properties of protoplasm are understood and incorporated into the thinking of the discipline attempting a rational and effective approach to these problems. The human being has three great advantages over other life forms:

1. The cortex and other brain developments permit the abstraction of experience
2. The peripheral body mechanisms are built as tools for the manipulating of the environment
3. Man has a long growth period after birth so that much of our manipulatory and communicative mechanisms cannot only take the form they are destined to take as the results of our endowments, but these mechanisms can be shaped for efficient action as the result of experience in specific surrounds in which we are going to function after maturity

Perhaps the most important of those three from the point of view of this chapter is the second, the tools! In truth, it is on this matter of prehension and manipulation that the whole modern concept of vision stands or falls.

Seeing Is Motor

The flat and unadorned statement that "seeing is motor" has behind it a long and elaborate documentation in the literature. Beginning with Bishop Berkeley in 1709, it has been upheld by John Dewey in 1890, Stratton, Dodge, Purdy, and so on through a list, with perhaps its final documentation in the work of Ward Halstead, Ph.D., researcher, (Brain and Intelligence), The Hixon Symposium on Cerebral Mechanisms in Behavior, and Roger Sperry, Ph.D., neurosurgeon, researcher, University of Chicago, in American Scientist, 1952, 40: page 291.

Samuel Renshaw has been by all odds the most vigorous and vocal proponent of the idea. He stated in a beautiful paragraph:

In the simplest cells such as the amoeba proteus, the plasma membrane is at one time the essential respiratory, muscular, and sensory apparatus of the animal. Every important living process takes place at the boundary. Locomotion, reproduction, and all other bodily functions are functions of changes in the structure of the plasma membrane. It has been pointed out repeatedly that there is no discrimination here between the sensory and the motor. All is motor. Stimulation is just another way of saying that there is an impact of chemical, electrical, or thermal energy operating on the complex structure of the plasma membrane. The concept, "sensory" is of interest. It only put in its appearance when animal organisms evolved far enough so there could be a disjunction, in time, between one energy change (stimulation) and the consequent restoration of equilibrium (motor process) instigated by the first energy impact (private communication).

Vision as Output

Vision, it would seem, is a matter of output. R. W. Sperry, in The American Scientist, as mentioned previously, says, "One searches the cerebrum in vain for any structure that seems designed for the purpose of forming, storing, or emanating copies or representations of the outside world." Renshaw has said this many times in print and in speech. Sperry continues, "If any scheme or plan at all is evident in the complicated fiber associations and nuclear interconnections, it is a design patterned throughout for governing excitation of the 'final common motor pathways'."

Here is a concept of vision with which a modem person can deal. It is in line with the whole of modern advancements in biological science. The static concept of the defective eye was a nice simple one, had it worked out clinically. It is like a space world founded on the idea of a still eye. In that event a perfectly good Euclidean geometry will fit all situations. The only difficulty is that the human eye is not a still eye, hence the necessity of the hyperbolic geometry of Luneburg, with its two individual variables. It is quite all right for anyone to choose to speculate mathematically on the hypothesis of a fixed, immobilized eye.

Man is not a single-celled amoeba. Man is, however, protoplasm. Elaborated into amplified structures, the final elaboration of protoplasm is the prefrontal lobes. This last flowering of the process began when the first single-celled living thing emerged as the resultant of forces active in the watery, gaseous world eons past. Vision has evolved with it. The following steps occurred in that evolution:

1. Specialized "warm spots" on the skin
2. Specialized skin that could allow the detection of light and shadow
3. Development of receptors for the various types of radiant energy utilized as triggering for different actions necessary to varying species

Finally, came the eye of man with its organization of receptors for a certain band of radiant energy that could start a multitude of activities. Some of these are primitive, as the retreating and prehension of pseudopod of the amoeba, others so abstract that no overt motion was detectable, that men call thinking. In this latter extension of the property of irritability, man has not escaped the limits of the original structural materials. Man has not developed processes outside of those inherent in the biochemical and biophysical nature of protoplasm. Out of the complex of specialized forms for metabolism, we get such systemic organizations as the autonomic nervous system. This system has been set up, through time, to maintain equilibrium between somatic function and visceral function.

Along with this development of the nervous system, there needed to be developed specialized triggering mechanisms for the specialized organs, to release the biochemical processes that would activate certain bodily organizations of activity for emergencies. However, all this elaboration of process did not escape from the original principle of the amoeba, that all behavior is motor. "All is motor," as Renshaw put it.

As the various organizations developed into the various animal forms, certain of the specialized organs took prominence in their survival need. The sense of smell in the dog is an instance. In the genus homo it was vision which became the dominant factor. This development is very recent in biological time. Lest anyone think in terms of acuity, let him note the soaring eagle, swinging high aloft on the buoying currents of the air, who sees the tiny victim below and unerringly swoops to the kill.

The tough minded says, "Oh, yes, but the eagle only sees moving things. Man sees the things which are still." The reader is referred to the beautiful monograph, Recent Evidence for Neural Mechanisms in Vision Leading to a General Theory of Sensory Acuity, by Wade H. Marshall and S. A. Talbot, physiologists (Johns Hopkins University), in Biological Symposia, 1942, Vol. VII, pp. 137-139. Impossible to repeat here in full, Talbot can be inadequately summed up in the sentence, "The neural 'image' plays continuously over the projection arc at every synaptic level, building gradients and peaks of activity at every edge and line," and a sentence from his summary (page 159), "Physiological nystagmus, in a (nearly) statistical distribution of amplitudes and speeds, applies the graded intensity discontinuously to the receptors, for conversion into impulse-frequency." In other words, man sees motion only. The still eye and still object would provide a situation of "no vision."

Vision, it would seem, can only be described on an experiential basis. There is no decrying the physical endowment. The baby has legs. He no longer uses four legs. In maturational time he will defy his anatomical structure and will stand erect and then will start to learn to walk. Now he is a creature in parlous balance with gravity.

He has long been building toward this moment. Slowly, he has structured a visual space world. In his early infancy (and fastest learning period), his manipulable space world was in reach of his small manipulating hands. Gradually the visual prehension was extended. Things must be seen that could not be touched. Seeing is more than contrasts of lighter and darker. Seeing is the getting of meaning.

It took a long time for the meaning that the tiny hands gained through kinesthesis, and the contrast pattern that the receptors for radiant energy obtained, to be linked into a usable unity. When that took place, there was vision. Though small in magnitude and limited in space, it was vision nonetheless, because it was a loading of a sensory-motor-feedback vector with the even-this-early synthesized and abstracted experience. This is the beginning of vision. Vision must extend beyond the hands. The growing child must be able to visualize what he is not touching. This is a further elaboration of the total process. It is the visualization, the "getting out there" visually founded upon and yet free from the limitation of touch.

This need to shift from a kinesthetically found interpretation into one based on it, but free of it, is a constantly to-be-repeated experience which the developing child—and the continuing adult—must go through. Heinz Werner, Ph.D., psychologist, researcher, (Comparative Psychology of Mental Development, Follett Publishing Co.) says, "During the development of space perception and space relations, a qualitative change occurs. The primordial space dominated wholly by kinesthetic-tactile factors (Piaget's 'practical space') is shifted more and more in the direction of objective space dominated by perception." This is a developmental shifting in levels that must occur over and over again.

Edith Meyer, who extended Piaget's experiments, says, "The process of progressive objectification of the notion of space in the child's mind goes along with the progressive shift from an egocentric point of view to a relativistic one. It is not the first time nor yet the last one during his mental evolution that the child goes through this development from a practical through a subjective to an objective notion of space. Comprehension of spatial relations occurs on different levels of mental evolution according to the difficulties of the problem. On whatever level it appears, it progressively develops by a continuous genetic process of which developmental stages presented mark the fundamental steps. Wherever 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." The first needed mechanism in this shift is one that allows the child to attain balance. The balancing mechanism of man has been another of those things taken as being "natural," as L. Z. Young says in his Doubt and Certainty in Science (Oxford Press).

However, the problem of the maintenance of the tonicity of the body in preparation for action, and the movements of the body in kinetic action, in relation to objects seen in the environs, is the basis of all effective vision. Mediated by the midbrain, with only loops of conduction to the visual cortex and feeding back again, it is probably the foundation of human vision. That this has been relegated to the "primitive" as though it were of no significance in this latter day, has been due to the preoccupation with acuity that has dominated all thinking regarding vision. There is a considerable basis experimentally for the notion that this photo-static and photo-postural factor in vision is the underlying basis for what is known as fusion.

Almost every worker has experienced the presented case where there was one or the other of the forms of avoided central binocularity, but wherein there was a good peripheral binocularity with a large degree of freedom of operation. This is not surprising when the survival value of peripheral vision is understood. Man could live without the degree of contour or texture refinement obtainable foveally. He could ill afford the loss of the posturing processes that allow him, in continuous parlous balance with gravity, to operate effectively in his relations to physical space.

Soon, maturationally triggered and culturally impelled, there comes the need for a further condensation of the synthesized and abstracted experience. Man talks; animals make sounds. They communicate with others of their own kind in a limited range of sounds that aid in the survival of the species. Warning, affection, content, are indicated by sounds. Man talks.

Sherrington says of seeing, "This is the wonder of wonders, familiar even to boredom. So much with us that we forget it all our time." So wonderful is talking. Man vectors innumerable experiences upon the instigating trigger of a sound that has come to have social significance. This sound is but a prelude to the infinitely more elaborate processes that are to come.

The use of the written (or printed) symbol depends on the acquirement of this intervening process. The oral stage is intermediate between the purely kinesthetic-gradient matching process that is the first stage in vision, and the infinitely more elaborate one that must follow when the child must again make a shift, from a verbal vector to a visual. Is it to be wondered that the child prattles, that he says the same word over and over, that he perseverates on sentences and questions; that his conversation is largely monologue? He has such a huge problem in just mastering sound sequences and the setting up of the organization that will allow these quite arbitrary sound symbols to become vectors for past, present, and ever-expanding future experiences. All this happens while he is building a space world. M. D. Vernon, Ph.D., educator, says that his space world is the most important thing a child ever learns. This space world is so infinitely varied and so elaborate that savants continue to write about it and make amazing discoveries about it, for they have come out of the laboratory into the world and have looked about them.

The Process of Vision

There are no mechanisms in the cerebrum for "forming, storing or emanating" copies of the outside world. To the modern scientist there is a distribution of light on retina. In the oscillations constant in the retina, the transformations occurring in the bipolar and then the ganglion layers, the further transformations in the various "levels" through which the ionic volley must pass, the complete reversal of representation in the visual cortex, come to pass the light density gradients that trigger the beginnings of the integrative processes. The total body is not alone an integral part of this process but is basic to it. As Darell Boyd Harmon, Ph.D., Ed.D., educator, once stated, one must consider optics not as free floating, but optics in terms of the supporting organism. Optical systems, no matter how much they have latitudes, must have a canonical position from which to function. Consequently, the child who does not develop, or who is prevented from developing the total bodily mechanism in the symmetrical form it should attain, will be expected to have a warped and altered visual behavior pattern, no matter how perfect the original globe in the socket may have been.

Here is again the matter of the learning of a space world. Learning is the direction of movement. All of the sense modalities would be involved in this learning. So also would be the maturational development of the body. One would not expect the learning of a space world to outstrip the maturation that made such development possible. The culture cannot alone create restraints to the proper development of a complete and adequately learned space world, but it can make demands!

Margaret Meade, Ph.D., the anthropologist, said in a newspaper interview, "I believe that each of these great inventions, language, the use of tools, science, art, and philosophy, has the quality of so combining the potentialities of every human temperament that each can be learned and perpetuated by any group of human beings, regardless of race and of the type of civilization within which their progenitors lived, so that a newborn infant from the most primitive tribe in New Guinea is as intrinsically capable of graduating from Harvard—as the infant born on Beacon Hill. But I believe also that once a child has been reared in New Guinea, Boston, Leningrad, or Tibet, he embodies the culture within which he is reared and differs from those who are reared elsewhere." In this idea emerges the concept of the demands of the culture. Here is the need for a complete volume. The student is referred to Heinz Werner's Comparative Psychology of Mental Development for extension of the idea.

Arnold Gesell, on p. 200 in the book, Vision: Its Development in Infant and Child, comments that the child at 13 months " ... sequentially picks up and releases one cube after another." He notes that " ... this serial behavior simulates counting." "At 1 year, the child spontaneously brings the crayon to bear upon paper" and the few marks are, at 15 months, " ... readily converted into an imitative back-and-forth scribble." At the same 15-month period, the child can recognize a picture. Here are three behaviors which would seem to contain "the genetic germs of the three R's which are destined to make such heavy demands upon the functions of vision in later childhood."

In this short compass has been outlined, ever so dimly, the underlying ideas of the impacts that may affect the orderly development of optimal vision. The child must have the fundamental biophysical and his chemical demands adequately met, else the total process of vision will not be complete. The child must have adequate opportunity to build and construct a meaningful and many-faceted space world, else there will not be the referential framework for the elaboration of vision. The child must have the opportunity to complete the satisfaction of those elaborations that fulfill the demands of the culture in which he must come to fruition. He must have manipulatory opportunity. He must have an opportunity for the bridging of the peaks between kinesthetic-tactile and the verbal, and from the verbal into the abstract.

It may be said that this is the province of education. For the moment, the consideration is being given to the fundamentals of the development of vision. Probably the ideal would be an insightful cooperation between pediatrician, educator, parent and optometrist. Here are being considered the thwarts that bring about the identifiable entities of deviation in the discipline of optometry.

There need be here but brief reference to the fact that physical maturation marches on. As John Paul Nafe, Ph.D., skin researcher, said, "The work on chimpanzees reared in darkness is conclusive." They were 18-month-old chimpanzees in everything but vision. Vision had not yet come into being. Vision is learned and there had been no opportunity for learning. The deprivation was complete. There was no need to subject them to investigation of individual parameters of performance.

They were, to all intents and purposes, blind. That was the ultimate of deprivation. Failures of the organism in the construction of that elaborate process called vision in fulfillment of the needs of the culture are not so apparent, but they are equally disastrous. They are very real deprivations. The number caller, who has been taught a staggering total of number combinations and who does not acquire the realization of the spatial number concept, suffers a visual and cultural deprivation. Until that concept is supplied, either by his own stumbling upon the solution or by artfully instituted instruction, he will have a gap or vacuum or warp in his visual development that cannot be otherwise supplied. The child who does not adequately attain a verbalization, who does not acquire the intricacies of the language, lacks the bridging from the primary visual experience to the vicarious, and will be permanently prevented from achieving complete development of the visual process.

The tough minded asks what that has to do with the fitting of glasses. The answer depends on an understanding of reasons for the application of lenses. During the early decades of this century the public was taught, "When your eyes ache, burn, sting, pull or scratch, or you have a headache, have your eyes tested and get a pair of glasses." The concept has dominated the mind of public and profession ever since.

The Visual Problem

It is the burden of this series that significantly increased achievement is the goal. It is further the thesis that distortion in process will be implemented by distortions in output. The final common motor pathways can be altered. This will, in turn, bring about a torque or stress on the external mechanisms and from that will or would be expected to evolve the manifestations that have so long been labeled ocular defects. They do become ocular defects. However, they are part of the process of adaptation to whatever stress or stresses may be impinging on the organism.

The development of more elaborate means of investigation has brought into the light more and more manifestations of forms of adaptation. Today the refraction, no matter how elaborate, is not enough. Arnold Gesell in a chapter of the monograph by Helen Robinson (Supplemental Educational Monographs, January 1953, University of Chicago Press, p. 133), states, "Refractive errors which yield to optical compensation are not in themselves likely to cause reading difficulties." This coincides with the evidence in the literature that scholastic achievement and "refractive errors" have a very low correlation. He continues, "The use of cycloplegics in refractive examinations interferes with the testing of visual functions at the near distances." This outlines the elaboration of examination from "refractive error" studies at the farpoint, the static concept, to the examination at the nearpoint, a dynamic or functional approach. Gesell continues, " ... but nearpoint is the area where reading anomalies become manifest." This is substantiation of the idea that the near- centered task is the foundation for many problems. Finally, the paragraph concludes with, "Accordingly it is desirable in suspected cases to apply a battery of far- and nearpoint orthoptic tests and visual skills."

Here, indeed, is a paragraph worthy of framing. In recapitulation, it outlines the developments in examination. The stages are set forth from the straight subjective, with the idea of the static eye, to the nearpoint emphasis, the functional approach to vision and, finally, the present-day insistence on skills and achievement tests.

The greatest confusion develops when an attempt is made to rigidly associate certain observable ametropic states and imbalances with definite balks, restraints, or deprivations in the culture. To be sure, some of them do seem to develop linearly. Darell Boyd Harmon demonstrated repeatedly that the axis of the astigmia can quite characteristically be determined by acute observation of the body and head departure from good balance. There is every reason to believe that a high incidence of correspondence exists between developments in the body and other measurements that have been considered wholly visual. These latter include: the rotation of shoulder and scapular position as they relate to associated exophorias or esophorias, and the position of the frontal facial plane coincident with myopia or hyperopia. It is not of prime importance whether the visual difficulty has brought an alteration in bodily formations or whether the distortion in bodily conformations brings about a deviation in vision. The real problem is to understand what has happened to the total organism.

Results of Adverse Changes in Process

The very questions posed above imply some sort of dichotomy between vision and bodily process that is itself impossible when the neural, physiological, and motor mechanisms of vision are recalled. The ocular defects, as end products of deviations in the process, are relatively easy to understand. In the light of the modern concept of progression through time it is easy to comprehend that it takes time for protoplasm to hold trace. The deviation would first show forth in some selected performance test. Then it would start to become manifest, and some degree of measurement could be made. Finally, it would be embedded in structure. This progression through time will be developed and elaborated in these chapters until it needs no restating.

Less easy to understand are the apparently weird and apparently quite useless types of deviation that emerge when refinements of investigation are made. In the series of chapters on the taking and interpretation of skills, there is considered a refinement of visual performances beyond that which can be determined by an analytical or any other method of syndromic refraction. Here are deviations that puzzle the investigator. Why would a given organism take this and that weird type of deviation in space? Unless one held the idea of a fairly simple visual mechanism, with few dimensions of freedom, it would be hypothesized that there would be almost innumerable avenues and methods of exteriorizing the deflections from the optimal in the visual process. The important item to hold in mind is that all of these manifestations are forms of adaptations being made by the organism to achieve the best possible equilibrium despite the impact of whatever stress may be present.

The original degrees of freedom, as determinable from the externalized mechanism operations, would seem to have been these gene matrixed factors:

1. Usable depth of focus in the sheer physiological optics of the human eye. This provided a range adequate to meet the demands of biochemical and biophysical changes for survival
2. The usable range in centering, developed for a like purpose
3. The decreasing range in centering from periphery inward to central vision

This would be largely anatomical, but functionally learned.

It is important to recall the emphasis placed on the notion that this dual mechanism exists in each eye. These freedoms are not held within rigid physical limits. They are largely learned, although there would seem to be no reason to question the idea of gene matrixed magnitude. The shifts in "with" and "against" motion with the retinoscope in the young decrease as growth and learning continue. The early random movements of the eyes, their independence and the slow development of precision in centering, would bring the same conclusion. The freedoms are learned and are, therefore, subject to revision.

Adaptation to Stress

It would seem that these provisions are what is being measured when the refractive state, the imbalances, and so on are measured. The exophorias, the persistent esophorias, the astigmias, at first varying and finally fixed, have a like interpretation. In addition, there is the type of avoidance of high gradient matching that results in vertical differences which have unfortunately been labeled phorias. All these, and many others, are worthy of consideration as revisions of the originally gene matrixed, maturationally directed and culturally guided degrees of freedom. It goes without saying that each and any of them indicate deflections in the visual process that will make it less effective in the total operation. The data from the literature would seem to show, however, that they constitute revisions which make for greater improvement in achievement than would be possible had some such revision not been made.

One recalls the statement from the famed Dartmouth report, Motivation and Visual Factors, Individual Studies of College Students (Dartmouth College Publications, 1942). It points out that an inspection of the table comparing performance and ocular defects reveals that those individuals having the higher scores scholastically were also those who revealed several ocular defects. This lead to a speculation on the part of the examiners as to whether a severe degree of ocular defect is an aid to success in college. Had they defined ocular defect as the end result of a stress within the visual process, denoting the best adaptation possible under the sum total of conditions, they would not have been so puzzled. Baffling indeed are the problems where no such externalized adaptation has taken place. This is the problem confronting the optometrist of the present decade. There are many individuals who cannot meet the demands of the culture, yet who show no such macroscopically or readily identifiable forms of adaptation. They fit into no convenient niche. They do not pigeon-hole readily. They demonstrate inexplicable departures from the standard without any readily available explicit apparent cause. Probably a poll of refractionists could list scores of them from the tortured memory of each. There would be soul satisfaction could some specific cause be assigned each such deviation. To say that every weird performance is another manifestation of deflection in the process, which inevitably must be externalized in some form, is so tenuous as to be almost infuriating. The germ of the truth is there, nonetheless.

Lens Enhancement of Output Performance

To the person who yearns for the security of an absolute, the approach offers nothing. It is far more comfortable to postulate an invariant, fixed, and immutable eye, which knows no change and no variation. That allows a simple mathematical treatment which removes all the paradoxes. Unhappily, as F. C. Bartlett states, "Like every other measure of human function this turns out to be a measure of RANGE." There are some who maintain with the greatest emphasis that there is no change. They blandly state that when change is measured, it is an error on the part of patient or operator.

However, the succession of measurements does show change. Statistically, the data that purports to demonstrate no change, in fact establishes the existence of change. How, then, does this affect the remedial aspect of the discipline of vision? Operationally, the fundamentals of spatial coordinates give rise to the conclusion that the only type of lens which can really restore a rectilinear relationship between the spatial and bodily coordinates is a sphere. Since the fundamental need for lenses is to meet an avoidance reaction, the most effective lens for the restoration of performance is a convex sphere. There is a recognition of the time factor in the development of the exteriorized deflections that become ocular defects. Lens application is adjusted to the point in time wherein the situation is found.

Here is the basis for the directive in lens fitting that, "When the case is in process, as nearly as individual conditions will permit, the lens indicative of an ocular defect is omitted from the prescription." There is a recognition of certain hierarchical levels of development in vision. Lenses are both a preventive and a palliative. They are preventive when used to shield the organism from the original unavoidable impact of the culture. The socially compulsive visually near-centered task is biologically unacceptable.

Note the emphasis on "socially compulsive." The organism, free to move, to avoid, to escape, to be free at will, need not construct a visually deviated pattern. However, freedom to move is a many-faceted concept. The demands of the culture are to be taken seriously. They form a binding that limits freedom.

The ape does not start a number concept at 13 months, nor show an emergence of a writing drive at 15 months, nor does he pick out and recognize pictures. The chimpanzee does not develop visual problems in the understanding of the term as used in these chapters. The visual problem demands an intellectual level not possible to the ape. He lacks the mechanism for it. Ward Halstead says, "Wisdom resides in the frontal lobes." One is almost tempted to say that visual problems have their abode in the same place. However, it would be absurd, needless, and misleading to even hint at such a rigid localization.

Vision is too permeating. It is the dominant process in the human organism. Body posture, metabolism, nutrition, and so on, to whatever elaboration the courage of the relater permits, all are included in vision. However, the most important function of vision to man is the development of abstract thinking. This entails the ability to vector enormous elaborations of synthesis and abstraction on a triggering that comes from contrast patterns. These contrast patterns are meaningless save as society has agreed on their meaning.

This agreement on meaning comes to be available to the child and the adult through long and laborious practice. It is physically based and visually transported. A deflection in the visual process impairs some degree of the ability. The lens localizes away and restores some magnitude of that degree of freedom. In accord with that degree of freedom, there will be restored the operation of the total process for vectoring elaborated experience. When time has supervened, and determinable and measurable changes have taken place in the external mechanisms, lenses become necessary to restore perceptual rapport with the environs. This is that final phase in vision wherein lenses become prosthetic devices.

It is possible to build a very effective approach to the care of the visual mechanism on the basis of lenses alone. This would be elaborated somewhat as follows:

1. When the subject is being placed in the impairing environment of school or industry, if no visual impairment is detectable, lenses are supplied to shield the process from stress in advance of its impact
2. When the stress has produced a measurable distortion in the external structure, manifested as a measurable refractive "error" or imbalance, lenses are fitted on a performance basis with the actual measurements serving as a guide for the amounts. This is the stage of the directive that "when the case is in process, the lens prescribed is in advance of the amounts indicated in the nearpoint findings."
3. When the exteriorization of the deflection in process has proceeded through time until the organism has "grown along the line of stress to reduce stress" and has changed supporting structure, then compensatory lenses are fitted in accord with the measurements and the social acceptability concept.

Remedial Measures

By this approach, a whole program of visual care can be laid out and a reasonably satisfactory approach made to coping with the visual problem. The limitation, however, is that it is only a reasonably satisfactory approach. Emmett A. Betts, by direct statement (Foundations of Reading Instruction, American Book Company, p. 175), and Arnold Gesell, by implication (Clinical Studies in Reading, University of Chicago Press, p. 133), bring the idea of the need for optometric visual training that accompanies, and in many cases is necessary to, the acceptance of the necessary lens. It would seem that there is a certain sequence of objectives necessary in a schema of visual training. When there is a demonstrable break or delay in the space-time relationship between effector and receptor (F. C. Bartlett, The Measurement of Skill), there would seem to be a need to restore this relationship before anything demanding more elaboration is instituted. This is postulated on the concept that the simple procedures used for this basic approach are, in fact, elementary. It is readily conceivable that they may not be.

Should the child not have made those very bridging shifts, to which reference will be made in these chapters, the deprivation in vision development would be far below the levels indicated by the familiar rotations, fixations, accommodative rock, and so on. Visuo-spatial relations of many sorts are the complex of which vision is built. Precast ontogenetically, as Gesell has opined, these are demands of the culture. The hand and eye development may not have brought about adequate writing. The visuo-spatial concept of numbers may have been left undeveloped, and the child may have rote learned number combinations. The bridge in speech may not have been completed. Such being the case, the child, the adolescent, and the adult will come to the office with a myriad of substitute performances beautifully developed to disguise and conceal the really basic problem. It was Thurstone who determined that the one test shared by all who showed high intelligence was the ability to see three dimensionally on a flat surface. Consider Thurstone's list of primary mental abilities: number facility, word fluency, visualization, memory, perceptual speed, induction, and verbal reasoning. In the light of the developmental sequences and the organizational complexes that have been advanced in this chapter (and subsequent ones), see how beautifully these all show evidences of some parameter of visual performances.

When these abilities are lacking, they should be provided. Every part of the visual mechanism is accessible. Gesell says that "it is desirable in suspected cases to apply a battery of far and near orthoptic and visual skills tests." In the same article he suggested an analytical examination. This determines the relationships existing between the ranges of subsystems of the visual system, those great movement pattern systems of identification and centering. The actual manipulation in space, as investigated by the character of the skills tests themselves, has been altered, distorted, or abrogated.

Finally, it is being suggested that there may be value in probing the even more fundamental skills, those that have been labeled as intelligence. How far the optometrist should go in this dimension of his discipline depends largely on his own ultimate definition of vision. Ward Halstead once said that when we investigate vision, we are not going from vision to intelligence; they are one and the same process. He should know. He made a factor analysis of biological vision—and all the factors turned out to be visual in origin!

This article is a powerful one for the optometric community. It provides readers with the notion that an eye problem is very different from a visual problem, and our approach in the eye room should reflect that.

Before any of my formal training, I used to believe vision was just about clarity. I have come to realize that vision is more than being able to read 20/20 on the visual acuity chart, and it is people like Dr. Skeffington who helped shape that evolution. The definition of vision we should subscribe to is "the primary purpose of the visual system is to derive meaning and direct action." He emphasizes that vision is the ability of a patient to perceive the world around them, take in the surrounding information, process it, and then do something with that information. It is the ability to integrate skills (acuity, visual efficiency, visual processing) and most importantly, understand them. It is derived and acquired based on prior experiences that a person has with their environment over time. Everything we do is directed by vision and then perceived as an output.

Each optometrist is free to define their own model of vision. This article was so important and allowed me to better understand the principles of vision and how it affects performance. As I continue throughout my optometric journey, my model of vision will continue to develop and change as I hope will the optometric community's.

—Tina Esposito, OD

Skeffington makes a brilliant, well-rounded, and irrefutable case for the importance of nearpoint, functional, and developmental optometry. He synthesizes biomechanical, socio-economic, and neurological factors to create a sound foundation for the work that we, many decades later, rely on (whether we know this directly or not) as the basis for a behavioral/developmental mode of optometric practice. I felt that this was as relevant today as it was ahead-of-its-time when it was written. If you have not read Skeffington's work, I cannot recommend it highly enough. If you have read Skeffington's work, it might not be a bad idea to have another crack at it. You will very likely get something new out of it, since you are something new yourself. It is thanks to works like this that optometrists change lives every single day in every corner of the globe.

— Steve Gallop, OD