21

LECTURE NOTES

on

STRABISMUS

by

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I. ORGANISMIC LAWS THAT PERTAIN TO VISUAL TRAINING

A. The purpose of visual training is to bring about a better adjustment of the individual to his natural surroundings.

Therefore, training conditions should be made to simulate natural surroundings as nearly as possible.

B. There is an organismic tendency toward full use of existing abilities.

Question: What, then, causes visual concessions?
Answer: Concessions occur when there is a lack of demand for all existing abilities.

Question: If there is a natural tendency to make use of all existing abilities, why do we need visual training?
Answer: Visual training if it is properly applied, makes a demand for all existing abilities.

C. There is a natural tendency toward completion of a contemplated act and to accomplish it with the least expenditure of energy.

We are usually determined to complete a task once we have started. In visual training of the child things go well until the given task is completed, but once it has been attained repetition is not interesting. Renshaw says that if we get five minutes of actual training per hour spent, we do well.

D. It is the nature of the posture which determines the nature of the responses.

The above statement means this: while the eyes are in a strabismic posture, the individual thinks strabismically, but the minute his eyes are in a normal posture he ceases to think strabismically and thinks the way we do. The shift from strabismic to normal posture brings about a complete change in his interpretation. This means that when he looks at a small target with both eyes directly, he cannot think strabismically; he must think the way we do. However, the shift from strabismic to normal posture cannot be accomplished without a change from wanting to look at a given fixation object with one eye only to wanting to look at it with both eyes simultaneously.

Binocular interpretation does not have to be taught! We don't have to break down anomalous retinal correspondence in order to establish normal retinal correspondence. Our sole purpose in visual training is to posture an individual adequately, and when that has been accomplished the rest comes easy.

We need controls. We need to know when we have normal posture and when we do not. No training instrument is worthy of its name if it does permit us to differentiate between what is normal and what is not. And no orthoptist is worthy of the name if he cannot differentiate between a substitute performance and a true performance. This is not a simple problem. It is not easy to determine when a child trains in a constructive way and when it simply performs to satisfy "minimum requirements". To differentiate between purposeful and "lackadaisical" performances takes adequate controls. Unless we have such controls we cannot hope to maintain a high level of response.

Binocular posture is the ability to maintain such relative eye positions in anticipation of a certain visual task that both eyes directly fixate a single object of special regard: Binocular posture means, essentially, "looking at a single fixation object with both eyes, at the same time."

Not all individuals who are adjusted to their natural environment depend on binocular posture. There are two other forms of posture around which an individual may successfully organize his seeing: (a) maintaining posture with one eye only, or monocular posture, (b) maintaining separate lines of direct gaze for each eye, or strabismic posture.

Maintaining monocular posture, means that only one eye fixates the object of special attention. The eye that looks at the object of regard is the eye that is used for the cortical interpretation of that object. The other eye is not used for that purpose. The other eye may be looking in an entirely different direction. This eye may have, at the moment, a perceptual purpose or it may not. The question now arises, is it used for any other purpose? If it has no other purpose, is kept in "cold storage" so to speak, we have monocular posture, for what the other eye is doing at the moment is of no interest to the organism.

Maintaining separate lines of direct gaze for each eye, or strabismic posture. In the sense defined here, it does not include all strabismics but is limited to those who are ambiocular in their visual behavior. The term "ambiocular" describes a condition where both eyes are used for separate and distinct purposes. That is, they attend to different functions at the same time. We find this posture in "anomalous projection" of alterating strabismics.

My investigations into the nature of ambiocular vision have definitely proved that these strabismics can look in two directions at once and interpret the macular images of both eyes simultaneously.

If you play the piano with one hand, it does not prevent you from playing some other chord with the other. If you cannot coordinate both hands in this way, you may concentrate your whole attention on the one task of playing the same tune with both hands. It takes more skill to play different measures with each hand than to play the same tune with both hands. The former ability illustrates the ambiocular strabismic, while the second exemplifies normal binocular vision, and playing the piano with one hand corresponds to uniocular posture.

You may write "cat" with the right hand while writing cat mirror-fashion with the left hand. This is easier of accomplishment than writing the word cat with both hands in a left to right direction. The latter requires an entirely different posturing mechanism for the left hand than for the right, while the former may be done with a single posturing effort for both hands. This may serve as a simile to show why binocular posturing is cortically less difficult and requires less mental effort than strabismic posturing. Monocular posturing is still less of an accomplishment, which may be the reason it is frequently found in the mentally deficient. In my own investigations I have never encountered a strongly integrated ambiocular percept in very young children or in individuals of low intelligence. All evidence points to the fact that strabismic posture is much harder to learn than binocular posture and that its acquisition denotes a high achievement level, visually speaking. For the same reason, once this posturing ability has been attained, the individual is not readily willing to give it up in exchange for binocular posture, unless the latter heightens his accuracy of spatial orientation for exceptionally demanding tasks with which he is being confronted and which cannot be solved while maintaining strabismic posture.

The term "strabismic posture", as above defined, represent's the sort of visual behavior which I have variously called "anomalous projection" (of the most accomplished order) or "ambiocular vision". It is often referred to in ophthalmological literature as "anomalous retinal correspondence", "vicarious fovea", - terms which are usually promiscuously given to essentially ambiocular and uniocular alternating postures.

It used to be my implicit belief that we had to "break down" anomalous projection prior to making any attempt to "building up" normal projection. This seems no longer justifiable because, strictly speaking, you cannot "break down" learned concepts. You may suppress them by presenting the individual with new and different demands which require new learning. If such learning is directed toward our eventual goal, the undesirable, (from our point of view) patterns, may gradually be replaced by the more desirable patterns and may eventually disappear from consciousness because of disuse.

When a binocular posturing attempt is made by an individual having strabismic or uniocular posture, the response will be of poor quality, but, since it will be based on a binocular field structure, it will be capable of interpreting retinal disparity in terms of depth variables; i.e., it will have stereoscopic qualities, provided stereoscopic demands are made.

Since stereoscopic demands require binocular posture, such demands may serve as a "special task" in an attempt to elicit binocular posture with the strabismic.

E. Varying perceptual demands may bring about varying postural sets.

1. An individual, who is capable of binocular posture, may at certain times maintain uniocular posture, if the latter involves less effort and the visual task can still be completed.

This is one of the most important tenets in visual training. It raises rather interesting questions. Why should an individual maintain accurate binocular posture when he can complete the task to his entire satisfaction with a less effortful posture? There is no organismic reason. It is therefore essential, in an effort to improve or establish binocular posturing ability, to present the individual with the kind of task which requires for successful completion exact binocular posture. An individual who habitually maintains uniocular posture can see no reason why he should make a greater effort at obtaining visual data which can be gained without such added effort. Such effort would simply be an "added burden", added energy expenditure, and without organismic purpose.

An individual who uses binocular posture can bring two pointers tip to tip. This an individual who depends on uniocular or strabismic posture simply cannot do, because the task is above his accomplishment level. It is important to know that pointers may be used to force an individual to maintain binocular posture.

I may point out here that the use of pointers, the way they are applied in "pointer training" in the stereoscope, does not fulfill the above requirements. This is so because the individual who is capable of rapid alternation of fixation can achieve more accurately by far, if he maintains alternate fixation than if he attempts binocular fixation while he performs this task.

It is common practice today to use stereoscopic photographs for binocular fusion training which contain a vertical white line in a certain area of the total field for the one eye, and a horizontal line in the corresponding area of the total field of the other eye. This may be permissible with individuals who are known to possess well integrated binocular field structures. However, it is readily demonstrable that the individual who has a strabismic posture can interpret these photographs to the entire satisfaction of the technician by alternate fixation and, by doing so, the patient himself will be of the opinion that he sees both pictures as one, containing a perfect cross. He arrives at his interpretation via two consecutive impressions by the simple expedient of "temporal fusion", even as we achieve temporal fusion of successive pictures when they are presented to us by means of a motion picture apparatus. In fact the Keystone "moving picture" slides for the Telebinocular are based on the same phenomenon. Such controls are patently inadequate for differentiating between binocular and strabismic posture, yet they are presently almost the only ones on which any reliance is being placed in vision training.

2. An individual habitually maintaining strabismic posture may, for certain heightened perceptual demands, use binocular posture if the latter is necessary for the successful completion of the task. That is something we have not known, but it is nevertheless true. If a task is difficult, the individual has two possibilities - ignore it or reach high enough to achieve it. The difficulty, of course, is to know what is "reachable" and what is not. It holds true in all training that it is harmful to work above the individual's achievement level.

F. The individual who possesses binocular posturing ability has a higher achievement potential than if he were lacking in that ability.

The individual who knows how to posture binocularly can therefore be confronted with a more difficult visual task than the individual who does not know how so to posture. Again, how high an individual can reach visually has diagnostic significance.

We can separate the individual who can and will posture binocularly (no matter for how short a time) under specifically arranged conditions from the individual who is totally incapable of binocular posture.

Centered corneal reflexes of a light which has been brought to the "crossing point" of the visual axes do not necessarily indicate that fusable targets can be brought into "retinal correspondence" by adjusting an instrument to the existing angle of strabismus (amblyoscope, synoptoscope, etc.)

Even in a push-up test, where there seems good indication of "binocular fixation" over some range, it is not possible to tell whether an accurate or an inacurrate posture is being maintained. A much more accurate way of telling is to observe the individual's ability to achieve at certain tasks. For instance, if he is capable of the extremely accurate spatial orientation which is necessary to successfully complete the Pointer test, we are assured that he is capable of accurate binocular posturing ability. This also means that, while he maintains such accurate posture, he is capable of interpreting with satisfactory stereoscopic accuracy. If he does not achieve, it means simply that we have not been able to provide the sort of test conditions which will make him reach for the highest visual achievement of which he is capable.

It is legitimate to come to conclusions by inference. If an individual is left in an empty room with a piece of clean white paper and a pencil, and he afterwards shows a written page and a used pencil, it is permissible to infer that the individual wrote what is on the page. It is also possible to deduce with which hand he wrote it, if his handedness is known and copies of his hand writing are available. If he attempts to write with the non-dominant hand, this will be readily apparent from the nature of his characters, because it would be almost impossible for him to simulate with his non-dominant hand writing done with his other hand. You could infer these facts only because you had something to compare. We know, for instance, that writing with the dominant hand is far better integrated, more ballistic, than any writing that may be attempted with a hand entirely new to the task. We also know that this skill is not easily transperable from one hand to the other.

How well an individual is postured for a task is indicated by the ease, the fluidity, with which the task is completed.

Normal binocular vision depends on binocular posture. The two terms are actually interchangeable. We cannot separate binocular vision from binocular posture nor can we separate binocular posture from binocular vision.

G. Binocular posture makes possible the appreciation of the different viewpoints of the two eyes looking at objects from different stations.

(a) the difference in the proximal stimulations received by the two eyes because of their separated position in the skull-is organismically interpreted as depth variables in stereoscopic perception.

(b) Accurate stereoscopic ability depends on (1) maintenance of accurate binocular posture; (2) an organismic desire to achieve; (3) the ability of both eyes to see clearly.

H. The specific purpose of all visual training is to bring about an adequate binocular posture which, in turn, guarantees the greatest adequacy of the visual responses of which the individual is capable.

II. THE MEANING OF RETINAL CORRESPONDENCE AND RETINAL RIVALRY IN VISUAL PERCEPTION

From a diagnostic point of view it is important that we know how to interpret retinal rivalry. Retinal rivalry is dependent on the existence of corresponding retinal areas. Before we can discuss retinal rivalry adequately, we must know more about the meaning of retinal correspondence.

I. RETINAL CORRESPONDENCE

We come back to the fundamental concept of retinally corresponding areas in the two eyes. I am prepared to say that in all cases the two foveas are such corresponding retinal areas. Once this concept is clearly established we shall have no further trouble with any of the visual training concepts which will be considered here.

A. Corresponding retinal areas are invariably equidistant and on the same side of the two foveas. No other areas are acceptable as retinally corresponding areas. There are no "secondarily" corresponding retinal areas - which are not geometrically corresponding - not even in strabismic posture or in the so called anomalous conditions. The two foveas are always retinally corresponding. Let us be clear on this one thing: there are no possible exceptions to retinal correspondence, as above defined. All responses which make it appear as if there were anomalously corresponding retinal areas are artefacts which have a different explanation. If we define retinal correspondence as fovea to fovea correspondence, our thinking becomes specific and we may lay out clear programs for visual training - programs which are not possible if we accept the theory of anomalous retinal correspondence. Acceptance of the concept of abnormal retinal correspondence, provides a very real reason why strabismus, which exhibits this supposed form of seeing, cannot be cured.

Let us assume that an area ten degrees off the fovea of one eye, has become corresponding with the fovea area of the other eye in a binocular field percept. How can we possibly change such a relationship? When an individual once has acquired this relationship he has no incentive whatever to give it up, especially if he can also have full stereoscopic perception. (Duke-Elder)

True, there are many individuals maintaining eye positions, which are within ten degrees of parallellism. Such individuals may have a very low grade peripheral stereo-awareness but they invariably show strong macular suppression. When the suppression is lifted, fovea to fovea correspondence is always immediately apparent. These conditions will be discussed in greater detail under the heading of "Retinal Slip".

The concept of fovea to fovea relationship in all binocular sensory fields is vital when we seek to determine adequacy of binocular posture. In accepting the presence of a binocular sensory field we must assume the existence of fovea to fovea correspondence. How else could we measure? If we use the phoria test of the Keystone Visual Survey Series for infinity, the position of the arrow in relation to the numerals which are visible to the other eye cannot be interpreted in terms of retinal positions unless fovea to fovea correspondence exists. When the arrow appears to point at the numeral 9, we must be able to assume that the two eyes are in exactly parallel position. If we could not make this assumption, the phoria test would lose all meaning, because we would have no means of determining the shift in retinal correspondence which would be "normal" for the particular individual and for none other. We should have no measuring stick.

But measurements are possible. Under normal conditions, when the arrow points to number 8 or number 7, it is possible to state in mathematical terms how many degrees the eyes are out of alignment. This we can do because the centers of both foveas are the points of reference from which all these calculations can be made. Phoria measurements can be made as accurately as we can measure the distance between two cities on a map, provided we know the exact scale of that map and are assured that it has been drawn correctly. If the map were drawn by approximation instead of by triangulation, these measurements could not be interpreted. In order to determine the distance between two cities, we put the points of the calipers in the center of the two city areas and always use these same points to make comparison between different cities on this map. Without such specific points of reference there can be no accurate interpretation of the map. We could not, for instance, measure the length of a table, if one end if it were hidden from view. The center of each fovea represents, in like manner, the unchanging point of reference in ocular measurements of all kinds. If only one foveal center were available, no measurements could be made. This is an important consideration in amblyopia. In amblyopia the center of one fovea may be necrotic, i.e., incapable of conducting nerve impulses to the brain. In an amblyopic eye the blind area is apt to include and surround the center of one fovea because of a central scotoma. This means that the individual cannot fixate along the primary axis. However, it is this axis, and this axis alone, that reaches the retinal point which must serve as the locus from which measurements are to be made. As long as we have the fixation point of the other eye, we can draw a circle around the blind area of the amblyopic eye. This circle is visible to the patient while its center is not. If it is possible to align the two eyes in such a way that the circle is phenomenally centered around the fixation target of the good eye, the center of the circle can be used as the second point to which to apply our measuring stick.

Even in an eye with a central coloboma, in which case there is a large visible destruction of retinal tissue, we can present this eye with a large enough circular target (a ring) to surround the entire coloboma. This ring may be centered around a spot source of light, which is visible to the fixating eye only (the light falling into the blind area of the defective eye). The relative alignment of the two eyes can now be accurately determined. By this method it is possible to plot the scotomatous area of the affected eye, but only because the relationship between retinal areas of the two eyes is always the same (while a binocular perceptual field is maintained).

B. Retinally corresponding areas cannot exist where there is no binocular perceptual field (as above defined). We know that a simultaneous percept is possible in certain forms of strabismus where the two eyes are not in normal alignment. In this case the two foveas are never in permanent relationship to each other, as Verhoeff has so ably demonstrated. The centers of the respective foveas can therefore not be used as a measuring-stick for binary visual perceptions.

Two films, taken with the same camera, from the same point, can be laid on top of each other so that like images are superimposed and a single clear print can be made thru the two films. On the other hand, even if the prints are shown separately each can be interpreted accurately and independently of the other.

C. Ambiocular (strabismic) perception seems to be dependent on the retention of two cortically separate sensory fields, which obviates the need for retinal correspondence.

Experiments show that in strabismic posture the cortical images produced by the right and the left eye are separately considered and that their closure into a single unitary percept is obtained by a process of abstraction (a frontal lobe process). The strabismic learn to accept the right and left images of a single object as belonging to that object, just as we can learn to accept by the same process a mirrored object as being part and parcel of the real object. The two images are never fused, as I have shown in my investigations relative to strabismic seeing. It can be demonstrated that in these cases a binocular sensory field does not exist, but rather two separate sensory fields, one for each eye. For this reason an anomalous horopter is never formed.

D. Difference between binocular and ambiocular sensory fields.

A binocular sensory field may be compared with two films being laid on top of each other for inspection. When variations in photographs of an object (because of the different locations from which the pictures have been taken) are superimposed they may be interpreted stereoscopically. A binocular sensory field percept is neither a right nor a left percept but differs materially from both. On the other hand, an ambiocular field percept constitutes a summation of right and left percepts. In the total field of the strabismic a certain area is foveally perceived by one eye and another area is foveally perceived by the other eye, resulting in two well defined areas of clear vision in the total percept. Each clear area is seen exactly as the corresponding eye sees it.

E. The presence of a binocular sensory field does not necessarily mean that we have a single spatial percept. A single spatial percept is possible only when binocular posture is available.

Suppose that we make binocular posture temporarily impossible by the elevation of one eye above the other by means of a base down prism. The fixation object can no longer reach corresponding retinal areas and it is seen double. This means that even though the binocular field persists, accurate binocular posture cannot be maintained. It is evident that we must differentiate between "usuable" and "non-usuable" binocular fields. Elimination (by suppression) of an unusable binocular field is difficult, and sometimes impossible with individuals who have fully matured before the eyes were thrown out of alignment. The use of prisms is definitely indicated when a non-usable binocular field can thereby be made usable. In a non-usable binocular field the spatial concept is distorted because of the very existence of a binocular field and accurate spatial orientation becomes dependent on the resumption of adequate binocular posture. When that is not possible, total occlusion of one eye will give temporary relief.

Suppose a binocular amblyope with 20/200 vision in both eyes. How can we know whether he has a binocular field percept or not? When we put a six degree prism base down over one eye, it is of diagnostic significance whether or not this prism produces diplopia. If diplopia results and the two images can be vertically aligned by addition of horizontal prism, it indicates that the amblyope had a usable binocular field prior to the introduction of the vertical prism. On the other hand if no diplopia is produced, we must assume that a binocular field does not exist. Establishment of a binocular sensory field is desirable because it will heighten the visual achievement level of the individual.

F. Adequate phoria measurements through 4 to 6 prism dipters of vertical prisms (over one eye) indicates the existence of a satisfactory binocular field. When the responses to these tests are uncertain, the existence of strongly established binocular visual percept can be doubted. When phoria measurements cannot be made through the above amounts of prisms, it is questionable whether a binocular field exists at all. When you cannot make phoria measurements easily and speedily, watch out! Be sure you are dealing with measurements and not with approximations. Remember that vertical diplopia may also be produced by base down prism (over one eye) with an individual who has a strabismic posture. But it usually takes more than six degrees to produce diplopia. The strabismic can bring the double images above each other, after a fashion, but he will usually give you a definite clue that his percept has been arrived at by abstraction rather than from retinal position. A patient of this type will almost invariably say "I think that the two images are now above each other", or that "one seems to be to one side and the other to the other side." It usually takes several degrees of base-out or base-in prism before he is aware of a lateral shift between these two images. The responses are always uncertain and sometimes quite unpredictable. The strabismic usually (but not always) refers the right retinal image as being to the right of the left retinal image, whether he is an esotrope or an exotrope. When double images produced by vertical prisms are reported to be in close proximity, we know that the patient projects according to his learned strabismic habits. It is, then, of no further significance whether he reports the one to the right or to the left of the other. No effort should be made to align them by the use of lateral prisms. The same holds true when an exotrope reports uncrossed diplopia. Such diplopia is evidence of strabismic posture and time spent on "aligning" the two images will simply be wasted.

In an effort to differentiate between strabismic projection and normal projection it is never advisable to use more than 4 to 6 prism diopters of vertical prism. If the test remains negative with that amount placed first base down and then base up over the same eye, the existence of a binocular field percept must be doubted under these test conditions. The nature and extent of a binocular field structure will have to be determined by other means. It is a red signal! The question now arises: Are we dealing with suppression or strabismic seeing?

To differentiate between an ambiocular and a monocular field percept, it is advisable to use a stronger vertical prism (ten p.d.) to determine whether or not diplopia can be experienced. When a four p.d. vertical prism produces diplopia, we may conclude that total suppression did not cause the prior lack of diplopia. We are then justified in assuming that an ambiocular field percept, adapted to the strabismus, exists on the assumption that an ambiocular field percept pertains a percept adapted to the strabismus.

The more vertical prism that is needed to produce a sense of diplopia, in a strabismic, the less adapted he may be deemed to be.

2. RETINAL RIVALRY

A. When the proximal stimuli, which reach corresponding perceptual areas of the two eyes, emanate from different objects in space, they are unfusable and under certain conditions may rival with each other for recognition.

The above holds true only under certain conditions. Retinal rivalry is lacking when one eye is suppressed. But it is not always possible to suppress totally all the stimuli that reach the cortex via one eye. If suppression does not occur, retinal rivalry results. This means a shift of dominancy from one eye to the other, neither eye being able to gain prolonged complete control. Washburn claims that all binocular vision is based on retinal rivalry and that without it there cannot be any binocular vision.

The rules governing retinal rivalry and suppression have been discussed elsewhere.

B. In a binocular field structure two unfusable macular stimulations create field stresses which are apt to interfere with the adequacy of spatial orientation.

The retention of two unfusable macular images is, as a rule, unacceptable to the organism. When a binocular field structure is present, retention of fusable macular images is of primary importance to the organism. (This does not hold true for peripheral imagery). If two fusable macular images are not maintained, one of these images must be totally suppressed. (This condition will be discussed under "Retinal Slip"). We must maintain fusable macular images to be comfortable, provided we maintain a binocular field structure.

C. If an individual finds it impossible to maintain eye positions that make fusion possible (binocular posture), he will make a determined effort to suppress all proximal stimuli which reach the less dominant eye, thus eliminating the field stresses which interfere with the adequacy of spatial organization.

That occurs when like images cannot be maintained on the respective maculas. Spatial adequacy cannot be maintained unless one image is eliminated.

One way to solve this problem is to change an inadequate posture to an adequate one, thus providing the two maculae with fusable images. If this is physically impossible, a determined effort may be made to throw the two eyes into greater disalignment, so that the non-macular image of the fixation object becomes so poorly defined (because of its peripheral location in the turned eye) that it can be easily suppressed.

D. The organismic tendency is always toward elimination of retinal rivalry, if it interfers with the clearness and quality of the macular image.

Retinal rivarly (particularly in the macular areas) is the most troublesome attribute in a binocular field percept when binocular posture is lacking. It is of primary importance that an individual maintains a clear and unencumbered view of the fixation object. If the macular stimulations of the turned eye can be ignored, i.e., prevented from reaching conscious awareness, the clearness and quality of the macular image of the fixating eye are thereby greatly enhanced. Uniocular suppression is therefore always practiced first in the macular area of the turned eye. It may be gradually extended to the paramacular areas and eventually may invade the peripheral areas as well. However, such suppression never materially affects the capacity of the suppressing eye to see clearly in a uniocular percept, i.e., when the normally fixating eye is occluded. Macular suppression is a process of adaptation to a new visual requirement and has to be learned.

E. The strengthening of retinal rivalry by visual training is contraindicated with individuals who are incapable of binocular posture.

This is a new concept but follows logically from what we have considered before. This concept is, at present, frequently violated in visual training.

When a strabismic patient is incapable of binocular posturing we have no right to attempt to establish retinal rivalry. It would interfer with his spatial adequacy. The proponents of this procedure claim that by developing retinal rivalry the patient may "straighten", or if he does not, he may then be operated upon with a better chance for a binocular pattern of seeing after operation. This used to be my own attitude toward the strabismics. However, I have found that the individual who shows no incentive, under any conditions, to posture binocularly prior to the acquisition of a binocular field percept, very rarely shows any more desire to straighten his eyes after a binocular field percept has been forced upon him. It is these individuals who develop the dread fusion aversion which is known as horror fusionalis.

Today I feel it much more advisable and certainly much easier, both for the patient and for the technician, not to develop retinal rivalry until the doctor is assured that the patient can (under certain test condition) posture binocularly. Where this assurance is lacking, I find it advisable to have the eyes straightened by operation, prior to any attempt on my part to establish a binocular field percept, and then to develop the latter by slow degrees.

The usual approach to strabismus is the establishment of binocular seeing, even if this had to be done with the eyes in strabismic posture. A binocular field structure is forced upon the individual by means of instruments which can be adjusted to the existing angle of strabismus. This normal binocular responses are being elicited with the eyes in a strabismic posture in the hope that, once fusion has been attained, it can be used to reduce, by gradual steps, the existing angle of squint.

This procedure is no longer acceptable to me. Instead, I limit the training for binocular field percepts to the particular situations where I have found that a patient has shown a desire for binocular posture. By doing this, I find that the patient learns to associate binocular seeing with binocular posture and, what is more important, to reserve binocular seeing to those visual tasks for which he is willing to posture binocularly. When he returns to strabismic posture, he also returns to strabismic seeing. This is the orthoptic procedure which I am following successfully today and which I am advocating for adaption by others.

Today, we are very careful, not to develop binocular field awareness in situations where it is not usable. We fear that projection of binocular field awareness into consciousness under such circumstances may result in its rejection in good and bad situations alike.

This new method is applicable in cases of paresis where concomitancy of rotations is lacking, at least in the areas controlled by the paretic muscle (s). It is possible to teach an individual to maintain stereoscopic awareness in those areas of his surroundings where he can posture binocularly and to let him maintain uniocular or strabismic posture (and uniocular or strabismic thinking) in those areas where binocular posture is not possible. The two modes of vision can co-exist.

It is quite all right to assume that if we make a strabismic sufficiently uncomfortable visually, he will straighten his eyes. Frequently that is so, provided only that he can keep the eyes straight. Unless we have definite evidence to that effect, we have no right to follow out the above reasoning.

When the patient resents the establishment of binocular field processes (usually for good and valid reasons, which we may not be able to recognize), and we nevertheless insist on establishing them, a conflict arises. Such conflicts are usually lost by the doctor. Many patients, who show ability to maintain straight eyes, feel that it is easier to maintain a slightly esotropic or exotropic position when looking at distant objects, although they are perfectly willing to maintain binocular vision for close range. I used to spend an immense amount of time in an effort to change this situation and occasionally succeeded in getting the patient to maintain adequate binocular posture at far (at least while he was in my office), only to discover, that after the patient had been discharged for a year or so, he usually came back with slightly strabismic posture at far, but maintained comfortable vision with constant binocular fixation at near. Further, such patients usually showed ability to maintain binocular posture at far for occasional heightened perceptual needs, whenever such needs arose.

We have learned by hard experience that it does not pay to establish certain visual patterns contrary to organismic desires. The organism must be considered first and foremost. Frequently its needs are not expressed in a desire for straight eyes. If the patient could have them as easily as he can wear a new suit of clothes, there would be no problems in strabismus. But even the best-looking suit will not be worn long, if it is uncomfortable. No man in his right senses would prefer to wear full dress clothes the year around, but he is willing, for the sake of appearance, to wear them on occasion. Many strabismics, who find it more confortable not to maintain binocular posture, will maintain it on special occasions. They are usually contented and happy, until we try to convince them that they should no longer continue in that state.

It is, therefore, always important to raise the questions; "Is it of sufficient consequence for the patient to undergo the visual training which I propose for him; to spend the time and money; or am I doing this simply because I am a perfectionist?"

F. <u>Binocular luster may be considered a form of retinal rivalry.</u>

Binocular luster, which is an incomplete color mixture, results when two corresponding functional areas are stimulated by different, undifferentiated colors. Let us suppose that we keep one eye closed while we gaze with the other eye at a blank green wall. When a pocket flashlight is held against the closed lid, so that its beam of light is directed toward the anterior pole of the cornea, an even reddish glow pervades the entire eye. We now have two areas of indifferentiated color - green in the open eye, reddish in the closed eye. In ambiocular (strabismic) vision the patient will state that he sees a green color with one eye and a red color with the other eye. This is so because there apparently is no color mixture in ambiocular vision. When a binocular field percept is present, the green wall is seen as if thru a red glass. The wall may at times appear quite red and at other times quite green. Its color is apt to vary between those two extremes. Under the most stable conditions the perceived mixture may be an even reddish-green.

The resultant color is not determined by the known laws covering color mixture. If we could inspect the phenomenal wall by means of a microscope we might find that it consisted of miscrosopic areas, which would show either all green or all red, as would a Kodachrome film which had been exposed to a red and green indifferentiated field. It would also be possible to determine that the mosaic of red and green would be constantly changing, green areas turning red and vice versa. This is the phenomenon of binocular luster. Its presence is an indication of a binocular sensory field. It also means that the other attributes of binocular vision, stereoscopic perception and retinal rivalry, are available under suitable conditions.

G. Testing the color-mixing ability of an individual in the binocular luster test is a useful means of differentiating between binocular, monocular and ambiocular field structuring. The first shows an incomplete color mixture; the second the perceived color of one eye only; the third two adjacent (sometimes slightly overlapping) areas of unmixed colors, splitting the total stimulated areas in half.

This method of differentiation is eminently usable. The only reason it is not universally applied is that we know so little about its meaning. It is essential that we spend much more time and thought on this problem; it will pay good dividends. I believe that retinal rivalry is destined to become one of the most important visual training means of the future. We haven't even begun to use it intelligently. I am happy to know that retinal rivalry rates are being investigated in routine optometric procedures.

Measuring the retinal rivalry rate of parallel lines running in opposite directions for alternate eyes - whether by color separation (BSM technique) or by polarization (Renshaw's technique) - is of great importance and will result in a better understanding of visual functions, as soon as a sufficient number of tests are available to compile statistics. There is no reason why retinal rivalry should not serve as a means of determining the quality of binocular seeing. Further than that, depending on how the patient reports seeing the lines, it is possible to state whether the patient has binocular, ambiocular or uniocular vision at the time the test is made. It is well worth while to determine the responses under varying posturing demands. By this method it is possible to determine the most desirable objective visual conditions for binocular posture, where the latter is not a constant factor in vision. It is for this reason that in our own testing techniques retinal rivalry tests are a MUST

III. THE MEANING OF "REALITY" IN VISUAL PERCEPTION

One must take human behavior into consideration when he deals with people. It is vitally important to listen to people and to try to interpret what they tell you. The reason is that what they tell you expresses much more accurately what they perceive than can be determined by any objective test. After all, what they tell you is a summation of what they perceive, even though it may be far from accurately reflecting the proximal stimulations. All proximal stimulations which impinge upon the eye go through a very rigorous sifting process. Such stimulation are gross and disjointed and have to be shaped into something that is coherent and, above all, something that makes sense. The product will not be acceptable to the organism until it does make sense. If I observe something that is not reasonable, I do not want to admit it, I am reluctant to admit that I saw something outside of my common experience. If I see a red bear in the park, even through I know that there is no such animal, I shall be very hesitant in telling you what I"thought" I saw, for fear that you might consider me an unreliable ovserver. So I look twice and attempt to get a different view of the peculiarly colored animal before I commit myself to admitting seeing the red bear. This means that only those things which are written within prior experience make up the reality of our visual percepts.

A. Things are not real because of their stability (or simplicity); they are stable because of their realness.

This statement is apt to upset our present ideas regarding visual functions. The human brain craves knowledge, yet our thinking capacity seems inadequate to comprehend complicated phenomena unless we break them down into smaller sub-wholes. We cannot, it appears, understand a complex mechanism or organism unless we break it down in to its various components and study each one separately. This analyzing process has been considered hitherto the only acceptable scientific procedure. B.

The breaking-down process seems to be admirably suited to "simplify" our original problems. For instance, in the investigation of matter scientists first dealt with macroscopic, then microscopic particles which eventually were reduced to molecules, atoms and electrons. There is but one difficulty with this process - its is not reversible. After we have all the pieces in greatest minutiae, we can no longer relate them to the original problem at hand. This truism starts even now to pervade all sciences, even medicine. The upswing of psycho-somatic medicine provides an illustration.

The holistic approach accepts as a fundamental tenet that the whole is greater than the sum of its parts. A watch that keeps accurate time differs greatly from a box filled with all the parts of a similar watch. The accurate movement is not contained in the wheels per se but is the outcome of much planning. For the same reason, a live human being is an entirely different thing than a cadaver on the dissection table. True, it is a great deal easier to study the histological features, the nerve paths, the individual cells, than it is to analyse the behavior characteristics and the thoughts of the live person.

Because of our limitations, as far as thinking power is concerned, we are given to over-simplification. The simpler a thing is, the better can we understand it, but the less it conform to reality. The use of atropin in eye examination is an example. Improved static findings are the sole justification for its use. Madigan, in an excellent paper, has recently shown that the use of atropin is of questionable benefit in static retinoscopy. However the inhibition of accommodation makes it a great deal easier for the physician to "scope". It is this consideration, rather than any other, which prevents this inadequate technique from becoming extinct.

The reality of what we see does not depend on the complexity of what we see. This is tremendously important. When we see something familiar, no matter how complex, it is more real to us than a very simple but ambiguous form. We are capable of perceiving a very complex, known, object more rapidly than a simple nonsensical outline. We can reproduce the former much more accurately on paper than we can reproduce the latter "simple" figure of unfamiliar shape.

B. <u>Stereoscopic perception is more fundamental and more real than "flat" (two-dimensional) perception because the normal visual surroundings are plastic (or three-dimensional).</u>

Laws pertaining to sensory perceptions are apt to apply to all sense organs. It is, therefore, well to study the laws pertaining to sense modalities other than vision and to try to apply them to the visual sense.

Inasmuch as our spatial surroundings form the medium which serves as our milieu from birth, it is not reasonable that the three dimensional quality of these surrounds should long escape the organism. Why, then, should "flat" seeing, or the seeing in a single plane, precede the three-dimensional percept? Is it not possible that we came to this belief because it appears to simplify our problems in understanding vision? The very fact that we compare the visual organs with the man-made camera is indicative that we try to reduce the immensely complex neural and cortical processes of seeing to the status of something which is within our understanding.

Consider that the one-eyed individual is capable of orientating himself in a three-dimensional world. Such an individual would be very much amazed if you should tell him that he had no plastic seeing. Koehler has shown that variable depth is inherent in certain uniocular sensory visual fields which have been exposed to certain specific figures. Many "flat" figures, such as the reversible staircase, geometric drawings of cubes, octagons, etc., are perceived as three dimensional real objects even though they are actually two dimensional projections. It seems unreasonable to assume that perspective seeing must evolve from flat seeing. Certainly, a great deal of experimental evidence seems to contradict such an assumption.

I should like to illustrate later (under heading D) the improbability of stereoscopic seeing being essentially a learned process - thru First, (Simultaneous perception) then Second (flat) and finally Third Degree (stereoscopic) fusion - by quoting the case of a small child who has been under my observation since infancy. The child has been severely cross-eyed since birth and never knew the meaning of binocular posture prior to a strabismus operation.

C. Objective visual training situations should be based on reality rather than on simplicity of design.

Provided the assumption, that stereoscopic vision is more fundamental than "flat" vision, is true, how can we justify our present visual training methods in regard to strabismus?

Any training instrument that violates the reality of perception violates a fundamental organismic principle and makes it harder for the patient to interpret through it. It is important to have instruments that reproduce reality as nearly as possible in order to make it easy for the individual to interpret the objective situation. If it is the intention to make it difficult for an individual to interpret test conditions, the above rule may be violated. But the testing and training must be limited to those individuals whose achievement level of interpreting binocular phenomena is high. But if the training setup is to create a situation that is simple and understandable, it must present something which is real, in other words, something which is within the prior experience of the individual. This is especially true when dealing with children. If it is possible, through certain instrumentation, to re-constitute something which the child knows, we are apt to get the response that we are seeking.

If we are to follow these principles it will become necessary to alter our concept of what constitutes a suitable training instrument. We have given primacy to training principles which can no longer be adhered to in the light of the above discussion.

D. A new visual experience, when sufficiently real, is apt to be adequate at once; but it may gain added stability thru repetition.

According to Goldstein, new visual experiences are not arrived at by the slow and gradual extension of prior experiences; rather, they appear suddenly as complete entities.

Here is the story of a small child which has been under my observation ever since she was born. The child had a severe internal strabismus from birth and consequently never had a chance to acquire binocular vision. One or the other eye was always turned so far in to the corner that you could hardly see it. At the age of about four she started to alternate fixation. This, in my estimation, was a critical period in the child's visual behavior because it might have meant the advent of ambiocular seeing, i.e., the emergence of the turned eye from the suppression stage. The father was informed that, should the child learn to interpret macularly from both eyes, it would seriously interfere with a future binocular pattern of seeing, were the eyes to be straightened. The father agreed to let the child wear plano lenses with opaque nasal sections. About a third of each lesn was frosted, (Also see Chapter X, half ocluders) so that when the child looked straight ahead with the right eye, the frosted section of the left lens intercepted the direct line of gaze of the (turned) left eye. Conversely, if she wanted to look straight ahead with her left eye she could do so with the result that the direct line of gaze of the (turned) right eye was intercepted by the shield.

It may be argued that we did not by this means prevent the formation of an anomalous retinal correspondence, because the contra-ocular image of the fixated object was not erased. This objection is valid only if it can be proved that anomalous retinal correspondence <u>can</u> form. All experimental evidence argues against such an assumption. Therefore, we did not worry about the secondary retinal image of the fixation object, formed on a widely peripheral retinal area of the turned eye. We were concerned that macular images of two widely separated objects should not form, because the child, in all probability, would learn eventually to interpret them correctly in space, i.e., learn to see ambiocularly.

The child wore the occluders until the parents were ready to have the child operated on. No visual training was given before the operation because we could elicit no binocular fixation attempt at any range. The operation was successfully completed when the child was seven years old. Two days after the bandages had been removed the child came to my office. Her visual acuity was 20/20 with either eye and the eyes were cosmetically straight. She did not fixate binocularly when an object was brought to within arm's reach; rather, the eyes retained parallelism (lack of convergence). Because the eyes were straight in distant gaze, an attempt was made at this first visit to elicit a binocular visual response on a distant projection screen (at 16 ft.). We reasoned that the attempt at eliciting a binocular percept should be made because the child could not have learned a strabismic posture (looking with both eyes in two different directions at once) but had always depended on a uniocular posture prior to operation.

Tests for retinal rivalry made on the distant screen showed an alternate percept, first one eye maintaining full control of the screen and then the other. Very soon, however, indications of the formation of a binocular sensory field were apparent and when the Brock Ring Test (BSM 1, 2, 3) was made there was but a very short period of "sideways motion" before the child exclaimed that the ring seemed to come toward her and to move back thru the screen. Appropriate size changes were also perceived.

Immediately after the stereoscopic percept became evident, the screen was filled with a complex stereoscopic scene, showing a water buffalo partially immersed in water (BSM 18, 19). This scene was selected because the child lives near a lake and is quite familiar with cows. The scene was the nearest approach to her habitual surrounds that was available.

She looked at the screen for a little while and then all of a sudden exclaimed - "Say, daddy, that cow is real!" This could only mean that she had reconstituted a real cow thru stereoscopic clues and that at first, she had seen it only as a picture on the screen. If this were not so, the sudden exclamation of surprise and joy could not be explained. That she saw the cow stereoscopically was definitely proved by giving her a flash-light projector which threw a baloon-shaped white figure onto the screen. This baloon, she placed selectively on the particular objects in the three-dimensional field which happened to be in the same plane with the screen. Inasmuch as the BSM technique permitted me to move any given object into the said plane, there was no possibility of her "guessing". This meant that she had accurate stereoscopic ability within half an hour after she had "learned" binocular seeing.

Was it learned? How could she learn it? And how did she know what stereoscopic seeing meant? Because that was what seeing a "real" cow meant to her. Why didn't she see "flat?" She had never had binocular vision before. Since she recognized the stereoscopic picture of the cow as a "real" cow, she must have had an appreciation of this reality prior to the time that her binocular percept was born. The only new feature which was added to what she had already experienced (in uniocular seeing throughout), was the <u>opportunity to reconstitute reality solely through stereoscopic clues</u>.

It is about time that we abandoned the concept that one-eyed seeing differs in any major particular from binocular seeing. All that is added in binocular vision is apparently a finer depth discrimination, and that primarily at close range. It is true that only through appreciation of retinal disparity can we reconstitute reality by means of stereoscopes or stereoscopic projection. That is why the BSM equipment is so valuable as a differentiating agent between binocular, uniocular and strabismic seeing.

E. <u>Reality of perception is only possible in adjusted behavior</u>.

Renshaw says that nothing can happen unless the organism is set to let it happen. This is a fundamental concept.

A person who does not know what to expect, or who is disturbed, is not in a position to give a clear account of what occurs. This holds true in all phases of human behavior. Our psychopathic wards are filled today with individuals of this type.

F. A very important factor in visual training is the setting up of training situations which tend to create stable visual conditions over as much of the total perceptual field as possible.

The peripheral portions of the visual field contribute largely to the maintenance of fusion in binocular vision (Halstead) and it seems therefore unreasonable to exclude so large a section of the peripheral binocular field in our training instruments.

One of the possible reasons why narrow fields were designed for visual training was simplification. We felt that we could simplify in two directions: (1) that the simplest and least detailed forms were the easiest to fuse (2) we could reduce the stimulated field area (and this was done in certain instances) until only macular figures remained. When such simplification has been reached the objective visual situation has lost all semblance to reality and instead of being easy to fuse, it has become difficult. The "easy" way for the binocular processes to function is in a unified total field, something which has scarcely been tried.

Our tendency in visual training should be to produce training situations where larger and larger portions of the total binocular field of an individual take part in the training. This will give us a powerful means of stabilizing the macular functions. It is these macular situations, which need our particular attention, because they are the one which come most readily under the influence of the patient's thought processes.

It should be noted that mental attitudes frequently disrupt, rather than enhance, the fusion processes. Peripheral responses are much less influenced by undesirable attitudes on the part of the patient.

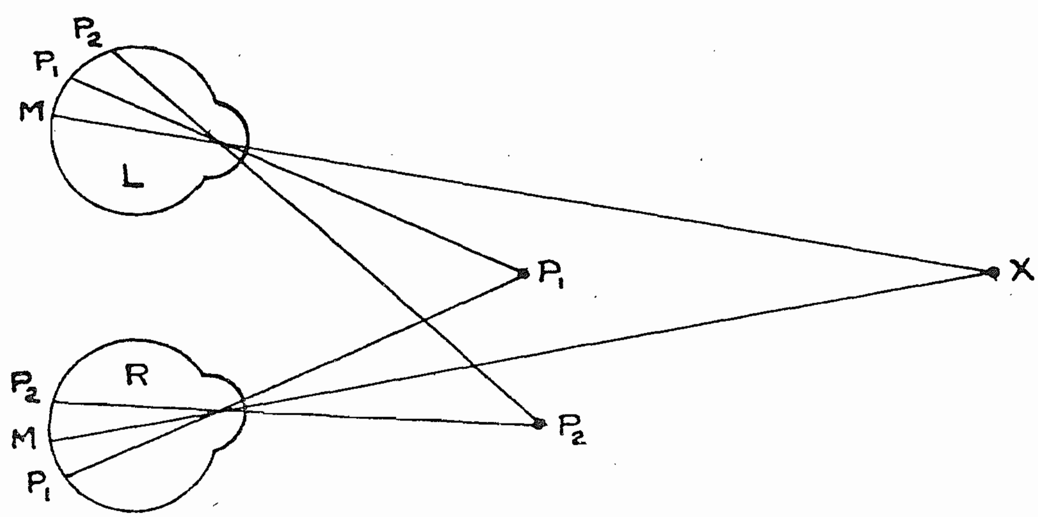
The fact that uniocular or alternate macular suppression is the most common visual dysfunction would indicate that it is the least difficult anomaly to achieve. We can hardly question that suppression of this type is a learned process.

IV. SINGLE AWARENESS IN BINOCULAR VISION

Suppression is a normal phenomenon in all organismic behavior.

A. Suppression is not only a normal, but a necessary, function in binocular vision, because all objects in three-dimensional space can not be on corresponding fusional areas of the two eyes while binocular posture is maintained.

There is no need to speak of the significance of physiological diplopia. The subject is adequately discussed in available literature. We all know that if fixation is held at 30 ft. the horopter will form there and that an object six feet from the observer will not be on corresponding retinal areas. In order to obtain fusion of this nearer object fixation would have to be altered so that the two eyes would converge at six feet. Nevertheless, if the horopter is held at thirty feet and an object is located somewhere in the binocular field but not in direct line og gaze, diplopia is, as a rule, not experienced. Diplopia is most likely to occur when the non-fixated object lies within the triangle formed by the two visual axes and the interpupillary distance. In this position the non-fixated nearer object is brought on non-foveal retinal areas equidistant and on opposite sides of the respective foveas. Both images are then close enough to the foveas to be quite clearly interpreted. Because they are not fusable, a sense of doubling readily obtains, provided attention is drawn to it. Placing a pencil ten inches in front of the nose, while looking at a distant object straight ahead, is in fact a preferred method of teaching an individual the awareness of physiological diplopia. If the pencil is shifted a few inches to the right or to the left, the feeling of "double" becomes less and less evident and soon ceases altogether. B.



Let X in the above figure represent the distant fixation object and P1 the location of the pencil where it is seen double most easily. It is apparent that the retinal points P1 are equidistant an opposite sides of the two maculae (M). When the pencil is intermediate to the two fixation axes, as when it occupies position P1, both retinal images are equally distinct and the organism is hard pressed to decide which of the two to suppress, if they both obtrude themselves to consciousness. If the pencil is now moved to a second position P2 to the right of the fixation axis of the right eye, the retinal points P2 are no longer equistant from the respective maculas so that the image of the pencil in P2 position is therefore easily suppressed, for the sake of single vision.

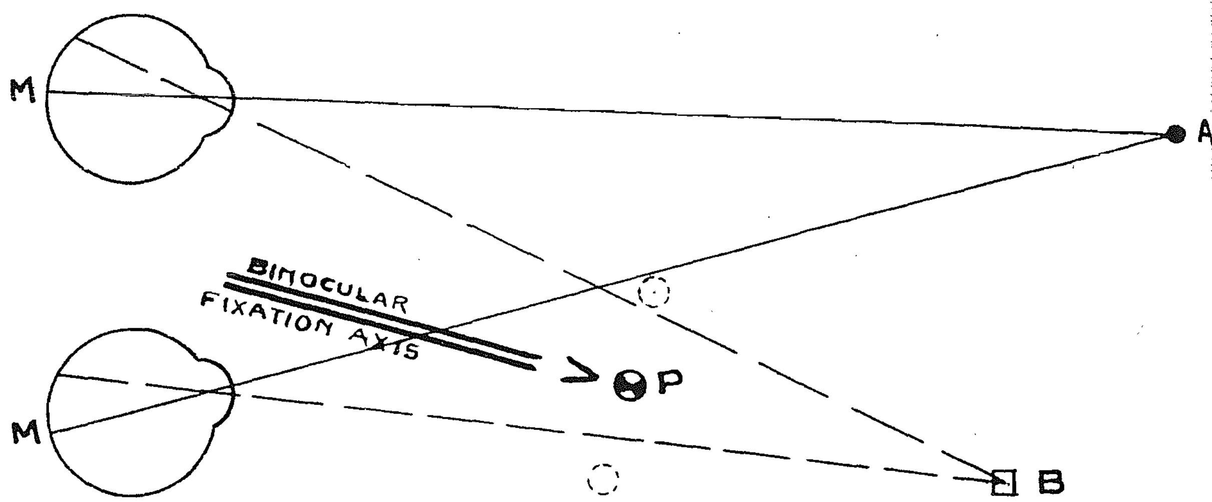
It is likely that in normal occupations and in normal surroundings a near object is more readily seen double when fixation is held at a farther object located in the same general direction, than when the reverse situation pertains, i.e., when a near object is fixated and an object farther away obtrudes itself to consciousness.

When an individual has been made conscious of physiological diplopia along the above lines, how does this affect his spatial adequacy at the time when he sees double? Suppose, he lights a cigarette, while keeping his gaze at some farther distance, and that he now sees two cigarettes. Will that pose a question as to where to hold the match? It seems reasonable that he would make a fusion attempt before proceeding with the lighting of the cigarette. This would mean that to light his cigarette, he would have to make an abstraction, i.e., he would have to think about how to do it, where before he did it without giving it any thought. Could we say, then, we has improved his spatial awareness? I believe the answer is, No.

B. Fusion is not an essential factor in "single" awareness of peripheral objects.

In normal binocular vision, as we have seen, the objects which do not have their images on retinally corresponding areas are still perceived singly. Is such an object seen in the direction where one eye sees it and is it totally suppressed in the direction where the other eye sees it? In other words, is the direction of such an object determined by a certain projection axis of one eye as if the other eye had been totally occluded? The answer is, No. The effective projection axis is apt to lie in a somewhat intermediate position between the right and left projection axes. This means that the locality of such an object is still binocularly determined even though fusion does not occur. Single awareness is then due to a closure by a process of abstraction.

The above sort of closure without benefit of fusion can only exist so long as the individual is not aware of diplopia. Diplopia forms an imperfect closure, even if the individual accepts the two images as belonging to a single object in space. Even the consciousness of doubling does not necessarily prevent knowledge of the singleness of the object. It is important to remember that this type of closure, be it either complete or imperfect, is gained by abstraction and is, therefore, a frontal or pre-frontal lobe process. From the "adequacy" point of view a total closure is of course preferable to an incomplete closure, yet we have been inclined to train individuals for incomplete closure where we formerly had a complete closure.



The above figure will illustrate the foregoing. If both eyes are fixating object A at some distant point and a pencil P then is aligned with a peripheral object B, it is placed in position as shown in the figure. The position of the pencil does not agree with either of the secondary fixation axes (broken lines) and projection occurs from an intermediate point between the two eyes. When diplopia occurs, the two pencils are seen in positions indicated by the broken circles. There is an organismic tendency to place the two phenomenal pencils equidistant on either side of the object with which the pencil is to be aligned. Only when one eye suppresses, so that the cortical image is no longer of any use to the organism, will the pencil be placed in direct line with the secondary axis of the other eye which reaches the object. In the latter case the object is less accurately localized; in the former, better. When the pencil is seen singly, without benefit of fusion, it is assumed that fusion attraction is still a factor in bringing about the desired effect of the two retinal images forming a single perceptual unit. It can be experimentally shown that, if diplopia is elicited, the two pencils appear much closer together than they should be, as determined by their relative retinal positions. It is assumed that fusion attraction furnishes the necessary binocular cue as to whether diplopia is crossed or uncrossed i.e., whether the object is nearer or beyond the fixation plane.

A additional experiment can be set up with the BSM slides No. 1 and No. 2 (the red and the green ring) and the rabbit slide (BSM 20). While fixation is held at the rabbit, the rings can be gradually displaced so that eventually fusion of rabbit and phenomenal ring can no longer be maintained simultaneously. If fusion of the rabbit is maintained, fusion of the rings is eventually broken. This is evident when the color of the perceived ring changes from a mixed reddish-green color to green or red, or when two interlocking rings are seen, one being green and the other red. It is possible, to interpret partially interlocking rings, both perceived in crossed disparity, as being closer to the observer than the rabbit on the screen. However, the two rings will appear more closely interlocked when the color filters are worn than when they are taken off. This indicates that a fusion attraction occured which, even though incomplete, was interpreted as depth variant between rabbit and the two rings. On the other hand, if the phenomenally perceived displacement between the two rings equals that of the actual displacement on the screen, both rings are seen to lie in the same plane with the rabbit. It may be said, then, that fusion attraction, even though it does not suffice for complete closure (seeing an object singly) must be interpreted as depth variable. It is important that we keep this in mind because it permits us to elicity gross stereopercepts when the two eyes are not adequately postured for stereo-accuracy. Many strabismics, when we first see them, are capable of posturing accurately enough for gross stereopsis. This becomes of importance in training.

C. Fusion attraction can only occur within certain limits of retinal disparity.

It may be asked, "If closure is possible, where there can be no fusion inthe strict sense of the term, why does this principle not hold true all the way to strabismic disparity?"

As previously reported, it has become apparent from actual observations that during incomplete fusion the depth variation between the objects in question is measurably less than if fusion efforts were lacking. These same experiments have shown, however, that if the ring disparity becomes too great, both rings (as perceived) suddenly "drop back" to the plane of the screen and are then interpreted as a pair of interlocking rings in a "flat" percept.

Dr. Verhoeff told me some years ago that he learned through practice to prevent fusion of stereograms to such an extent that all figures which are not exactly alike (i.e., having stereoscopic qualities) are seen double and flat rather than single and three-dimensional. It has been my experience that many individuals are capable (and willing) to inhibit stereoscopic fusion (prevent fusion attraction) and some, in fact, will keep their eyes sufficiently off alignment to prevent fusion at all cost.

The above phenomenon is frequently encountered with adults who are subjected to the Brock Ring test on a distant screen. Some of them will not, at first, let the phenomenal ring come off the screen. They prefer to see two rings in interlocked position. However, once this mental inhibition is broken they rarely are capable of preventing stereo-fusion in subsequent trials, unless they are psychopathic.

In the Brock ring experiments binocular fixation is held at the rabbit, in other words, the rabbit is maintained as a single fused object in the center of the total binocular field. Within certain small limits of disparity the rings may then be appreciated as fused and being nearer or beyond the central target (the rabbit). If the disparity is widened, there may be awareness of double-rings capable of stimulating the fusion sense to such an extent that they also are seen either nearer or beyond the rabbit. This means that the disparity is then beyond fusion ability but within fusion-attraction. Finally, the rings may be brought to such widely disparate positions that they are seen as interlocking rings in the plane of the rabbit. Fusion attraction has then been broken. In all three cases there is one common factor: The central target is being maintained within fusable limits. Another possibility may be encountered: An individual may elect to retain the ring (s) within fusable limits of retinal disparity and let the rabbit "double" when the disparity between the two perceptual objects (ring and rabbit) becomes too great. In all instances, however, one of the two perceptual objects is maintained on sufficiently corresponding retinal areas to make fusion possible. This is not the case in strabismus where fixation is maintained by one eye only. Here one end of the measuring stick is lacking in determining disparity in terms of depth variable.

D. It is the inability to suppress diplopia in normal surroundings that leads to the most serious visual difficulties.

That is something which needs to be remembered in strabismus training. I am glad to have found a means of helping the strabismic to obtain binocular posture without having to teach him to see double in the process. I am reminded of this time and again by patients whom I taught to see double before they knew the true meaning of fusion. These patients found it very difficult to lose the sense of seeing double even though their eyes remained straight. I know of a few who after seven or eight years of binocular seeing still complain of diplopia on small fixation objects, although they show good peripheral and peri-central fusion. These cases were classed as instances of horror fusionalis. It has been my belief for a long time that it was this condition which prevented successful completion of the cure. Today I am inclined to believe that it could have been prevented, had I known then what I know now. The fact is that since I have trained strabismics without attempting to establish diplopia at the outset, fusion aversion has not been a serious problem. For this reason I believe that visual training methods which tend to produce "double seeing" in the habitual surroundings of the patient are to be considered unsound.

E. Foveal suppressions are almost due to lack of adequate binocular posture. They usually disappear when adequate binocular posture has been regained. Visual training must be directed toward strengthening binocular posture.

If subnormal visual acuity may be caused by lack of direct fixation ability of the affected eye, the establishment of binocular posture must bring about a better ability to fixate directly with the subnormal eye and, perforce, bring about a heightening of visual acuity. When a central scotoma is not the cause of low visual acuity, such training always produces increased acuity of that eye.

F. Macular suppression does not create amblyopia-ex-anopsia.

It has frequently been assumed that if an eye is suppressed it loses its ability to see clearly. This assumption appears no longer to be true. Such an eye simply takes on other functions which are adaptations to the particular visual set. The retinal fibres never cease being stimulated by the light impulses that reach it; proximal stimuli will invariably reach the brain. In otherwords, the afferent nerve paths remain open and active. How, then can the perceptual faculties of the amblyopic eye deteriorate? This question has to be answered before we can intelligently consider the nature of amblyopia-exanopsia. The only possible answer is that these undesirable impulses are blocked in the brain in such a way that they cannot reach the level of conscious awareness, and that this blocking may eventually result in permanent inability to see clearly with the affected eye.

In uniocular amblyopia, where the amblyopic eye is not noticably out of alignment, almost normal peripheral awareness can freqently be demonstrated to exist, but macular awareness seems to be definitely lacking. In some of the eyes where visual acuity is below 6/200, foveal stimulation of the affected eye, by a strong point source of light, only produces the sensation of a "glow", the patient not being aware of the light itself unless it is thrown on off-foveal retinal areas of the eye. It can also be shown that when the light is not seen directly, the pupillary reflex constriction to light stimulation is also lacking, showing that the foveal retinal stimulation is being blocked prior to the geniculate body, i.e., before it reaches the cerebral cortex. In these instances the blocking is not on a cortical level but is due to a lack of transmissibility of these stimulations from the fovea to the geniculate body. If the blocking occured in the cortex, the pupillary reflex arc would be intact. This information has been obtained through experimental evidence and should be indicative that the anblyopia is due to destruction of foveal fibres rather than to non-use.

V. RETINAL SLIP - A VISUAL CONCESSION

A. An inadequate binocular posture results in retinal slip.

When binocular visual functions can be shown to exist while one eye fixates a small fixation object directly but the other eye is slightly off corresponding position, then that eye has "slipped" away from accurate binocular posture. This phenomenon is best described by the term "retinal slip". It is a descriptive term, which may not be any longer in general use.

Peckham, many years ago, established experimentally that binocular vision is not lost when the eyes are not accurately aligned on a single object of regard. These findings gave the psychologists the basis for their theory that retinal correspondence is not innately determined and that it may vary considerably with different individuals and for different visual demands. They have long since abandoned the concept of point to point relationship between the two eyes.

During retinal slip we may assume either that a new horopter, which no longer maintains correspondence between the centers of the two foveae, has formed, or that the normal horopter is still present. In the latter case it has been moved away from the plane of the fixation object, to a farther point in a slip toward convergence. The latter assumption is more likely to be correct.

Personally, I have a variable condition of exophoria and retinal slip toward exo. I often maintain a binocular pattern that is just adequate to maintain a peripheral binocular field structure but is no longer capable of accurate stereo-perception, due to a lack of macular fusion. I have noticed when driving a car that suddenly I am aware of two traffic lights (quite close together), if there is not any particular need for keen visual discrimination. It is a simple matter to fuse them, but this results in appreciable difference in the general appearance of the landscape. It seems to me that I have this sensation of doubling during "retinal slip" only because I have taught myself to be aware of diplopia and because my eyes are almost equally dominant. Most individuals, who demonstrably have an exophoric slip, report that they never see double. The fact that doubling occurs in my own case shows that during phases of retinal slip my horopter lies considerably beyond my gaze, (or normally behind the eyes), the eyes being in a somewhat divergent position. The significant fact remains that I have never seen the doubling of a cowl light of an oncoming car or of the tail light of a car. This must mean that accuracy of binocular posture is maintained whenever the need for concentrated attention arises. It is also significant that in a Keystone Visual Survey test I show orthophoria at far and moderate esophoria at near, and that my stereometric accuracy is high. Only after prolonged total occlusion of one eye does an exophoria at far, which may reach considerable proportions (beyond 10 prism diopters), become apparent.

While a retinal slip prevails a high degreed stereoscopic acuity cannot be obtained. It is fortunate for my safety and for that of other motorists on the road that I do not maintain a retinal slip whenever visual demands require good binocular posture. As soon as the eyes become alerted the retinal slip is immediately and instinctively taken up.

Let us define retinal slip as a tropia position of very moderate amount. (This must not be confused with conditions of excessive phorias which may not be in evidence while binocular posture is maintained.)

The essential difference between retinal slip and a tropia position is that in the former case the binocular pattern of seeing is peripherally maintained while in the latter case such a pattern is lacking in all of the overlapping visual fields of the two eyes. The one may be classed a tropia within small limits of disparity while the other is usually a tropia of large dimensions (as expressed in prism diopters). Yet the tropia is usually an extension of a prior retinal slip. It is quite likely that, at least when the tropia develops in later life, it is preceded by a retinal slip. This holds particularly true in exotropia at far, when a binocular pattern of seeing is being maintained at near. Retinal slip may be considered the stage between tropia and phoria conditions.

B. Retinal slip is possible only in uniocular suppression of the foveal percept.

The extent of the suppression area depends on the amount of the retinal slip or vice versa. We may safely say that the suppression area will always include the foveal area of the suppressing eye and will gradually extend into the periphery.

It used to be my belief that I could not take up the retinal slip unless awareness of diplopia could first be produced. It has become evident to me that this assumption is not tenable. For one reason, I frequently find myself seeing two traffic lights for one and the experience is not at all disturbing, in fact it is a rather pleasant one. There seems to be no organismic urge to pull the two lights together. This observation agrees with that made by others who show diplopia under experimental conditions. Secondly, it is quite easy to demonstrate that retinal slip is often taken up by patients who do not remember afterwards of having seen double prior to the postural shift. Thirdly, the ease with which a macular image can be suppressed has a direct bearing on whether or not retinal slip occurs. This is important in our setting up of objective training situations.

C. When suppression is limited to foveal vision, a gross stereoscopic awareness is still in evidence. That means that stereoscopic perception is not lost but only stereoscopic accuracy. For accurate determination of depth variables the retinal slip has to be taken up. The nature of the task, therefore, determines whether or not accurate posture will be maintained.

The lack of understanding of these underlying principles has been a source of a great deal of perplexity to many examining practitioners. Frequently we observe a high exotrope who, nevertheless, shows adequate stereo-accuracy behind a stereoscope. Because, we may not be able to observe the individual's eye positions, we fail to see that for the special task which he cannot successfully perform with the eyes in a tropia position, - he posture binocularly long enough to perform it. By the time he looks out from behind the instrument he again shows his exotropia. It follows that, unless a desire can be developed in this individual for maintenance of binocular posture under less demanding conditions, his strabismus cannot be "cured".

D. Periodic strabismus is an extension of retinal slip.

The only effective way to solve this problem, that I can see, if to strengthen binocular posture in visual situations which correspond with his normal visual surrounds. It is for this reason that a projection screen placed across the room is becoming so important in visual training. Pictures that recreate thru color separation or polarization) visual situations similar to the patient's normal surrounds can be projected onto the screen. He can then be taught to posture binocularly instead of uniocularly in situations which are transferrable to his normal surrounds. Until we train in normal surroundings, we shall find that the periodic squinter may walk in with one eye in a tropia position and then proceed to maintain binocular posture in all our training instruments. This will be true regardless of his ability to maintain fusion through lateral prism which forces him to over-converge. Duction exercises are, definitely, not the answer in such cases.

The periodic strabismic chooses to have binocular vision whenever he wants it, but frequently, for his own reasons, chooses not to have it. That is why you dare not leave it up to an individual's judgment whether or not he wants to keep his eyes straight. The only way to overcome these habits is to strengthen binocular posture so that he no longer needs to make this choice. Until you do that, the occasional squinter will invariably be seen with his eyes turned at a time when he is not particularly interested in what is going on. The minute he sits behind a training instrument he follows through in great style. He gets an hour's or half hour's workout and this can be kept up for years without his ever getting beyond that stage.

E. In more extensive suppressions the suppressing eye may be turned to a noticeable degree and stereoscopic ability will, then, no longer be evidence.

As with a periodic squinter the fusion processes become less and less important to the individual, the central suppression extends farther and farther into the peripheral field. This may bring about an eventual shift from a habitual binocular posture to an habitual strabismic posture. He may eventually abandon binocular vision altogether, except for special occasions.

Nearly all strabismics have occasional moments when they maintain binocular vision. The only reason this is not generally known is that most of us have never taken the trouble to discover the fact. My whole training procedure now centers around the search for the particular visual tasks to which the strabismic responds by an effort to find out under what conditions he will respond binocularly. To visiting doctors it appears as if we spend an unreasonable amount of time to obtain binocular posture (macular stereopsis). But time thus spent invariably pays good dividends.

We find a point of attack, once binocular posture has been obtained - under whatever conditions and at whatever range-that eliminates the "breaking down" process, which used to be a long preliminary period of training before any attempt to elicit binocular percepts was made. We are no longer concerned with breaking down anomalous (strabismic) projection, provided we find a means of getting the patient to posture binocularly for even fractional periods. We tackle the problem at the most logical position. This means that we do not attempt to get an initial binocular posture at infinity position. Parallelism is expected only at the end of training.

F. Marked retinal slips or actual intermittent tropias occur most commonly in distant gaze or during moments of inattention requiring only low postural demands.

Because we found the above to be true, Strabismus training in our office follows this general routine:

1) We find the position and visual task which will bring about an attempt at binocular posture. Almost without exception this position is found to be within easy arm's reach of the patient, at distances varying from four to twenty inches.

2) In order to succeed in that attempt we see to it that the patient is confronted with a visual problem that requires binocular posture for adequate solution. We assume that the patient will make an effort to posture binocularly if he is presented with a problem that cannot be solved while maintaining strabismic posture or by alternate fixation.

3) Because flat fusion targets do not require binocular posture for their solution we no longer consider the attainment of First or Second degree fusion as an adequate criterion of a binocular field structure. For this reason "flat" targets are seldom used in our

office for strabismus training, nor for correction of marked retinal slips. From hard experience we have learned to remember that all strabismics who have fair visual acuity with either eye can look alternately at targets presented to them in stereoscopes or other training instruments and are capable of interpreting the total situation in terms of both, the right plus the left, percepts. A report of three dots in a row (BF Unit) or a cross (O series) is therefore not proof of binocular posture. Additional evidence is necessary.

4) Individuals, on whom no duction findings can be made, are not admitted to stereoscopes for further tests. This is one of our inviolable rules.

5) We do not consider the Keystone Visual Survey Test to be a diagnostic test in Strabismus. This does not mean that a Keystone Visual Survey test would fail to disqualify a strabismic in a general survey. The individual might conceivably report "the dog above the pig"; "the arrow under nine"; the "three balls in vertical alignment" if he were a clever alternator, but he could not master the stereometric test and would be disqualified on that account. On the other hand, if we have no other information we cannot conclude from the Keystone Visual Survey above that the patient has any certain type of strabismus. When the stereoscopic test is failed, we immediately question all other tests of the visual survey as to their validity.

6) We accept as a fact that a strabismic may gain information from one eye and then the other, in temporal sequence, relative to a given single area in space (straight ahead) and that these impressions may undergo a cortical closure. We have seen that such closure occurs often without the patient's wishes. Most of these individuals seem to be incapable of maintaining permanent fixation with one eye in training instrument. Alternation of fixation seems for them to be an entirely involuntary act.

G. To overcome retinal slips, it is necessary to make perceptual demands which require adequate binocular postures for their completion.

Skilled manipulations that require adequate binocular posture, provide the requisite demands. Stereoscopic ability also furnished this control.

Let us remember that cortical closure of temporally successive events is a common occurence. We see in it moving pictures, in successive fixations while reading. In other words, it is not a prerogative of strabismics only. The ability to differentiate between fusion and closure at a higher cortical level is one of the essential controls in testing strabismics.

H. An individual does not depend on conscious awareness of physiological diplopia to regain adequate binocular posture. In fact, such awareness may have an inhibitory effect on the resumption of binocular posture.

VI. AMBLYOPIA - A PERMANENT VISUAL DISABILITY

A. Amblyopia is the result of destruction (or congential lack) of foveal nerve bundles in one or both eyes. This is my definition. Other types of subnormal vision will be defined later.

B. In uniocular or binocular amblyopia the eyes may be in an adequate binocular posture, which means that they are in such alignment with each other that stereoscopic clues are most effective under the existing condition. The individual is then capable of the most sufficient responses which are possible to the partially disabled organism.

Stereopsis is the appreciation of the differences between right and left visual images as depth variations. Since stereopsis is the product of the different viewpoints of the two eyes when looking at objects in space, a single eye cannot have stereoscopic qualities. This does not mean that a single eye may not have three-dimensional appreciation of space.

In good binocular posture, regardless of central retinal defects, the achievement potential of an individual has been reached. The visual responses will be adequate within the achievement level of the partially disables organism.

If we define amblyopia in the above manner, and good binocular posture is in evidence, the patient's existing amblyopia represents close to the maximum possible visual acuity.

It must be said, however, that such ideal postures rarely exist with amblyopic patients. There is a strong organismic tendency to center attention on the better eye while the poorer eye is proportionally pushed into the background. By pushing into the background is meant a shift of awareness toward the better eye so that eventually most of the consciously perceived phenomena are related to the visual impressions received via the better eye. The local signs from amblyopic eye affect the total interpretations less and less and may eventually cease entirely. Thus, the posture of the amblyopic eye becomes of less and less importance. Such over-dominancy of the better eye may be corrected through visual training.

It is, therefore, important for us to know whether a person has a good, fair or poor binocular posture in amblyopia, particularly in uniocular amblyopia, in an effort to determine how far the cyclopean eye has been shifted toward the better eye. There are means to test it. We can tell almost instantly whether a person has shifted his cyclopean eye toward the better eye, by employing a cardboard with a central hole about an inch in diameter. The patient (especially if he is a uniocular amblyope) looks at a strong light some ten feet away and above eye level. He holds the cardboard, which contains the central round opening, with both hands, at arms length, in such a way that he sees the hole in the cardboard directly below the light which he fixates. He is not to lower his gaze to determine the position of the opening but to judge it while he is looking at the light. He is then instructed to bring the cardboard straight upward in a slow sweeping motion until he "can see the light thru the hole." Inasmuch as the cardboard is then between the patient and the light, the hole produces a brilliantly lighted area on the patient. It is important to observe where this area is located immediately after the cardboard has been brought "straight up" and before the patient can look at the light thru the hole. It is also important to observe what lateral adjustment is made by the patient if he finds that he cannot see the light in his first approximation.

(a) If the lighted disc is seen center to the patient's forehead, a medially located cyclopean eye can be assumed to exist. In that case the cardboard occludes the distant light from either eye and the patient is forced to make a secondary lateral adjustment toward the dominant eye.

(b) If the lighted disc is placed so that the one eye is very close to the lateral edge (with the medial edge extending well past the ridge of the nose) the cyclopean eye has shifted markedly toward the eye which is inclosed in the light keg, but a binocular pattern is still strongly in evidence.

(c) If the lighted disc is brought straight up so that one eye is exactly center to the keg, then dominancy of this eye is complete and the existence of an effective binocular field structure may be seriously questioned and will certainly need to be investigated.

Why is it that, in well balanced binocular field behavior the hole in the cardboard is placed in such a position that, when it is brought straight up, it conceals the light from either eye? Let us suppose that the hole has been brought directly in line with the visual axis of the right eye. The center of the hole then lies directly below the light as seen by the right eye but it will be markedly to the right (and below) of the light as seen by the left eye. The local signs from the right eye will indicate "the light is directly below this eye" while the local signs of the left eye will indicate "the light is decidedly to the right and below the light". The total percept, if both eyes were equally important to the organism, can therefore not be "the hole is directly below my (both) eyes." On the other hand, if the hole is brought into the central vertical plane of the head, the hole as it appears to the right eye is a bit to the left while as seen by the other so that the total percept of the hole being directly below the more distant light is perfectly reasonable and logical.

In amblyopia the eyes may be in an inadequate binocular posture so that stereoscopic clues are just barely utilizable. Poor posture then interferes with the maximum response of which the individual is capable.

Poor posture means that the related retinal images are so far disparate that the fusion attraction between them is just barely utilizable, which results in lessened ability to peform certain demanding visual tasks. If binocular posture is so poor that the macular images from single objects in space can no longer be fused, it means that the individual must learn to suppress the image from the amblyopic eye, but it does not necessarily mean that peripheral fusion must also be totally abandoned. There are many non-strabismic individuals who maintain such poor binocular posture (at least for non-demanding tasks) that total suppression of the contra-ocular image of the fixated object is the rule, although they maintain binocular field awareness para-centrally and peripherally. While such poor posture obtains, the eyes remain cosmetically straight but large retinal slips are common and stereoscopic accuracy is nil on stereometric tests.

Stereoscopic accuracy is determined by macular imagery; it cannot be determined on any other retinal areas. Stereoscopic perception, on the other hand, is dependent only on the existence of a binocular field. If a binocular field is lacking in direct line of gaze, because of a central scotoma, this does not affect the peripheral stereoscopic ability unless the binocular field percept has also been abandoned. Such an individual remains permanently incapable of stereoscopic accuracy even though his peripheral depth clues may be normal.

Stereoscopic ability can be measured quantitatively and qualitatively. Qualitatively, it measures the smallest possible retinal disparity which is discernible as depth variation; quantitatively, the stereoscopic range. The latter is expressed by the distances beyond and nearer than the horopter in which single binocular awareness can be maintained. This range is peripherally determined because in direct gaze the stereoscopic range is most limited. While stereoscopic accuracy is determined with small and sharply defined targets, the stereoscopic range is determined with large and not necessarily well defined targets, preferably rings.

It may be assumed that an individual who can pass a stereometric test also is capable peripheral stereoscopic awareness, at least I have never come across an individual who had macular stereo-awareness and lacked peripheral stereopsis. The reverse is not true.

Peripheral stereoscopic awareness is quite frequently found in individuals who do not show any measurable stereo-accuracy even though both eyes are visually capable of normal resolution.

It is quite possible that macular and peripheral stereo perception may be functions of two entirely different cortical processes. This is in line with the opinion of Halstead who claims that "central vision in man is projected to the striate cortex of the occipital lobes while peripheral vision is mediated by the cortex of the lateral surfaces of these structures" (Brain and Intelligence, Dec. 1947; pg. 53). Halstead's investigations have shown also that "peripheral vision ordinarily has little direct relationship to consciousness or awareness"

His far-reaching investigations have lead him to the conclusion that the peripheral portions of the visual field have a steadying effect on the binocular field structure and that they thus contribute to the maintenance of binocular visual functions at a high operational level because they integrate vernier postural adjustments. (pg. 54)

In amblyopia the eyes may be in monocular or in strabismic posture, when fusion attraction can no longer occur. Stereoscopic vision is then absent and visual adequacy is at its lowest.

The term "fusion" needs some explanation. We normally think of fusion as the "superimposition of fusible images on corresponding retinal areas, producing a single perceptual image of heightened discriminative qualities." Many investigators doubt whether the closure - making one out of two - ever occurs in the cortex of the occipital lobes. Some investigators believe that this closure occurs in the frontal lobes, at high-level consciousness. Be that as it may, it seems that the field stresses become less and less potent when retinal disparity between right and left-eyed seeing is increased. This may be likened to the magnetic fields produced by two magnets. When they are held close together the magnetic force is considerable and tends to close the gap between them; but as they are held farther and farther apart, this force, which effects "closure", becomes weaker and eventually reaches the vanishing point. Also no matter how strong the magnetic attraction between two magnets may be, their pulling together (closure) can be prevented by applying equal but oppositely directed pressure (pulling them apart). It seems well established experimentally that fusion can be inhibited to a marked degree (in exchange for diplopia) at least in the macular areas and that this blocking is a frontal lobe process.

The psychologists and physiologists also speak of visual fusion in the sense of fusion of temporally successive images. In fact, such temporal fusion is accepted as being existent in all sense modalities. Halstead speaks of a critical fusion faculty as the temporal resolving power of the visual system and measures it by determining the flash rate of an intermittent source of light which just eliminated flicker. This closure, according to Halstead's findings, is due to central (cerebral) processes rather than to peripheral (retinal) processes.

Single awareness in a binocular field process is, of course, a desirable feature. To teach an individual to be consciously aware of physiological diplopia is paramount to inhibiting such single awareness. To be conscious of physiological diplopia means seeing objects in a state of unreality. Thid does not seem to be in the best interest of the individual's spatial awareness. By developing an excessive amount (or any amount for that matter) of awareness of physiological diplopia, we prevent the "closure" of retinal figures which belong to single objects in space - a closure which should occur before these figures emerge into consciousness.

The term fusion is ambiguous when applied to the various forms of closure which we have just discussed. Yet, at present we do not differentiate between the various processes. This accounts for many of the misconceptions that are prevalent in optometrical and ophthalmological literature relative to the meaning of fusion. It becomes, therefore, of paramount importance that testing methods which make an absolute differentiation possible between the various forms of closure in two eyed vision be devised. This is particularly important because all three processes can co-exist in one and the same individual.

The organismic desire is to achieve closure, i.e., to see all objects in space singly even though these objects are usually so situated that only a comparatively few can, at any one time, be brought on retinally corresponding areas. In normal binocular vision it is organismically important that the macular images are fusable since otherwise stereo-accuracy is lost. Yet, other objects in the same visual surrounds may be projected to such widely disparate retinal areas that they cannot be fused at the lowest cortical level and have to be brought to single awareness by a closure process on a higher cortical level. It can then be readily demonstrated that projection still occurs from the cyclopean eye. For instance, if a peripherally perceived object at twenty feet, say a lamp shade, serves as the object of indirect fixation, while the gaze is held on an object situated some six feet to the right of it, we may hold a pencil at arms length so as to point directly at the shade. If we then close the eyes alternately we are likely to discover that the pencil is not in direct line with either eye and the center of the shade. Yet, individuals who have not trained themselves to observe physiological diplopia will never be conscious of two pencils.

The same principle, of course, is operative in the dominancy test where a cardboard with central round opening is used to determine the position of the cyclopean center. Very few individuals are conscious of two openings in the cardboard. These are confronted with a choice as to which of the two they should align or whether both should be equally disaligned. Such a choice, of course, requires abstraction and becomes, therefore, a frontal lobe process. However, in absence of physiological diplopia, it seems that this choice is made subconsciously, even though it must still be thought of as a frontal lobe process.

There can be no question that the awareness of diplopia interferes with adequate spatial orientation as regards the object in question. A strabismic who "sees double" out on the street is in potential danger. When he meets up with a situation which requires an immediate response (escape), he will have no time to organize around these double images. The decision he makes may be the wrong one. On the other hand, the individual who maintains single awareness of both the near and the far object may have a less accurate (retinal) percept (at least those who teach physiological diplopia will say so) but he certainly behaves as if he had the more accurate spatial percept.

For the above reason it seems best never to develop awareness of physiological diplopia on purpose. In our own training procedures we absolutely prevent its appearance, if it is at all possible. The only situations in which feel that we can make use of physiological diplopia in training are those where it is not directly transferable to the normal visual surroundings. For instance, in posture training we produce vertical diplopia, which cannot be carried into normal surroundings. In convergence training we use a string which is stretched from a distant wall attachment to the nose. These situations are highly artificial and are not likely to find counterparts in normal visual surroundings. Because we have the means today of training a strabismic to normal binocular function without the intermediate step of diplopia, we are in the happy position of letting the strabismic maintain an adequate spatial awareness while this shift from strabismic to binocular posture is being made.

The above considerations bring us to an entirely different concept of the value of diplopia training in strabismus. Further discussion will have to be postponed.

Coming back to our tenet that in monocular and in strabismic posture stereoscopic vision is wholly lacking, we can now restate it by saying that in uniocular and strabismic posture a closure can no longer occur except at the highest cortical levels (frontal lobe).

Uniocular posture may be maintained in alternate vision. How may we speak of closure in uniocular posture? Here the closure concerns the temporal fusion (as in movie projection) of right and left alternate postures. When such closure is obtained the individual will be entirely unaware of how he arrived at the final interpretation of his visual surrounds.

Inasmuch as stereoscopic range seems to be definitely limited to retinal disparity within fusion attraction, it cannot exist when the eyes are markedly out of alignment. If under such conditions a binocular sensory field can be assumed to exist only if patient complains that he sees everything double (as in paralytic strabismic of recent onset). Conversely, when it can be shown that when an individual possesses good stereoscopic discrimination under certain test conditions, it may be assumed that during the particular visual task his eyes were in perfect alignment with each other.

C. The purpose of visual training in amblyopia is to teach the individual adequate binocular posture by strengthening his binocular field percept and by gradually increasing the demands on his perceptual abilities.

The best training approach is to increase, gradually, the demands made on the visual performance of the patient, as expressed by his perceptual or manipulatory competency. This means that he must be confronted with visual problems which cannot be solved unless he postures better than he is wont. If such heightened ability has once been attained, it can be achieved again and again and eventually become the habitual pattern.

Phorias are expressions of inadequate postures. Posture training is actually the simplest sort of phoria training and is exceptionally effective in changing undesirable phorias.

When it is found that adequate posture is maintained in amblyopia, visual training can accomplish little to heighten the quality of the existing binocular vision responses.

VII. SUBNORMAL VISION IN UNIOCULAR STRABISMUS

If I define AMBLYOPIA as an incurable condition, it becomes necessary to describe the type of subnormal vision found in uniocular strabismus that responds to visual training. There are many cases of uniocular amblyopia on record where an eye has been brought from finger count to usable vision and in certain cases even to normal acuity. How can we account for this visual improvement?

Before this matter can be satisfactorily discusses we must define what the term STRABISMUS means and what is meant by UNIOCULAR strabismus, in particular.

A. STRABISMUS may be said to be the condition where a single fixation object (of small dimensions) can be brought into direct line of gaze of only one eye at a time.

If the fixation object is a house at twenty feet, the lines of gaze of both eyes will be likely to intercept different parts of this house but a single window can not be looked at with the right and left eye, except by alternate fixation.

B. People who have one good eye and a subnormal eye will tend toward uniocular strabismus because it is easy for them to suppress the macular images of the subnormal eye.

On the other hand, individuals who have two equally good eyes cannot maintain suppression so well as the amblyope and tend to evolve gradually from suppression to the organismically much more acceptable use of the two eyes as independent visual organs, integrated without the benefit of fusion.

C. Uniocular strabismus represents the type of squint where one eye eventually loses the ability of direct fixation, so that, on occlusion of the dominant eye, the individual is no longer capable of bringing the object of direct regard onto the macula of the turned eye.

To illustrate what I mean, let me tell of a family of strabismics. The father, a physician, is a uniocular strabismic and all his sons are strabismics. Some are alternators, the rest are uniocculars. One of the uniocular strabismics, on examination, was incapable of direct fixation with the habitually turned eye when the good eye was occluded. He kept the eye turned in the habitual squinting position. This individual was subjected to tests with the Macula Stimulator which I described in the June 5th issue of the Optometric Weekly (1947). The method used was to align the test letter with the direct line of gaze of the turned eye. Visual acuity was found to be 20/40. When the good eye was now occluded the patient turned the other eye away from the test letter, which he had been able to recognize, with the result that he no longer could see this letter. His effective visual acuity came up very rapidly and finally reached 20/30. Can this be classed as amblyopia-ex-anopsia? I think not. In this particular case the squniting eye was amblyopic only to the extent of visual reduction to 20/30, the other eye being 20/15. With direct fixation assured, the lack of normal visual acuity may be considered amblyopia.

What really becomes ex-anopsic is not the vision of the turned eye but the fixation ability. If I should wear for years a strap which would prevent my left upper arm from being brought above a horizontal position, the arm would not atrophy because there would be a sufficient number of of movements to keep it active. Yet, I might in time lose the incentive to raise the arm straight up even when the strap was removed. I should have to learn to manipulate this arm in a normal manner in order to become proficient in the coordinated use of both hands above the head.

When a strabismic has been entirely uniocular for years, the turned eye is never called upon to fixate any object of special regard directly, because this has become the sole function of the other eye. Why, then, should it be surprising that the ability for direct fixation may no longer be present? The lack of direct fixation, in turn, results in subnormal vision. With such individuals the turned eye remains in its habitual strabismic position when the habitually straight eye is being occluded. Is it any wonder the off-macular acuity of the strabismic eye is very low when resolution of the object of direct regard is attempted with the dominant eye totally occluded?

C. Low visual acuity, due to lack of ability for direct fixation, readily responds to visual training, when such training brings about direct fixation of the object of regard by the strabismic eye provided that the foveal area of such an eye has not been damaged by prior injury or or disease.

D. By the time an eye has lost direct fixation ability it has assumed a position of some importance in the total visual behavior of the individual, but only in the direction of the turn. In that direction the individual now sees more clearly when both eyes are open than when the squinting eye is occluded. This constitutes an adaptation to the existing strabismus, an adjustment shift that may lead eventually to ambiocular vision.

E. Building visual acuity of the strabismic eye by prolonged total occlusion of the normally dominant eye, without the simultaneous establishment of an ability for binocular posture, may have the undesirable result of speeding the strabismic on his way to ambiocular seeing.

If the above propositions are correct, the following is also true:

F. Teaching the uniocular strabismic binocular posture, automatically raises the visual acuity of the turned eye.

VIII. STRABISMUS

A. In strabismus, a single fixation object can be brought into direct line of gaze of only one eye. Therefore, the adequacy with which this object is seen depends on the organismic ability to suppress conflicting sensations that reach the macula of the other eye, i.e., it depends on the organismic ability to prevent a binocular field percept.

When both eyes cannot look simultaneously at a single (small) object in space, although a binocular field percept exists, some other object is apt to be projected to the macula of the non-dominant eye. This object sets up rivalry sensations with the first one. The image of the second object must be suppressed for the sake of a clear and unhampered view of the first.

The sufficiency of the spatial concept of the uniocular strabismic is measured by his ability to retain selectively the object of direct regard in its totality as the central figure of his total percept. His ability to maintain spatial awareness depends directly on how well he can prevent the macular image of the turned eye from interfering with the macular image of the straight eye.

B. The prevention of a binocular field percept can be attained in two ways by:

1. Maintaining an essentially uniocular field by means of suppression (concession squint.)

If the strabismic has not learned to dissociate his eyes, he must, for the sake of correct spatial interpretation, suppress the macular image of the non-dominant eye. If he cannot do this, intolerable retinal rivalry results.

True suppression squint is rare because it represents a transition period to more effective strabismic seeing. The organism is apparently not willing to shelve an eye because it can no longer cooperate in normal fashion with the other eye. This holds true especially when the strabismus has developed in infancy or childhood. But even when the condition develops in fully matured individuals some adaptations, which delegate some useful purpose to the turned eye, are possible. Here the concession squint turns into a more or less adapted strabismus, where the turned eye takes over visual functions not normal to binocular seeing.

A suppression squint remains a "concession" squint so long as nothing new is learned toward an adaptation to ambiocular seeing. A true suppression squint pushes that which is not desirable into the background. We all have a tendency to do that, but not to the same degree. The squinter simply has more undesirable visual experiences to push aside. He learns to do this by totally suppressing the vision of one eye. This eye, then, no longer has any use except in the monocular field where the other eye does not see.

Such a situation is not acceptable to the organism for long. If the suppressed eye is capable of good vision along the direct line of gaze, the organism usually finds means to draw out all the capabilities of a turned eye. This causes no undue interference with what the straight eye wants to see. However, the process of re-adaptation is a very slow one.

2. Maintaining separate fields for right and left eyed seeing, as evidenced in the ambiocular vision of the adapted alternating strabismic, who seemingly relates the visual impressions received via the two eyes by a "thinking process" devoid of true fusion.

It has already been stated that there is an organismic tendency toward full use of all existing abilities. This holds just as true for visual as for other human behavior. It is a fundamental principle that no matter how handicapped a person is he will try to develop all remaining abilities. An individual with an artificial leg is prevented from moving about in the manner and with the ease formerly experienced. Yet, he will learn to coordinate the artificial leg with his good one. He may even learn to perform some special feats that cannot be accomplished by an individual who hasn't an artificial leg. There are, of course, individuals who do not care to recover the full use of their faculties after a calamity has befallen them, but they can no longer to be classed as following normal behavior patterns.

In respect to vision, while some semblance of the old habits of seeing can be retained, no matter how poor or inefficient they are, the subject will not make nearly as decided an effort to learn a shift to an entirely new performance. That is, the individual who can maintain a binocular pattern of seeing at near, though not as far, is not likely to acquire a highly developed ambiocular seeing.

C. How is it possible to acquire the ability to maintain separate perceptual fields for the right and the left eye?

This is one of the problems that will interest us for a long time to come. From the visual training angle it is important only to remember that ambiocular vision acts as if separate sensory fields for the two eyes exist. We can infer only from what these strabismics report that they "think" separately with either eye, and that closure of the single unitary percept is more nearly allied with the closure of the temporal sequence of events, as previously discussed.

It has been well established experimentally, that the alternation of right and left percepts, is not always a closure of temporal sequences. The ambiocular strabismic, in some manner, acquires the ability to interpret directly his visual space in two directions at the same time, in accordance with the respective lines of gaze. These two macular impressions are incorporated into a unified ambiocular percept by what is most likely a frontal lobe, a thinking process. Since there is no binocular field, there can be no fusion attraction between right and left images belonging to the same objects in space. Because there is no fusion attraction there can be no stereoscopic awareness, even of the lowest quality.

If one eye is turned off position so far that a binocular pattern of seeing cannot be maintained, how does the organism come to terms with such problem? Several adaptations are possible.

1. <u>The individual may make a strong attempt to straighten his eyes by an effort of will.</u>

   If a head injury causes a child's eyes to begin to cross, he will make every effort to prevent the strabismus. Even though by a considerable effort of will he manages to keep them straight, most likely parallism cannot be maintained indefinitely. He must occasionally relax and then the eyes assume a temporary crossed appearance. The child may organize around a particular head position which permits him to maintain straight eyes with the least effort.

2. <u>The macular image of the turned eye may be suppressed in the manner already discussed, if maintenance of binocular vision becomes too much of a mental burden.</u>

   The individual maintains uniocular posture during suppressio and sees the world from the straight eye, that eye becoming the locus of reference for all visual projection. The cyclopean (binocular) projection is discarded. If a pencil now is placed between the individual and the fixated object, the pencil is placed on the fixation axis of the straight eye. This is a subtle but important change which paves the way for the learning of a ambiocular seeing.

3. <u>Dissociation between right and left brain centers may occur through the constant maintenance of uniocular posture, the cortical disjunction resulting in dissociation of the sensory fields of the two eyes.</u>

   The return to separate sensory fields may be considered a regression to an earlier mode of seeing, phylogenetically speaking (Verhoeff), inasmuch as the binocular sensory field represents the highest development in the evolutionary scale.

The shift from separate sensory fields to a binocular sensory field is not a gradual transition, but an acquisition of something entirely new. Shifts of this type are well known in all phases of evolution. They are not extensions but mutations. It is essential to remember this, because it has a direct bearing on our approach to visual training of the strabismic.

4. The formerly suppressed eye can function organismically on a different basis, if the dissociation between the two eyes becomes complete. It can act as an auxiliary information center, capable of supplying spatial information because its line of direct gaze has a different direction than that of the other eye. The heightened acuity, which is available in the direction of the turned eye, may become a desirable feature in the total visual percept and may eventually be incorporated in the total spatial percept, but on strictly new terms - separativeness of right and left visual fields.

D. <u>When a strabismic has learned to see ambiocularly, he is not prevented from forming a binocular field structure if the opportunity arises</u>.

When, due to some fortuitous circumstance, conditions are such that a strabismic <u>can</u> maintain binocular posture for a certain visual task, <u>he may do so</u> and then return to his ambiocular seeing. In other words, a strabismic who has learned to interpret from both eyes in a strabismic posture may still organize his seeing around a binocular sensory field percept, if he has the opportunity and the desire. He may, allegorically speaking, leave the door between the two rooms open, entering one or the other at will; but he can <u>never be in both at once</u>. The fact that such an individual usually has the choice of both forms of seeing is not generally known. Yet, it is the most important single factor in considering ways and means of reconditioning the squinter to normal visual habits.

Returning to our allegory of going from one room to another when the shift is made from strabismic posture to binocular posture, the conditions existing in these two rooms must be considered to be entirely different. Suppose, for instance, that one room is occupied by people speaking English only and the other by people speaking only German. The individual who wants to be at home in both rooms will have to have knowledge of German as well as of English. If he is not equally fluent in the two languages, he will naturally prefer to remain in the room where the language with which he is most familiar is spoken and will enter the other room only on special occasions.

We find such a situation frequently occuring in visual training - that the strabismic converses with us thru the open door, so to speak. This is a substitute performance, because the shift from one form of seeing to the other has not actually, but only seemingly, occured. Much of the present day "training" if os this nature. It behooves us to devise controls to prevent such occurences.

Let us follow this allegory a bit farther. I was born and raised in Switzerland. My mother's tongue is German. If I had stayed in Switzerland, German would still be my preferred language. Because I came to America at the age of 21 and have resided here ever since, I have spoken English longer than German and now prefer English to German. This state of affairs was, however, long in coming. The only reason I have acquired a preference for English is that I have practically ceased to use German, except for short periods when I meet up with someone who can not speak English but knows German, or for the purpose of reading a German book.

The most difficult phase of the transition was that from thinking in German to thinking in English, particularly when mathematical problems were concerned. It was much easier to calculate mentally in German and report the result in English than to complete the whole mathematical probelm (silently) in English. It took a tremendous effort of will for me to make a total shift from German dominated thinking to English, but if tests were made today, only traces of my formed way of thinking would be found. Many foreign born never learn to make this transition, no matter how long they remain in America.

For the cure of a strabismic a similar transition has to be made. A complete transition is not necessary for the habitual maintenance of binocular posture. However, such an individual may occasionally (or frequently) return to strabismic behavior, simply because of his preference for it. Even if this state of affairs is far preferable to constant strabismic posture, it does not constitute a cure.

Just as individual who is inherently left handed can be taught to learn to use his right hand for writing and to become essentially right handed thru constant practice, so can we teach a person to maintain habitually a non-preferred visual posture.

It is my belief that no individual is inherently strabismic and that strabismic posture is always a learned adaptation. When an individual has learned strabismic seeing, it is never because of his preference for it, but due to necessity. It is helpful, at least, to make this assumption in our consideration of strabismus. We no longer have to fear the possible lack of a fusion faculty or fusion desire in our patient. We may concentrate on finding the underlying causes of the strabismus.

We are now ready to lay down certain postulates and restrictions in regard to the fully adapted strabismic as a basis for our training and testing program.

E. The ambiocular (fully adapted) strabismic can maintain direct fixation on two spatially separated objects, if they lie on the direct lines of gaze. Ambiocular vision means the ability to see in two directions at once. This describes the achievement level of the fully adapted strabismic.

A good deal of experimental evidence has been accumulated to prove that bimacular interpretation can be accomplished within 1/100th of a second. This indicates that we are not dealing with temporal sequence, but with a simultaneous process. The only difference between the ambiocular strabismic and the alternating strabismic is that the alternating squinter attempts closure of visual events (seeing alternately with one eye and then with the other) that follow each other in temporal sequence, while the ambiocular strabismic obtains a single unified percept of two spatially separated fixation targets (one belonging to the right eye, the other to the left eye) at a simultaneous glance.

The ambiocular strabismic has certain characteristics.

1. He is usually not aware of the fact that he shifts eyes, when he alternately fixates a single object in space.

When the ambiocular strabismic is confronted with a situation where there is but one target to draw his attention, he is apt to fixate it alternately, just as an habitual alternator does. The visual impressions gained by alternate fixations are cortically summated to form a continuous unitary impression. In this sense, his behavior does not differ from the alternating strabismic, who has not progressed to the point where he can simultaneously fixate two objects in space.

2. The strabismic has as little awareness of the temporal sequence of alternate right and left fixation as one normally has of the temporal sequence of the "fixation jumps" that occur in the process of reading. This, again, agrees with what the alternator, who is not a fully adapted ambiocular strabismic, may accomplish.

From the above it is apparent that the fully adapted ambiocular strabismic has simply extended the learned accomplishments of the less completely adapted alternator to include simultaneous fixation of two spatially separated objects. The alternator would have to interpret these objects in temporal sequence.

F. Ambiocular vision, which depends on strabismic posture, gives way to normal binocular posture when the individual makes a binocular posturing effort to fixate a single object in his normal surroundings.

It is the effort that guarantees his ability to do it. It is therefore, the posturing effort that matters, we do not have to question the patient's ability to interpret a binocular posturing effort.

The above postulates have been established through studies, through experimentation, through clinical observations. If we accept these postulates, how does that affect our approach to the problem of strabismus? These questions are considered herewith.

IX. VISUAL TRAINING IN STRABISMUS

A. The purpose of visual training in all forms of strabismus is (a) to elicit an effort at binocular posture under specific test conditions, (b) to extend this posture gradually over ever widening retinal areas in the individual's normal surroundings (c) to maintain it over more and more extended periods.

The rules laid down above can be followed explicitly and include all forms of strabismus, the suppressor, the amblyope, the alternator and the ambiocular. They all point in a straight direction toward the goal. The main purpose for all is the establishment of binocular posturing ability. It becomes, therefore, apparent that we can follow a single program of visual training for all of them.

I spent many years teaching how to differentiate between the various types of strabismus, because different training procedures had to be applied to the different individuals. As recently as a year ago I still was of the opinion that the ambiocular strabismic had to be "broken down" before a new pattern of seeing could be developed. This belief is still an accepted principle in most strabismic clinics.

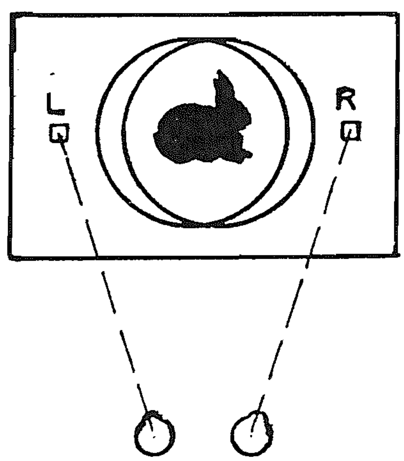
It has always been throught that the ambiocular strabismic and the individual who posseses normal visual functions represented opposite poles of specialized achievements and that the ambiocular individual individual had to be shoved by slow degrees toward the distant goal of normal binocular vision. If we think of the ambiocular strabismic as being at one end of a long path and the normal individual at the other end, according to old way of thinking, the distance between them has to be shortened one step at a time until they meet. Today we know that the distance can be covered in a single step.

It was not until I had experimented with the BSM technique, using an intermediate screen, that this realization was forced upon me in a rather spectacular fashion. The story has been told before but it bears repeating.

An exceedingly intelligent girl in her teens, an alternate exotrope, came to my office some months ago, not to have her eyes straightened but because she needed new glasses. It became apparent that she did not know how to look at any object with both eyes simultaneously. At the time I was interested in ambiocular phenomena and it was not difficult to interest her in becoming a subject for my studies.

We set up the testing procedure described in detail in my article on Binocular Vision in Strabismus under the heading "Measuring the Speed of Bi-Macular Perception." (Frederick W. Brock: Binocular Vision in Strabismus Part 2, Relationship between the two fovea in strabismus, Optometric Weekly, 1945-46). Two letters were projected onto two squares which had been drawn on a translucent screen. The patient was placed in front of this screen in such a way that the right axis of gaze intercepted one square, while the left axis of gaze intercepted the other square. Interchangeable letters were flashed onto these squares. The letters were read off without error at a hundredth of a second. This ability identified her as an accomplished ambiocular squinter.

It occured to me that this individual would be a good subject on whom to test the validity of my belief that retinal disparity clues would not be available for the interpretation depth variations produced by the Brock Ring method. It was decided to project the rabbit and rings (BSM 20-1-2) between the squares with the rabbit in the center of the total field. The green and red rings surrounded the rabbit and were initially brought to exact superimposition. The physical set up between the above is shown in the below figure.



While the right eye looked into square (R), the left eye was directed toward square (L). The patient reported that she saw the letters in both squares and that she also saw the rabbit and surrounding ring. The ring appeared to her to be half red, half green, as is customary in ambiocular vision. B.

When the rings were motivated, one to the right, the other to the left, the patient stated at once that she was aware of a single ring which seemed to move to C. the right and the left, but did not appear to leave the screen. She thought of the ring as being squashed and pulled into a barrel shape, and yet it seemed to remain perfectly round. Suddenly, she reported that her appreciation of the objective situation had changed and that now the ring seemed to come closer toward her and at other times appeared to recede to a position beyond the rabbit. A shrinking and swelling of the perceived ring also became apparent.

This was a distinct shock to me. At the time she reported these changes I was attending to the instrument and was on the opposite side of the screen from the patient. Consequently, I could not watch her eyes while she reported. When I realized the significance of her answer I felt as if ten years of study had come to naught. My whole structure, so laboriously built up over these many years, seemed to tumble. I had hardly the strength to change my location to view the patient. It was both a decided surprise and relief to find that her eyes no longer seemed in their former exotropic position but appeared to be directed to the center of the screen. My question "Where are you looking?" seemed to come as a surprise to her, because after a moments hesitation she exclaimed rather dazedly that she felt she was looking at the rabbit rather than the two letters.

It was but a very short period of time before the girl learned to maintain binocular posture both at the intermediate screen and the near-viewer. She progressed very rapidly in her acquisition of normal binocular vision.

This was the first indication which I had that posture determines the nature of the visual responses: If an individual postures binocularly he thinks binocularly; if he postures strabismically, he thinks as a strabismic must, if he wants to maintain an adequate spatial percept. To me, this was, of course, the beginning of a new line of reasoning regarding what an ambiocular patient can do, when proper test and training conditions are provided.

I have followed this lead since and found it applicable in most strabismic problems.

I have found it desirable to attempt to obtain a binocular posture with all strabismics right at the outset of training. When this can be done the training procedure is tremendously shortened.

B. In convergent strabismus the setting up of training situations at the crossing point of the visual axes by setting the training instruments to the existing angle of squint permits the patient to maintain his habitual strabismic posture. This is the most unlikely position where a binocular field percept can be developed.

C. In divergent strabismus, the placement of the target at the angle of deviation, either by adjustment of the instrument or by prism prevents a binocular posturing effort and therefore inhibits the formation of a binocular field percept.

Alignment of the eyes of a divergent squinter on a single distant object by means of prism is simply another method of bringing a fusable object on his two axes of gaze while he maintains an habitual strabismic posture. This procedure has a tendency to inhibit a binocular field percept because of the existing strabismic posture. As a matter of fact, when the above procedure is followed it is frequently found that the strabismic "runs away" from the impossible situation either by increasing his turn or reducing it just enough to prevent the like retinal images from forming on the respective maculae. He may report that he sees two objects at widely different points in his total field. He instinctively feels that the objective situation has no meaning, i.e., that it cannot be interpreted to his satisfaction.

1) Most divergent strabismics find it easier to posture binocularly at near than at far. Many of them maintain occasional binocular posture at near long after they have abandoned binocular seeing at far.

The object that is close enough to the person to be manipulated can be handled more satisfactorily while binocular posture is maintained. Threading a needle or using a screw driver becomes easier when the two eyes posture for the task. Greater competence of manipulation, which appears to be the main purpose of binocular vision, justified the development of this exceedingly complicated visual process.

2) The first binocular posturing efforts are, therefore, apt to succeed at close range when the perceptual demands are kept beyond the highest achievement level in uniocular or ambiocular posture.

This follows the reasoning we have been expounding in our whole approach to visual training. It is fundamentally sound and will pay dividends if followed explicitly.

Let is assume that we have a strabismic who has a 30 degree exotropia. This individual is persuaded to undergo an operation in which the surgeon pulls the two eyes straight by shortening the ligaments of the two internal recti. The question I would like to raise is, "Was the posture of this individual changed from a strabismic posture to a binocular posture by the operation?"

We may consider this question from a different angle. Suppose, instead of the operation, the patient had been supplied with sufficient base in prism to bring the two eyes to an effective parallelism, we should have accomplished essentially what the surgeon did. Again, had we placed the individual before an amblyoscope and had adjusted the instrument to the 30 degree exotropia, the resultant objective situation would not have differed from either of the above.

We all agree, I think, that the strabismic retains in both these cases, his strabismic posture. It must, therefore, also be assumed that thru operation no shift to binocular posture occurs. That so many of these operated individuals with straight eyes see double after operation, attests to truth of this assumption.

This undoubtedly, is the reason why it is customary in strabismus operations not to attempt to bring the two eyes in to exact parallelism, unless no establishment of binocular visual habits (after operation) is contemplated. Usually a near-straight position is found to be more satisfactory. The patient can then, by effort of will, bring about a binocular posture, if he so desires.

When the eyes of a strabismic are fully straightened, there is apt to occur a more or less violent reaction to this new status. The patient will make a decided effort to escape this new visual sensation by moving his eyes away from "there". If his eyes were fully straight before he makes this effort, any voluntary shift in the relative eye positions is necessarily away from the position where a binocular field pattern can form. In other words, any shift will be away from the very posture he should maintain. But if the eyes are not fully straightened by operation a shift of posture away from the original position may go either way. The chances are equal that it may be in the direction where a binocular field percept may become possible. The patient may suddenly realize that with a moderate effort he can now direct his eyes toward binocular posture, which is then apt to form. He learns to see binocularly by making the effort. Take away the need for effort, you take away the occasion to learn.

Let us remember that adjusting an instrument, or using prism to compensate for the habitual turn, is not synonymous with establishing binocular posture. Unless an individual wants to look at the same object with both eyes directly, he is not posturing binocularly for it, even though he may be made to look in that direction.

The question arises, How can we tell when an individual postures binocularly? Few strabismics know how to posture properly, and certainly not on their first attempt. It is fortunate that we do not have to have perfect binocular posture to obtain stereoscopic vision, provided we do not desire stereoscopic accuracy. We have seen that fusion attraction can occur with the eyes in considerable dis-alignment (possibly as much as 10 prism diopters of lateral disparity). This makes visual training a great deal easier. We should help the strabismic in his effort at binocular posture. When it is not within his power to posture at 12 inches, it may be possible for him to do so at 8 inches. It is, then, our duty to see to it that he gets a chance to attempt it at the closer range. Our job is to bring the target close enough for the patient to posture the way we want to. This is our main problem. It is also our responsibility to present him with an objective visual situation that does not require accurate posture for its successful accomplishment.

D. <u>The more realistic the objective situation is, which confronts the strabismic, the easier it will be for him to respond adequately when he makes a binocular posturing attempt.</u>

A septum in an instrument, which divides right and left eye seeing, has a tendency to foster separate field percepts (where the latter have previously existed) and is contraindicated in the early training of the strabismic. This is important to remember. Ignorance of this rule has caused a great deal of confusion amongst eye specialists and technicians alike.

Where a binocular field percept already exists the stereoscope is the instrument of choice. The use of the stereoscope should, however, be limited so long as regression to strabismic posture is to be feared. Even after full stereoscopic perception can be demonstrated to exist by the BSM or Vectograph techniques, an individual who has not been trained in the stereoscope may not be able to interpret through it and may revert to alternation in preference to binocular posture. We must be constantly on the watch that we do not present him with objective training situations which he can more easily associate with his strabismic posture than with his newly acquired binocular posture. Interpretation through a stereoscope is a special skill.

The strabismic should be trained as much as possible 'in the open', in other words, under conditions that approximate his normal surroundings. BSM (anaglyphs) and Vectograph methods of training seem to be the least artificial approaches for the training of stereoscopic perception.

Binocular rotations, under strict supervision, given by having the patient observe a candle or small lighted bulb, are a MUST in strabismus training. Care must be taken that the corneal reflections are well centered in the two pupils.

My favorite method of "touching pencils" is another excellent means of creating demands on visual skills that can only be met in binocular seeing. This method lends itself excellently to home training.

E. <u>Shrinking the perceptual field to exclude peripheral awareness is an unsound procedure, especially in amblyopia and strabismus, because a peripheral binocular field structure has a steadying effect on the macular visual processes.</u>

Only by inclusion of the periphery can the eyes be steadied sufficiently to permit of gross stereo-awareness. I have already mentioned Halstead's recognition of the importance of peripheral perception as in aid to fusion (Brain and Intelligence, p. 54).

F. In case of paralysis of specific eye muscles, the establishment of a binocular field percept in only certain areas in the total perceptual field is not contradicated, provided the individual is permitted to retain his ability to suppress the undesirable "secondary images" in the areas of his total field where he finds it impossible to maintain binocular posture (because of the existing paralysis.)

Training can be given for the purpose of effecting more adequate visual behavior in paralytic strabismus, where concomitancy of ocular rotations is known to be lacking.

As recently as a year ago I spent a great deal of time teaching how to differentiate between concomitant and non-concomitant ocular rotations so that they would learn to differentiate non-trianable and trainable cases. The non-concomitants were the non-trainables.

This still holds true for the doctor who insists that a sense of diplopia is perequisite to normal visual functions (stereoscopic vision). Only after we have learned to establish binocular posture without creating a sense of double vision, when the eyes are not straight, may we attempt to help the paralytic squinter to become more efficient visually. The improvement will of necessity be limited to those areas in the individual's surrounds where he can learn to maintain binocular posture.

As a matter of fact, some individuals will exhibit stereoscopic ability and binocular fixation in certain directions and show a tropia position (without seeing double) in other directions, before they come to us for eye care. In such cases it would be a disfavor to "improve" the situation by teaching them diplopia in the areas where binocular posture cannot be obtained.

G. The establishment of binocular posture at near (in both eso- and exotropia) is desirable, even though such posturing is not possible at infintiy. Binocular posture at near tends to keep the eyes cosmetically straight and raises the achievement level of manipulatory tasks.

Organismically, the important causative factor in binocular vision is the demand for space manipulation. This is not, however, the important consideration, as far as the patient's wishes are concerned. The individual who has never had stereoscopic vision does not miss it except on certain occasions. He is primarily concerned with the fact that his eyes cosmetically look different from those of the people around him. He comes to you for relief from the disfiguring turn of his eyes. That to him (or his parents) is the important consideration. If we can straighten the eyes to cosmetically acceptable proportions, we have accomplished a great deal.

This is of course the surgeon's argument who often hopes that the strabismic will go on seeing alternately after operation, as long as he keeps the eyes cosmetically straight. There is only one objection to this policy. If fusion does not develop when the eyes are quite straight, one eye loses its ability (to look into a different direction) and the individual, without knowing it, will gradually grope for an inclusion of the "ditched" eye in his total spatial percept. There are only two ways in which this can be done:

a) He may fall into a binocular pattern of seeing by learning binocular posture often to the pleasant surprise of the surgeon or

b) He may turn the non-fixating eye so that it can assume a position of some organismic importance - where it can observe (directly) a different object in space than does the fixating eye. This opens the way to a return of ambiocular seeing, which is the second way of establishing a stable relationship between the two eyes. Unfortunately, once the turning away from parallelism has begun, there is no way of telling how far it will progress. We can control the situation only through the establishment of a binocular pattern of seeing.

H. Any individual who can be taught to posture binocularly will be able to interpret according to normal binocular vision.

This is somewhat in opposition to conventional thinking. It is generally assumed that the chance for normal binocular vision after operation is greatly enhanced by developing the fusion faculty prior to operation. This is logical assumption but it has a dangerously weak spot. How do we know that binocular posture will be desirable, or even possible, after operation? I have seen some of my own patients undergo strabismus operations, after I had built up what I thought to be a strong urge for fusion by placing fusible targets at the angle of strabismus. Several of these patients showed after operation a total inability (or what I now believe was a total lack of desire for binocular posture) to fuse. As a result they developed a fusion aversion and a sense of diplopia which continued through the years although their eyes were in sufficiently straight position for normal binocular vision to function. We had created a binocular sensory field that became a burden and an annoyance to the operated strabismic. Today, I know that if I had waited to establish a binocular field until after the operation, my chances in all cases of strabismus where no binocular posture can be obtained prior to operation would have been better. By following this procedure we have avoided horror fusionalis and none of our patients is troubled with an annoying sense of seeing double.

Questions and Answers.

Question 1: Why is strabismus prevalent in certain families and not in others?

Answer: The prevalence of central scotomata in certain families seems to be one of the reasons. Until we know how many scotomatous conditions are due to lack of development of the macular nerve bundles, to birth injuries, to septic diseases or abnormalities in the formation of the orbital cavities (which create a greater susceptibility for scotomata in certain individuals) this question cannot be answered with any degree of accuracy. It is quite possible that the study of brain functions by means of measuring brain waves may throw some light on the cortical involvements which tend toward the development of divergent and convergent strabismus in cases where no physical abnormalities are demonstrable.

Retrobulbar neuritis is one of the known factors in the development of central scotomata. Whether the location of the central nerve bundles (reaching the macula) on the temporal side of the optic nerve immediately behind the eye makes them more accessible to toxic involvement is a question which is still debated. Apparently these nerve bundles are most susceptible to permanent injury in cases of optic neuritis. There may also be an inheritance factor.

Question 2: Is it advisable to start training at the crossing point in esotropia?

Answer: This is the one point where training should not be started. The place to "coax" a binocular field is always some distance beyond the crossing point. Let us assume that by bringing a light toward the eyes until the reflexes are centered on both corneas, the crossing point is found to be at three and a half inches. When the patient makes no effort to fixate the light binocularly at that distance, he should attempt it at five inches. It is this effort that is apt to bring about the shift from strabismic to binocular seeing. The establishment of rudimentary binocular field processes depends on the effort which the patient makes to posture binocularly. When the target is placed at the crossing point, we not only do not invite a binocular posturing effort, but we actually prevent it from occuring. On the other hand, if the object is brought beyond this point, the patient feels that he has "done something" when he is able to look at the target with both eyes (as he has been instructed to do). It is this effort to "do something" which is capable of changing his concept of what he sees. He has been forced to enter the other room instead of talking thru the door.

Question 3: How do we know whether or not a patient will respond to training?

Answer: If a patient cannot be brought to make the necessary posturing effort, the chances of establishing a binocular sensory field are slim. The only question is how far from the crossing point should the original attempt at binocular posture be made.

The push-up test can furnish the desired information. Increases in the convergence of the strabismic eye, when the light is brought closer, is frequently noted. This overconvergence stops at a certain point and both eyes suddenly fixate the light. Let us assume that this occurs at 3 1/2 inches. The retinoscope light should then be brought still nearer to the patient's nose in order to observe whether both eyes will follow the light in or whether the strabismic eye now assumes a position of under convergence. When the latter is the case we have no right to assume that the individual had shown a binocular posture at 3 1/2 inches. If, on the other hand, both eyes follow the light in to two inches before an apparent break occurs, the light is drawn slowly away from the nose and careful watch is kept as to when the two eyes abandon direct fixation. This may happen at 4 1/2 inches or at 10 inches. In the former case we should likely attempt binocular posture initially at five inches, while in the latter case at 12 inches, approaching the target closer only when the initial attempt proved a failure.

Question 4: What use has the amblyoscope in strabismus training?

Answer: The amblyoscope has a definite place in visual training of the strabismic. However certain restrictions should be observed to prevent the violation of the rules just discussed. For instance, it is important to remember that it is not permissible (to our way of thinking) to adjust a synoptoscope or amblyoscope to the existing angle of squint for an initial effort at establishing a binocular field percept. To try to establish a binocular pattern, in an individual who is permitted to maintain his habitual strabismic posture, simply means that you elect to fight against odds that you don't have to take. Besides, if you succeed, how will you induce him to change to normal posture?

When, on the other hand, you determine the existing angle of squint to be 35 degrees, and you attempt to establish fusion with the instrument at 25 degrees, your chances of success are greatly enhanced. However, even this does not constitute an advisable procedure. What the individual learns in the amblyoscope set-up cannot easily be transferred into his normal surroundings. When a stereo-percept can be established at nine or ten inches with the BSM technique the individual can apply what he has learned (or rather experienced) in his normal surroundings when an object is brought to this distance in front of him. To see that this happens is a part of the training program.

Question 5: If we achieve binocular vision in a former strabismic, without teaching him diplopia, can we afterwards take phorias and ductions as we do with non-strabismics?

Answer: This is an important question and the answer is NO. The reason is that when making duction or phoria tests, the patient can still revert to his strabismic thinking. Rather than see double, he will simply revert and report seeing only one target. In duction tests he will not be conscious of the breakpoint and the only was we can determine it will be by his observing a lateral motion of the fixation target, indicating that binocular seeing had been abandoned. It will be very difficult to determine a recovery point. The chances are that he will not again recover a binocular pattern of seeing, unless he is permitted to reorganize his binocular pattern outside of the phoropter. As a matter of fact, only if I am assured that the patient can maintain a binocular pattern at all times and <u>without undue discomfort</u>, do I consider that diplopia training may be given as a safeguard against occasional lapses into the former tropia position. Care has to be taken that as soon as a complaint of annoying diplopia is made diplopia training is immediately abandoned, at least for the time being. Also, before diplopia training is undertaken (as a final step) it has to be ascertained that fusion can be maintained in all portions of the field.

APPENDIX

A. Notes on testing the pre-school child.

This afternoon I attempted to show you how you can handle a two and a half year old child to get the maximum information. We had a very good subject for the demonstration. The doctor whom I approached for the selection of a little patient did not want to suggest her because she is so very bashful and shy. I assured him that was the very child I wanted. It seemed all very easy the way we went about it, but the child would have been a very difficult patient in the ordinary office routine.

You all watched me get a glimpse at the child's two foveas by playing the game of the two of us peeping into the ophthalmoscope from opposite ends, to see what was inside. This, of course, came after the delightful past time of "blowing out the candle." You noticed that as soon as the child blew at the exposed ophthalmoscope bulb (the "candle") I switched it off, regardless of how much I hated to do it at the moment because I was observing her for indications of binocular fixation (push-up test). After a while, I managed to tell her to wait with the "blowing out" until I told her to blow. In that way I could observe rotations and saccadic fixations at will.

When I was ready for the fundus examination I turned the light on inside the ophthalmoscope and from a distance directed the instrument in such a way that she could see the light. Then came the "game". "Do you see how I look inside this hole?" "Would you like to look in from the other side?" It was as easy as that. Once she did look inside, the macula was in clear view. I did not go for the disc, but by finding the macula centered in my light beg I knew that she had direct fixation ability with either eye and that she could not be very amblyopic. An amblyopic eye usually wavers and may not show the macula at all when the game is played. If a child refuses to play the game, don't ever force yourself on the child. B.

I would never set a child up on a refraction chair without making it difficult for him. I raise the chair up high and put an additional cushion on top of it and then am apt to say: "I bet you can't get up there by yourself - without having Mother help you!" The usual answer is: "I bet I can!" And up he goes! But you have to give him a better incentive to climb the chair than to have his eyes examined. That is as unpleasant a prospect to a child as is the dentist's appointment.

The child has, by now, become accustomened to two different lights. I show him that I have still another one. "Look, can you see the light while I wiggle it like this?" It is, then, not very difficult to get him to look at the little red dog, which serves as my dynamic target. The little red dog has still a smaller black squirrel underneath. "Did you ever see such a very red dog? What is he jumping over?" By the time the child has made up his mind how to answer the scoping is done.

Two things are, of course, important in all examinations: occular motility and the fundus picture. Refraction comes third. Once the child has permitted you to look into his eyes, refraction should not pose too much of a problem.

I never put a trial frame on a small child. If I need a lens, the big problem is how to get it in front of the child's eyes. As a rule, the minute you start holding something very close to his eyes he starts to get scared.

For the purpose of refracting children, I always use the standard old-fashioned trial case with the bi-concave and bi-convex lenses. I hold a lens up about midway between the child and myself and move it around. Soon the child wonders what I see through it and makes an effort to look through it also. That is the time to bring the lens, by slow degrees, nearer and nearer to his eyes. The difficult task is accomplished. A good refractionist can estimate a cylindrical correction quite closely without the use of cylindrical lenses. If I can get within a diopter of an accurate scoping, that is all I need at the moment.

It may be stated right here that we are very much in need of a suitable subjective test to determine within reasonable accuracy the visual acuity in a pre-school child from two years up. It is a difficult problem but by no means insurmountable.

B. Notes on occlusion of a pre-school child.

In order to make monocular tests for visual acuity or to prevent alternation of fixation during the difficult task of scoping, it is necessary to occlude one of the child's eyes. May I counsel you right here that you should never attempt to occlude a small child's eye yourself, at least not the first time. It is much better to let the child occlude his own eye by keeping his hand in front of it or to let the mother hold her hand cupped in front of the eye which is to be occluded. This does not permit you to place a trial frame in front of the child and that is just as well, because a frame would be apt to evoke a catastrophic reaction. It is much better for the examiner to hold a trial lens in front of the child's seeing eye and to be ready to withdraw it the minute he notices any sign of anxiety developing.

We had a little girl here this afternoon - the one I used to demonstrate how to approach a pre-school child in an effort to get the most information with the least amount of unpleasant reaction. You noticed that I played with the little girl while assembling my data. The parents came to the clinic, not to let my play with the shy little girl but to arrive at some decision regarding her strabismic condition. After I had finished the mother wanted me to advise her as what she should do about the strabismus. As you may well imagine, it takes more than one short visit to assemble sufficient data to give a valid opinion, but we were able to ascertain that the little girl is an alternating strabismic and shows no marked tendencies toward binocular posture. She seems to be well on the way ambiocular vision. What can we do about it?

C.

Because of lack of sufficient information let us make a few assumptions. Let us assume that the child had come to your office and you had gone through the first session in some such manner as you saw me.

Let us suppose that, on the third visit you had been able to find indications of binocular fixation ability at very close range. Having gathered this information it would not seem advisable, to my way of thinking, to order prolonged total occlusion of one of the other eye or alternate occlusion on alternate days because, by doing so you might destroy the binocular pattern of seeing. In this case it would be more advisable to order partial occlusion of both eyes which I shall describe shortly - to prevent the development of ambiocular seeing.

First let us discuss other questions which might leas us to occlusion. Suppose the little child in question had shown unilateral strabismus and that turned eye showed little inclination to follow a light or to turn directly toward a fixation object. It would, then, become necessary to occlude the good eye to determine the usability of the squinting eye. When such a situation arises with a pre-school child it is never advisable to occlude the good eye except for fractional periods until an estimate of the usable vision of the turned eye can be made. When total prolonged occlusion of the good eye is necessary we usually proceed as follows:

The mother is instructed to take the child home and tell him the next morning that one eye has to be closed up because it "looks bad." The mother then proceeds to occlude the <u>turned</u> eye rather than the good one by fastening a celluloid shield over it with cellophane or adhesive. The child is not apt to resent having his turned eye occluded after he gets over the first shock of having a "bandage". By the occlusion of the bad eye he is in no way handicapped visually and usually is quite willing to leave the occluder on for a quite a spell. As soon as it it becomes evident that the child is irritable because of the occluder, orders are to remove it for the rest of the day. This procedure is followed daily until the child tolerates the occluder for a whole day. Only <u>then</u> begins the process of occlusion of the good eye, at first for very short periods. Specific orders are given that the child is not to be let out of sight while the occluder is on the good eye and the every effort must be made to entertain the child and to coax it to <u>play</u> while the occluder is in place. Under no circumstances must the occluder ever be used as a means of punishment for bad behavior, or for bad behavior during occlusion. It is only after it has been ascertained that the occlusion of the good eye has no bad effects on the child's behavior and ability to get around that the occluder may be left on the good eye for days at a time. If the child shows indications of inadequate vision when the good eye is totally occluded, it becomes necessary to attempt to improve the visual deficiency. Low vision may be due to lack of fixation ability of the "abandoned eye" or to a central scotoma.

C. Notes on training the pre-school child.

In our own procedure this child would be brought to the office at least twice a week for "play". Carefully supervised "games", such as tracing the bunny (BSM 20) as projected through a ruby filter onto the intermediate screen, would be played. The child would wear red and green filters, the green one over the good eye. Thus the bunny could not be seen by the good eye and the child would have no feeling of occlusion of that eye. Other games are - playing with marbles, picking up small pellets, or stringing beads with the good eye totally occluded.

We usually advise parents to buy the child two identical coloring books with bold outline drawings. The child is allowed to color in one book with the good eye, followed by an attempt to color the same page in the other book with the good eye occluded. In this way it is often possible to establish a desire in the child to do as well with one eye as with other, without causing resentment in the child that the specific task has always to be done with the "bad" eye when he knows that he could do the task so much better with the other eye.

When it is possible by such methods to bring about satisfactory fixation of the formerly turned eye, it is permissible to alternate total occlusion of the good eye with a day when both eyes are allowed to remain open. This gives the child a chance to develop binocular posturing ability, if that it within his achievement level. It is not permissible to maintain both eyes unoccluded for very prolonged periods, if after a month of two there are no indications that binocular posturing occurs. Keeping both eyes permanently in the race is simply to invite the emergence of an ambiocular mode of seeing (associated with alternation), which will complicate the original problem rather than simplify it.

Case Report. The following story was given as a background - At the age of three the child's eyes become partially turned. The mother became perturbed and brought the child to a local medical practitioner. The latter furnished the information that the refractive condition was approximately plus 2.00 OU and that she had 20/20 vision with each eye. The doctor ordered occlusion of one eye when the child was three years old. The child now is nine, so that occlusion was begun six year ago. Every six months the child was brought to the doctor's office but apparently nothing was done except to take the occluder off one eye and place over the other eye. This procedure was carried on for six years, so that, as of today, the child has had every minute of her waking hours one eye or the other totally occluded. Now this is what her parents report: - Year by year the occluded eye turned in farther and farther so that today the child has a tremendous convergent squint with one eye almost lost from view when the occluder is removed. On examining the patient I recommended removal of the occluder. When the mother agreed, the child broke into a terrible fit. She became completely hysterical at the thought of the occluder being removed from her glasses - for the first time in six years. It was an insurmountable problem for her to face. Because of her violent reaction the matter was dropped immediately. After a few more visits, her acceptance was gradually obtained, as psychologically she accepted the new situation. There is the background of that story.

Has this child been able to develop a binocular posture? The answer is that binocular posturing has been inhibited for the last six years. On the other hand, occlusion has not permitted her to develop an ambiocular (strabismic) posture, and in that sense the procedure was justified.

The fact that the eye turned more after occlusion is not an isolated case. We have recently had several reports in the ophthalmological literature of similar occurences, which questioned the advisability of total occlusion for this very reason. The report went on to say that in several instances, where occlusion was carried out because of amblyopia associated with straight eyes, they had strabismus to deal with after occlusion therapy. Actually some parents sued the doctors responsible for the occlusion because of the resultant strabismus. It is therefore quite true that total occlusion has its drawbacks.

I do not agree to total occlusion of one eye for any extended period. It is not an acceptable procedure in my way of thinking. If total occlusion brings about a better fixation, the better fixation can be brought about more directly by visual training. So why not train? Total occlusion certainly cannot build a binocular posture, because it destroys any possibility of an occasional attempt at binocular posture from becoming effective. These factors have to be considered in occlusion therapy.

On the other hand, subnormal vision in uniocular strabismus frequently improves under total occlusion, the patient becoming an alternator. In such cases occlusion therapy is acceptable until direct fixation ability has been established. Then a different kind of occlusion should be started.

The second kind of occlusion is the one we want to consider now.

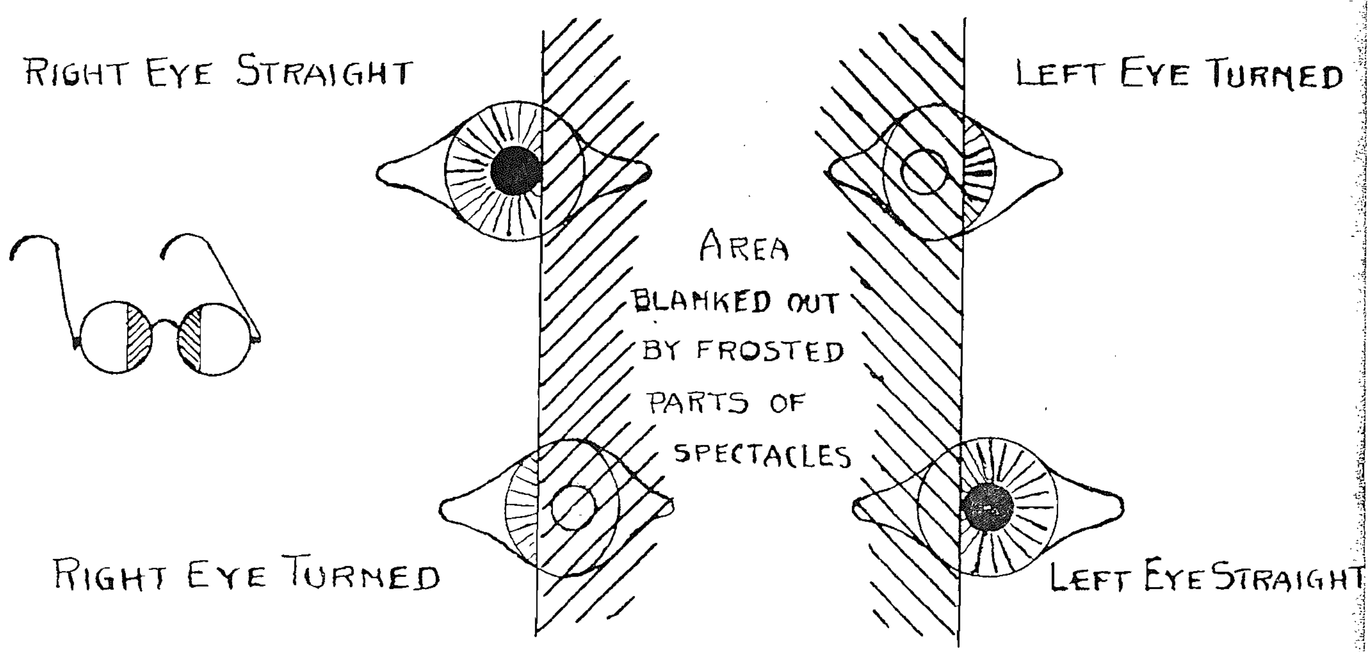
D. Notes on the use of HALF OCCLUDERS

If we take the total occluder off the little patient, she will have no incentive to binocular posture. Also, if total uniocular occlusion is abandoned, the visual impressions that enter via the turned eye will have to be cortically "suppressed" or interpreted according to the relative eye positions. Inasmuch as this patient is so very strabismic, interpretation will follow strabismic laws, in other words, ambiocular seeing (strabismic posture) will eventually evolve, unless prevented.

Question: Could ambiocular posture be prevented by occluding one eye the first day, the other eye the second day and not occluding either eye the third day, so that the child might "fall into" binocular fixation at least at near?

Answer: In my opinion this procedure would not effectively prevent the advent of ambiocular posture. By alternate occlusion each eye would be forced to take over the visual functions of the other (occluded) eye. The third day there would result a rivalry between two eyes as to which should take the lead and which should be suppressed. It is quite likely that this procedure would hasten strabismic posture rather than prevent its occurence.

It seems to me that the answer to the problem is - put on half-occluders on both eyes for a prolonged period. This is best done by frosting the nasal areas of both spectacle lenses so that, on gazing straight ahead the whole pupil clears the frosted area (see figure). This method can, of course, only be applied in marked convergent strabismus, because it would not be safe to occlude the temporal fields in divergent strabismus (one eye cannot take over where the other eye does not see) they are not overlapping fields.



From the figure it is evident that, when the one eye looks "out" the direct line of gaze of the other eye is directed under the occluder. A macular image cannot form in that eye so long as it is turned. If both eyes can clear the occluder, the eyes are cosmetically straight and a binocular pattern of seeing is possible, provided the strabismic wants it.