THE INTERRELATIONSHIP BETWEEN MYOPIA, PERIPHERAL AWARENESS, AND ATTENTION: A HOLISTIC APPROACH

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INTRODUCTION

When one considers the etiology of myopia both hereditary and environmental contributions must be accounted for. Several studies have been undertaken in the past which lend support to both theories, so it must be believed that both add a factor in the development of myopia. This duplicity creates an enigma for the optometrist attempting to give the best possible care.

If the optometrist concerns himself with the genetic factors of myopia his regimen of care will primarily be concerned with the compensation of the refractive disorder and possibly attempts to alleviate its progression by use of questionable techniques. This philosophy of treating myopia is remediative. The myopia is already present and treatment entails the utilization of prosthetic lenses to eliminate the blur at distance. This may, however, be the only way to reduce the hereditary aspects of myopia.

On the other hand, if the clinician decides to also concern himself with the environmental contributions then care can become preventitive. Environmental theories consider a more holistic approach to myopia and such external factors as lighting, temperature and environmental structure, and such internal factors as accommodation, convergence, personality and visual style. Functional optometrists are alert to the fact that one's visual performance requires skills far more extensive and diverse than that of simply visual acuity.

The difficulty in obtaining acceptance of the fact that the environment indeed does have an effect is that it is difficult to undertake controlled studies,and when they are done, not everyone is affected the same way. This is because people do not undertake tasks in the same manner. How one approaches visual tasks depends upon an individual's visual style.

Visual style is dependent upon many internal factors. It has even been stated that the genetic factors of myopia may be only familial influences on personality and influences on how the child undertakes visual tasks. Whetever the reason, a person's visual style, specifically how an individual approaches and is affected by nearpoint tasks, does contribute to refractive errors.

There is a difference as to how a person with a myopic tendency attacks a nearpoint task. He becomes very centered and loses awareness of the periphery. "Myopia may be regarded as the abandonment of a part of the total space world." (Skeffington; 1970) Whether this centering tendency is a personality characteristic is not up to the optometrist to determine. The optometrist must only realize that differences in methods of attacking nearpoint tasks do exist.

V. I. Shipman stated at the Eastern Psychological Association Conference in 1955 that "stress brings up a constriction of the perceptual fields, and the child observes less, sees less, remembers less, learns less and generally becomes less efficient." Since myopia also results in loss of peripheral awareness then perhaps the visual style of the myope results in a less effective ability to obtain information from the environment.

One must also realize that nearpoint stress, personality and myopia are all interrelated. One cannot differentiate as to a cause and effect. Yet one must also remember that not everyone develops myopia along a functional model and not everyone develops myopia because of nearpoint stress. An optometrist must consider all factors when treating myopia.

The purpose of this paper is to look at the visual styles of myopes and determine if indeed there is a loss in peripheral awareness during cognitive functioning and whether this reduction results in a decrease in attention. Even though this has been stated in literature for many years little evidence has been found to support this hypothesis. The study undertaken in this paper will hopefully provide some support.

RESEARCH

The word stress denotes forces which act against a resistance. It designates the sum of all the non-specific effects of various factors which can act upon the body and create induced changes within a biological system which are dependent upon an individual's external and internal conditioning factors. These diverse environmental situations result in a universal organismic reaction (Selye; 1956). Many people are capable of coping with stress, but for those who cannot, a reasonably uniform group of maladaptations occur. These bodily changes act upon mentality and vice versa.

The human body, within certain limits, is fit for survival by its capacity to adjust itself or its various relationships to each specific environment that it finds itself in. It is able to maintain homeostasis, to go into action establishing balances with the forces and restraints which surround it. This is accomplished by the organism by shifting its internal equilibria between various body parts and systems. Through repeated function, many of its structures are modified or adapted to fit the specific environmental factors it encounters in its day to day existence (Harmon; 1951).

This rate of adaptation varies directly with both the intensity of the stress and the time over which the organism is subjected to the stress. The effects of the stress induced by any given situation for any individual varies inversely with the readiness of that person to successfully cope with that specific stress. It also varies directly with the individual's motivation to overcome or respond to that stress at a given moment (Emory; 1970).

Any impairment in any area of performance spreads to the total performance. The impaired organism then must come to terms with its total environment as best it can, but when it cannot, it shrinks the environment into one in which it is able to function optimally. When this occurs, it happens suddenly, without the knowledge of the patient. This means that it is not a product of a learned response (Skeffington; 1961).

Visual stress may also result in functional reductions in peripheral sensitivity (Margach; 1975a). This shrinkage of the environment may not be due to a loss in acuity, as in adventitious myopia, nor a loss in the ability to center bilaterally, as in strabismus, but may be entirely cortical. These distorted cortical responses impose changes back upon the receptor mechanisms themselves. Consequently, these distortions, or shrinkages, of the visual mechanism that do not result in myopia or squint do result in changes in the spatial coordinates so that measurements made thereafter will reveal the presence of a deviant performance (Skeffington; 1962).

A person can react to stress in one of two ways, fight or flight. Consider the pressure of obtaining an education, which involves a great deal of reading. Man is built for survival as a hunter which requires flexibility of the visual system at the far point. He is not built for such sustained closework as reading and writing. However, in order to meet the demands of the educational process, man must develop the facility to maintain visual attention at near (Wiener; 1970). "Reading is a task as distinct from the total, nonrestrained process of seeing in the more primitive world... The organism comes to terms with its total environment as best it may. It usually shrinks the environment internally and externally" (Hendrickson; 1976).

The philosophy of the Optometric Extension Program is that near vision places demands upon individuals today that constitutes a "culturally imposed, socially compulsive task, for which we are not biologically suited" (Birnbaum; 1978). There simply has not been sufficient time for evolutionary changes to meet the demands that reading results in. As a consequence, many individuals develop compensatory changes in the visual system. Those who do not sufficiently adapt to the near visual requirements may withdraw from and avoid nearpoint tasks or may persevere and endure the resulting asthenopic symptoms. This is not adequate since the investigations of Dr. S. Howard Bartly concluded that asthenopia occurs only when visual achievement has dropped to a point unsatisfactory for the organism to meet his needs (Skeffington; 1961) and so function must somehow be altered.

All systems in the body have a range of function. When the demands are high the systems of the body must work harder in order for the body to meet the demand. Then, once the high demand is gone, the body returns to a relaxed state. Should the tension producing demand remain, the body will change its structure to make it easier to function. This range also exists in the accommodative and convergence systems of the eyes.

Hyperopia and exophoria represent buffers that protect the visual system from nonvisual stress, especially the accommodative and convergence mechanisms necessary in near point tasks such as reading. The eyes focus enough to give the brain adequate information so that meaning can be derived from the situation being viewed. The amount of accommodation and convergence utilized tends to be directly related to the demand of the material being read. Many experiments have been done which show that complex reading material results in over-stimulation of the accommodative system.

"Reading is a highly complex, purposeful, learned, disciplined, thinking process engaged in by the whole organism" (Sutton; 1976). When a person focuses more than is necessary to meet the focal distance demand of the reading task tension results. This tension will show up in the eyes and the muscles of the body. This tense state results in the expenditure of more energy than the task requires. Dr. Samuel Renshaw demonstrated this physiological interrelationship between body function and reading (Wiener; 1970). As a student engages in reading tasks of varying difficulty, changes were noted in blood vessel size, skin temperature, respiration, blood pressure and pulse rate, as well as the focal power of the eyes. As the comprehension level of the reading material was increased in difficulty, stress levels as indicated by bodily functions increased and the student focused at a point closer in space than the distance at which he held the book.

Maintained attention is one of the more basic potential visual stress procedures. The physical immobility required while undertaking near visual tasks is in direct contradiction to the biological need for mobility. The increasing accommodative and convergence responses are a measure of that resistance. One can therefore view limitations of movement as being a major cause of the convergent response of the organism which is then reflected in all its operational styles (Forrest; 1980).

Voluntary attention is sustained by force or effort and is accompanied by a sense of strain or tension. It accompanies the doing of anything that is done when one would rather be doing something else; tasks done as a means to an end rather than an end in themselves. Activities driven by voluntary attention are therefore more or less unpleasantly toned in feeling-quality. They must be supported against pressures of competing thoughts and impulses despite the absence of any immediate compensatory pleasure for the labor extended. Attention is a form of psychological reaction which is voluntarily controlled (Grant; 1938).

Visual processes therefore enter into localizing a person in space, adjusting his posture to create a balanced and efficient relationship with that which he wants or needs to manipulate. Holding his body in support, the individual identifies the significant factors or symbols in the surround, synthesizing and unifying other sensations and experiences with the immediate visual ones in order to derive meaning. As the centers of action in performing a task get closer to the individual, the organic stresses produced by these reflex body mechanisms are intensified (Harmon; 1951).

Under increasing stress, perceptual behavior is disrupted and becomes less well controlled than under normal conditions. This makes it less adaptive, affecting the major demensions of perceptual function. Selection of items from a complex field becomes less adequate and sense becomes less well differentiated from nonsense. The maladaptive accentuation is towards the direction of increased aggression and escape (Postman; 1948).

An individual must learn how to select an area within the visual field when he will extract attention and meaning. In the process of selecting an area for attention certain portions become figure and other areas become ground. In order to derive proper meaning there must be a relationship between figure and ground. Some people tend to see more in terms of detail or figure. Others deal more with generalities or ground. An individual's figure-ground relationship tells us how a person is structuring his visual space world (Sutton; 1976).

The very nature of selecting an area in the visual field where attention is extracted implies visual loss. At every step of the way some aspects of stimulation are transmitted at the expense of others. Those selected become represented in a new way such that recovery of the previous form is often impossible. This process is accompanied by an irreversible loss of all information not present in this new representation (Haber; 1973).

During extreme concentration one group of impressions become very clear while others become correspondingly obscure until a sharp degree of contrast is obtained. The more acutely in focus the center of the field is, the more vague and sketchy the margin. This implies that there is only so much "attentional energy." It is possible that this energy level remains constant, varying simply between center and margins (Grant; 1938).

We do not merely see what is "out there". "Perception is an ongoing process that involves our image of ourself, our needs, values and purposes as fully as it involves the image of the object perceived" (Wittreich; 1959). It is important to understand that visual attention is not simply an ocular alignment: It is a learned awareness of the surrounding visual space based upon many inherent factors.

Studies have been undertaken to show the many problems of sustained attention. Vigilance performance has been found to improve when short periods of rest, conversation, mild physical or mental exercise or sensory restriction were introduced into the task. It also helped when the area of the visual field in which the information is to be extracted from is restricted. Greater rewards also tend to improve performance, as do knowledge of prior performance. It was also found that the subjects with high introversion scores did better at the vigilance tasks (Stroh; 1971).

Since the functional capacity is usually determined by the subject's awareness, the findings are influenced by psychological and physiological factors. The two components cannot be strictly differentiated. However, when the task becomes more complicated, the more influential the psychological factors become (Aulhorn; 1972). An individual's visual information style is part of his total pattern of behavior and is reflected in all areas of his performance. "One should therefore find a consistent relationship among a given individual's cognitive, perceptual, personality and even visual styles" (Forrest; 1980).

It is the general belief of many that the only way to succeed is to close off awareness of the periphery. "Carrying this early indoctrination into adult life may have profound negative effects on not only the learning process, but on every aspect of a person's life" (Wiener; 1970). It can be argued that there are times when intrinsic concentration is necessary. However, persons with this particular visual style function continuously in this fashion. People must learn to trust that their visual and mental processes take the information they receive and convey it to the brain. Comprehension and understanding occurs automatically.

The effect of peripheral items on the recognition of foveal items has been studied by numerous individuals. Mackworth (1965) found that foveal recognition was impaired by peripheral visual noise. "Recognition scores for material in the fovea fell to three-quarters to two-thirds of achievement at the noise-free level when extra letters fell on the periphery of the retina." The concept of the useful field of view or the dynamic field of view helps to understand the results. Too much information causes the field to contract to prevent "overloading the visual system." Excessive visual noise creates tunnel vision because priority was given to foveal items. However, the addition of unwanted peripheral stimuli also impaired foveal vision.

Hagen (1972) found that the level of central and incidental scores were directly correlated with age. "At younger age levels those children who did well on the central task tended also to do well on the incidental while at the oldest age level, high central performance was associated with low incidental performance." This shows that the ability to maintain central task performance by excluding certain information increases with age. The major evidence of this change did not occur until the age of twelve to thirteen, however. It is interesting to note that this is also about the same age that functional myopia begins.

Children are taught to perform by restricting peripheral function even though this often results in undue tension and decreases in overall efficiency. "Though he may achieve high grades, he will see less, hear less, and be less physically aware of himself" (Wiener; 1971).

The problem with studying the effects is that these are learned styles that are difficult to remove without visual training. Hallahan (1972) studied the differential effects of proximal and distal distractions on the performance of learning disabled children. Learning disabled children were more distracted than normal children by irrelevant distractors that were placed in close proximity to relevant stimuli. Experiments involving extraneous peripheral distractors did not decrease the learning disabled child's performance. "Some evidence, in fact, suggests that these distal distractors improve the performance of learning disabled children, educable mentally retarded children, and young normal subjects." It was felt that extraneous distractors help children to discriminate relevant from irrelevant aspects of the task.

The potential contribution of the periphery to the functional performance of the eye must be appreciated when one considers that the fovea encompasses only a small portion of the visual field and only about 16% of the visual fibers are concerned with maximizing acuity. Studies have shown that the refractive error of the periphery varies greatly. It has been found that correction of peripheral refraction increases sensitivity but did not result in improved performance (Leibowitz; 1972).

Also, the use of the peripheral vision is not only dependent upon physiological factors. Learning and experience have been shown to play a very important role (Leibowitz; 1973). Some people show disproportionate amounts of peripheral loss under high demand (Margach; 1975b).

A distinction between the dynamic and the static fields is significant in evaluating the performance of an individual in any situation involving peripheral fields. The static visual field represents the physiological field of view. It is the field obtained with the eye fixed in the straight-ahead position while viewing a nondiscriminating target. This creates a type of passive attention which allows for a greater degree of awareness to the external world. Ferrie and others (1929) utilized a Ferrie-Rand perimeter to measure the breadth of the field variations among various refractive errors. The field measured 67.42° for emmetropia and 64.98° for myopia. "In general the emmetropes and hyperopes have the wider fields, the myopes, the narrower fields" (Ferrie; 1926).

The dynamic field of view represents the functional field of view. It is the volume of peripheral vision that a person is aware of while he is engaged in a cognitive task. When a person is engaged in a task demanding more of him than he can easily meet his visual field reduces. "The clinical testing is done essentially by questioning and observing a person" (Weiner; 1970).

The size of the dynamic field is dependent upon many factors including difficulty of the cognitive task, personality, stress factors and other variables that cause it to alter from day to day. With all of the other factors accounted for, a person's visual style will determine how much constriction will result. Not all people start with the same pattern of skills.

> "Some have great eye movements but lack flexibility of focus. Others have seemingly adequate focus flexibility and yet are not well-oriented in space. Individuals may be grouped into general categories based on the presence or absence of the various visual skills previously discussed. These categories are called perceptual styles, and they relate to the integration of various visual skills that are available to the individual. An individual's perceptual style is the characteristic method or technique which he employs in order to solve a problem or process information..."
> (MacDonald; 1976)

MacDonald has made various postulations concerning visual styles based primarily upon their central-peripheral organization of their space world. Some individuals tend to see detail and see by building a total visual world by scanning. They see in terms of figure. Others tend to be more peripheral, to be more aware of their entire visual space world simultaneously.

Variations in visual styles can be found in everyday life. The "bookworm" child becomes so wrapped up in what he is reading, so central, that he loses awareness of that which surrounds him. Others seem to be able to do two different things at the same time; they can attend to a task while maintaining awareness of what is going on around them. (Birnbaum; 1978).

It may be that myopia originates in some because of a more central visual style. The key to maintaining efficient binocular performance is to maintain flexibility in the system and to only put in as much effort as the task demands. If a person puts too much energy into a task at near it creates a problem for viewing at distance. "Myopia is held to be one of the more common deteriorations of visual performance stemming from nearpoint stress" (Margach; 1978).

The parasympathetic system innervates accommodation. Under stress, the parasympathetic impulses are inhibited. This creates a drive to converge creating more eso. Stress thereby produces a drive so that centering, the selection of an area in space for attention and meaning, takes place closer than identification. The person then must inhibit convergence.

To look at distance, convergence relaxes even more resulting in the distance phoria findings becoming more exo. This could develop into an exotropia at distance. Most people, however, release accommodation only enough to straighten the eyes. This represents the pseudomyope, the first measurable stage in the development of myopia, and the shrinking of the person's visual space.

Myopia may be described as a restriction of the person's volume of operational space and his ability to locate where objects are in space. The movement of his volume of space towards himself may occur concurrently with the restriction of information from the peripheral areas. It is not that one loses the ability to see out in the periphery, it is more of a problem of utilization of material obtained in it.

When attending to a task such as studying, the myope aids his visual style by studying in a quiet room with his desk up against the wall. The myope puts all of his concentration into whatever he is reading. This results in a lot of excess energy being wasted.

Studies on the effect of restricted visual space on monkeys by placing hoods on them resulted in an average change of 0.75D in six months. "Since the animal can only view the parts of his body and the chair when enclosed within the hood, he must converge and accommodate if he looks at anything. This nearwork is not exactly comparable to that performed by humans when reading or doing work which requires concentration. It is possible that a greater change would have occurred if a closer approximation to the human near work situation could have been obtained" (Young; 1961).

It has been known for over 100 years that college life resulted in an increase in myopia (Derby; 1879). More recent studies have also been done. At the U.S. Naval Academy first year plebes must have good acuity since it is a requirement for admission. In one class more than half of the class ended up with myopia (Kavner; 1978).

The reasons that not all students develop myopia is because of differences in visual styles as discussed earlier and psychological variables such as personality, interests, and values. A number of studies have been undertaken to delineate the relationships between myopia and these variables.

Although no conclusive evidence has been found, tendencies towards certain characteristics have been found.

> "A parsimonious framework for the available data could involve the following: (a) some persons engage in visual nearwork more frequently than others, either because they find it more rewarding or personally compatible, or because their life's circumstances demand it; (b) this behavior has physiological consequences, perhaps involving the accommodative mechanism, resulting in increased axial length of the eye and therefore increased refractive error; (c) this behavioral-psychological process may be reversible to some extent; and (d) a variety of undetermined factors including possible influences are also involved."
> (Lanyon; 1971)

Myopes have been found to have a tendency towards introversion, introspection, shyness, a disinclination to sports, and seem to prefer sedentary activities. They tend to be self-centered, dogmatic, diligent, and in control of their emotions. Myopes are ambitious and tend to pick occupations in which individual achievement is prized. They tend to avoid high stress situations and are cautious, doubting, and compliant, and enjoy examining and analyzing things. In stature, myopes tend to be tall and thin (Kavner; 1978).

Myopes, on the average, score higher on every measure of academic aptitude. Myopia correlates positively with wisdom and imagination, while it tends to negatively correlate with caring for happiness, family, security and politeness. In general, myopes have been described as introverted, more interested in the world of ideas than of action, and oriented towards academic achievement (Singer; 1978).

There is no evidence on whether myopia precedes or follows the development of these personality and achievement characteristics. However, Francis Young wrote "these results suggest that it is possible to classify individuals as to myopia before the condition develops, so that the person could be referred to an eye physician for preventative treatment" (Singer; 1978). This has yet to be proven.

Myopia, therefore, is not simply an elongation of the axial length of the eyeball. It entails a more holistic response to a stressful environment. "In the over one hundred years since Helmholtz, visual scientists have been busily engaged in a dedicated endeavor to divorce the eye as an organ, and the retina as a sensory surface from the rest of the body, in the hope that by this isolation they could arrive at fundamental laws governing the visual process... Instead of being considered as an organ and a sensory surface independent of the body and the muscles, the eye and the retina are viewed as critical components of dynamic motor sensory feedback loops which govern both the receptors and the brain... Instead of viewing the afferent pathways of the eye as psychophysical mechanisms, they are considered here as input pathways of the head, an eye motion feedback system that also processes closed loop arrangements with body motion" (Dram; 1979). Myopia indeed is a reaction of the entire body to the stress produced by near visual tasks as well as a response to various intrinsic factors.

METHODOLOGY

The purpose of this study is to evaluate the visual style of the myope, specifically whether cognitive functioning results in a greater loss of peripheral awareness in the myope and whether this results in a decrease in attention. It is the contention of this author that myopia results in reduction in cognitive efficiency which results from the expenditure of excessive amounts of energy in order to restrict peripheral awareness.

Testing therefore involves measuring the size of the peripheral fields during cognitive functioning while measuring the level of attention the individual is utilizing while undertaking the task. The task undertaken was the reading of the Educational Developmental Laboratories Reading Eye Test Selections (1958). The size of the field was determined by use of a Bausch & Lomb Projection Perimeter.

Difficulty resulted in determining the most accurate method to record attentional function. It was decided to utilize variations in the amplitude of the occipital alpha rhythm. There exists a relationship between the amplitude of the alpha wave and visual processing. "In most people the amplitude is largest during the least visual processing, i.e., eyes closed, no mental visualization activity and is minimal, i.e., attenuated and desynchronized with eyes open, clear, fused, macular visual imagery (Ludlam; Jan. 1979).

However, it is not certain what this attenuation represents.

Alpha attenuation is used as an objective correlate of attention in visual and psychological experimentation. In most people the eight to thirteen Hertz undulating waves characterize alpha activity with a maximum amplitude of forty to 60 microvolts with the eyes closed. Walter stated that the occipital alpha rhythm represents a perceptual "gating mechanism through which sensory inputs from the various modalities may enter the stream of consciousness, thus acting as an electrophysical result of the psychological process of attention"(Ludlam; 1976).

Ludlam believes that suppression of the alpha wave resulted during attention to a visual stimulus. In order for a person to attend to a visual task he must suppress his alpha responses. The alpha response varies in respect to perceptual control from central cortical areas, perhaps the reticular activating system. Central processes determine whether alpha waves are suppressed or not.

[illegible]lland, [illegible] and Peper feel that the alpha wave is related to oculomotor functions. They feel that changes in the EEG can be explained in terms of changes occurring in cortical regions responsible for visual control processes. A relationship has been established between the oculomotor function in areas 17, 18 and 19 in the brain and the ability to [illegible] changes in the alpha response (Ludlam; 1976).

Many other theories concerning the origin of alpha waves have also been proposed. Probably the amplitude is due to multiple influences. None of the theories available account for all factors involved in the alpha response. It is probable that the answer lies in the existence of a mechanism incorporating facets from all of the motor, sensory-neural and attentional functions. For this reason during various parts of this experiment it was attempted to have only one aspect of the task change, namely the subject is asked to perform the same task utilizing a different EDL Reading Eye Test selection while being aware of the periphery. It is contended that since the task is the same the oculomotor component will be the same and therefore any resultant change will be due to a change in the attentional component.

The set-up for the experiment is as follows:

In a shielded room a subject is seated comfortably in front of the B & L Projection Perimeter with his chin situated in the left chin rest so that the right eye is positioned in front of the fixation target. The test is performed binocularly. The EDL Reading Test Selection appropriate for the subject is attached to the white disc fixation point so that it is centered along the subject's midline. A 1mm white target with no filters was utilized for determining the extent of the peripheral static and dynamic visual fields.

An electrode is placed just above the inion on the subject and connected to the Physiological Amplifier HGA-100 positive A input. Another electrode is placed on the top of the head and is connected to the negative A input. An electrode connected to each ear is then connected to the ground.

The amplifier's GAIN/ELECTRODE INTERROGATE switch is set to a gain of 10^4.

The amplifier was then connected to the Ultra-Low-Frequency Band-Pass Filter Model 330A from the Krohnhite Instrument Co. in Cambridge, Mass. The Low Cut-Off Frequency is placed at 7, while the High Cut-Off Frequency is placed at 14.

This is then connected to the Nicolet Instument Corp. Model CA-1000 Clinical Averager. The analysis is set at a time of 3000 ms with 1 repetition. The Bandpass Hz is set with a Low at 1 and a high cutoff frequency of 100. The Sensitivity is placed at ± 100 µv.

Finally, in order to trigger a response in the Averager, the Grass PS 22 Photostimulator is attached to the External Trigger Input of the Averager with the Flashlamp not connected. Lighting should be optimal for reading.

The procedure for the experiment is as follows:

The experiment is done binocularly with the optimum correction utilized. First the baseline data is taken. The alpha rhythm is taken with the eyes open and closed and the average amplitudes are recorded. The subject is then asked to position himself in the perimeter and asked to read a EDL Reading Test Selection. The time it takes is recorded. Then the size of the right peripheral field is measured while utilizing the fixation target.

In the initial phase of the experiment a different Reading Test Selection is used. The subject is told to read the selection for content, not speed and to concern himself only with the reading task. The subject is then to state when the perimeter testing target is first noticed. Also, at a random interval the alpha response is taken. The alpha amplitude, the time to complete the task, and the size of the dynamic field are then recorded.

The second phase is exactly the same except that it is untimed and the subject is told to be aware of the periphery as much as possible. Once again the time to complete the task, the alpha amplitude and the size of the dynamic field are recorded.

Subjects with at least one meridian that is plano or hyperopic are placed in the control group. The rest are placed in the test group. Differences between phase one and phase two results of the experiment are determined in terms of percentage change so that actual differences in amplitude by individual subjects cannot bias the overall average of the group.

RESULTS

Six subjects were tested using this technique. Two of these individuals met the criterion for the control group while the other four entered the test group. The results for the individual subjects are presented on the following pages.

The average for the control group was a -6% or a 6% increase in the amplitude of the alpha wave. Testing statistically at a 95 per cent confidence level indicated that this is in the same interval as no change.

The average for the test group was a 21% decline in the amplitude of the alpha wave. This also tested out as statistically within the same interval as not having any change at all.

The small groups resulted in data with extremely large variance indicating that the sensitivity of the study was very low. This means that the results cannot prove anything conclusively. In order for that to occur the sample sizes would have to be much larger.

However, an interesting conclusion did occur. When the two groups were compared against each other at a 95 per cent confidence level it was found that the difference between the means of the control and test groups was statistically significant. It is realized that a single individual could alter the conclusion, yet a tendency was found.

The results for each of the individuals in the test group indicated a greater decline than for each member of the control group. This indicates that even though statistically the results do not conclusively indicate a significant decrease for the test group there was a difference from the control group. Whether this tendency can be expanded to the general population can be revealed only by the use of a larger study.

The time required to perform the reading task was unchanged for all three of the tasks. The greatest increase in time expended between tasks two and three was three seconds by J.R. in the control group. The greatest change was a two second increase by a member of the experimental group. The average increase in time was 1.67 seconds when the subject was asked to be unconcerned with the length of time to read the task. Therefore it can be concluded in this study that peripheral awareness does not result in a loss of reading efficiency.

In all cases the size of the dynamic field of view was less than the static field of view. This was expected since the target of a reading task requires greater attention than an X target. The average decline for all six subjects was 8.5°.

When asked to be aware of the periphery the control group averaged 1.5° increase in the size of their field. The experimental group had an increase in the field size of 5°. This difference was not significant.

When the subjects were asked the questions from the back of the EDL Reading Eye Test Cards the number of correct responses remained unchanged for the three reading tasks. Most subjects got nine or ten correct in all three cases.

SUBJECT: M.P. spec. corr. DATE: 12/7/80

REFRACTIVE ERROR: -5.25 O.D. 20/20 V.A.

-5.25 O.S. 20/20 V.A.

	ALPHA AMPLITUDE	TIME	SIZE OF FIELD
BASELINE DATA: OPEN:	6.7	27 sec.	70°
CLOSED:	17.42		
INITIAL READING:	7.85	26 sec.	62°
SECOND READING:	5.79	28 sec	68°
DIFFERENCE:	36%		+6°

SUBJECT: J.R. uncorr. DATE: 12/7/80

REFRACTIVE ERROR: +0.75 ⊃ -0.50 x 085 O.D. 20/20+ V.A.

+1.00 ⊃ -0.75 x 105 O.S. 20/20+ V.A.

	ALPHA AMPLITUDE	TIME	SIZE OF FIELD
BASELINE DATA: OPEN:	7.85	28 sec	80°
CLOSED:	22.15		
INITIAL READING:	5.26	27 sec	71°
SECOND READING:	4.83	30 sec.	70°
DIFFERENCE:	8%		-1%

SUBJECT: L. Z. C.L. CORR DATE: 12/8/80

REFRACTIVE ERROR: pl. ○ -2.00 x 180 O.D. 20/20 V.A.

pl. ○ -2.00 x 180 O.S. 20/20 V.A.

	ALPHA AMPLITUDE	TIME	SIZE OF FIELD
BASELINE DATA: OPEN:	5.63	33 sec	72°
CLOSED:	5.86		
INITIAL READING:	4.62	33 sec.	62°
SECOND READING:	5.53	33 sec.	70°
DIFFERENCE:	120%		+8°

SUBJECT: B. Z. spec. corr DATE: 12/8/80

REFRACTIVE ERROR: -4.75 ○ -0.50 x 180 O.D. 20/20 V.A.

-6.50 ○ -0.50 x 180 O.S. 20/20 V.A.

	ALPHA AMPLITUDE	TIME	SIZE OF FIELD
BASELINE DATA: OPEN:	5.07	30 sec.	68°
CLOSED:	10.1		
INITIAL READING:	5.72	28 sec.	60°
SECOND READING:	4.91	30 sec.	65°
DIFFERENCE:	14%		+5°

SUBJECT: S.B. – C.L. CORR. DATE: 12/10/80

REFRACTIVE ERROR: -7.00 D.S. O.D. 20/15 V.A.

-8.00 D.S. O.S. 20/15 V.A.

	ALPHA AMPLITUDE	TIME	SIZE OF FIELD
BASELINE DATA: OPEN:	4.53	30 sec.	80°
CLOSED:	5.33		
INITIAL READING:	4.78	35 sec.	68°
SECOND READING:	3.77	35 sec	70°
DIFFERENCE:	11%		+2°

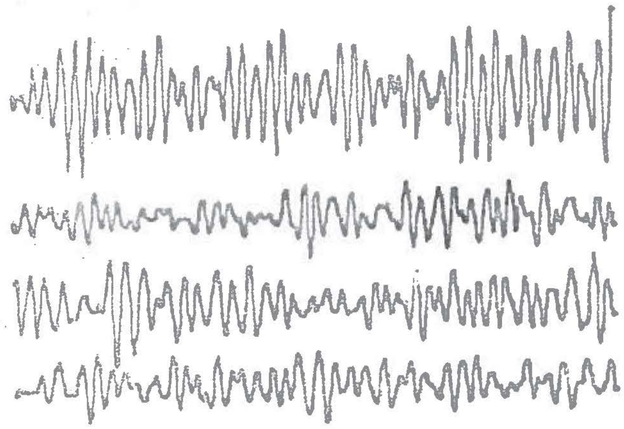
SUBJECT: M.T. spec. corr. DATE: 12/10/80

REFRACTIVE ERROR: -2.00 ⊂ -0.50 x 100 O.D. 20/20 V.A.

-2.25 ⊂ -0.50 x 180 O.S. 20/20 V.A.

	ALPHA AMPLITUDE	TIME	SIZE OF FIELD
BASELINE DATA: OPEN:	9.95	23 sec.	60°
CLOSED:	18.5		
INITIAL READING:	10.9	27 sec.	56°
SECOND READING:	8.2	30 sec.	60°
DIFFERENCE:	25%		+4°

NAME M.T. PATIENT # ______ DATE ______



ACQUISITION PARAMETERS

Test # ______ **FILTER:**

Time ______ ms Low ______ High ______

Sensitivity ______ Display Mult ______

Sensitivity / Display Mult = Display Full Scale ______

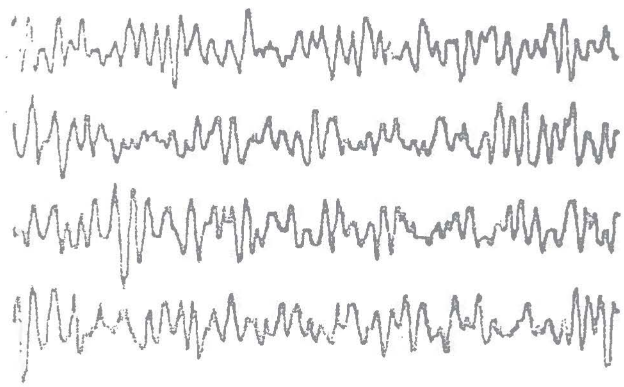
STIMULUS PARAMETERS

Rate ______ Duration ______

TEST BY

NIC Nicolet Instrument Corporation, Madison, WI 53711 — Reorder #082-7010-00

NAME S. B. PATIENT # ______ DATE 12/8/80



ACQUISITION PARAMETERS

Test # ______ **FILTER:**

Time ______ ms Low 7 High 14

Sensitivity 100 Display Mult 2

Sensitivity / Display Mult = Display Full Scale 50

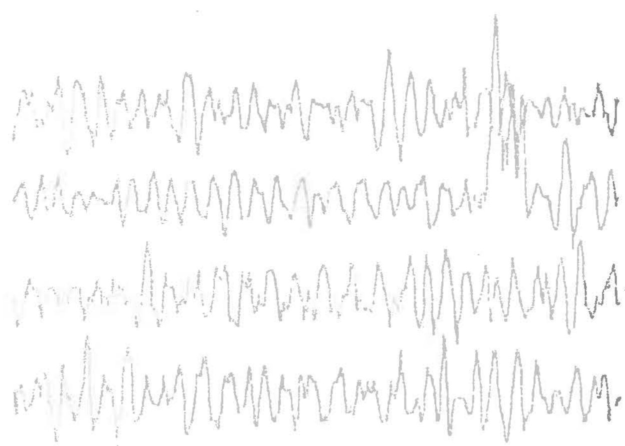
STIMULUS PARAMETERS

Rate ______ Duration ______

TEST BY

NIC Nicolet Instrument Corporation, Madison, WI 53711 — Reorder #082-7010-00

NAME ______ PATIENT # ______ DATE ______



ACQUISITION PARAMETERS

Test # ______ **FILTER:**

Time 3000 ms Low 7 High 14

Sensitivity 100 Display Mult 2

Sensitivity / Display Mult = Display Full Scale 50

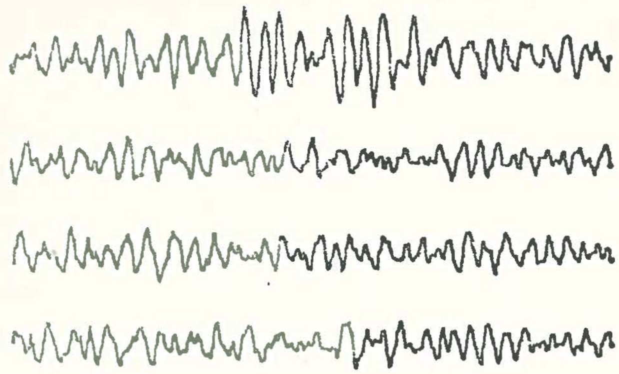
STIMULUS PARAMETERS

Rate ______ Duration ______

NIC Nicolet Instrument Corporation, Madison, WI 53711 — Reorder #082-7010-00

NAME B. Z. PATIENT # DATE

TEST BY



ACQUISITION PARAMETERS

Test # FILTER:

Time 3000 ms Low 7 High 4

Sensitivity ~~5000~~ 100 Display Mult 1

Sensitivity / Display Mult = Display Full Scale 100

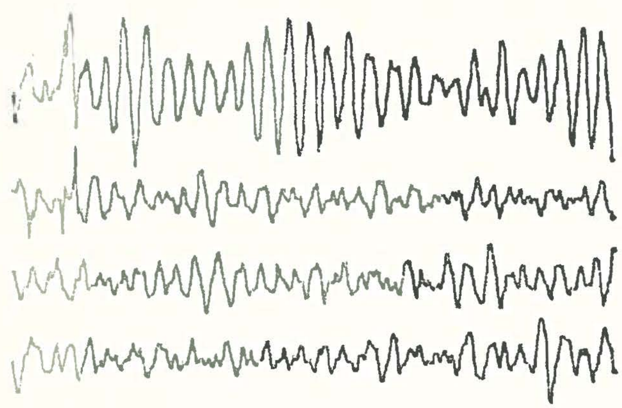
STIMULUS PARAMETERS

Rate Duration

Nicolet Instrument Corporation, Madison, WI 53711 — Reorder #082-7010-00

NAME M. P. PATIENT # DATE

TEST BY



ACQUISITION PARAMETERS

Test # FILTER:

Time ms Low High

Sensitivity Display Mult

Sensitivity / Display Mult = Display Full Scale

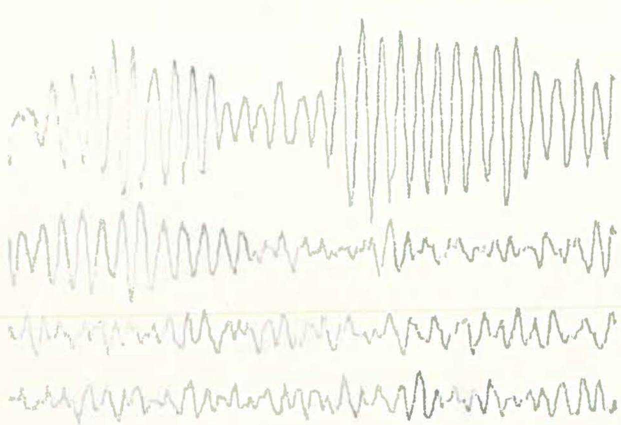
STIMULUS PARAMETERS

Rate Duration

Nicolet Instrument Corporation, Madison, WI 53711 — Reorder #082-7010-00

NAME . B. PATIENT # DATE

TEST BY



ACQUISITION PARAMETERS

Test # FILTER:

Time 3000 ms Low 7 High 14

Sensitivity 100 Display Mult 1

Sensitivity / Display Mult = Display Full Scale 100

STIMULUS PARAMETERS

Rate Duration

Nicolet Instrument Corporation, Madison, WI 53711 — Reorder #082-7010-00

CONCLUSIONS

Myopia is caused by a number of factors and not all have been dealt with in this paper. Yet there does seem to be a relationship between myopia, peripheral awareness and attention.

Ludlam (January, 1979) has studied the relationship between the alpha rhythm, visual skills and academic performance. He found that the alpha amplitude declined after visual training indicating that training results in improved visual attention. The relationship between reading and alpha amplitudes was also noted.

This study demonstrates two important considerations which can be conjectured upon. Only further testing would result in conclusive evidence.

First, this technique could be modified so as to be used as a test criterion for rate of success in attention training. If, under conditions such as this stressing peripheral awareness a person can reduce the amplitudes of his alpha waves then it follows that a person's attentional factors can be improved.

Since these factors depend upon visual skills necessary for reading, attention can be improved by improvement of accommodative, fusional and binocular skills that have been stressed in the past. However, the goal may be to train the attention function rather than the skill itself. By improving attention a person's skill in reading will also be improved.

More importantly this paper recognizes that during the development of myopia there is a constriction of the visual space which also results in a decline in attention. This has been the philosophy of the Optometric Extension Program since its inception.

The constriction can partly be explained by the optical relationship of the myopic visual system. However, the rest must be psychological in nature.

As stated previously, this loss of peripheral awareness is accomplished by the expenditure of energy which must be lost to some other process such as attention. The visual style of myopes is such that they close off as many external distractions as possible thereby allowing for maximum concentration on the given task. However, there are differences between concentrating or putting a lot of energy into a task and attention.

Studies have shown that selective attention is improved by the use of peripheral distractors resulting in the increased extraction of information from the reading material. This study showed that by simply telling the person to be more aware of the periphery more energy could be utilized for attending to the task. This study showed that no loss of time for the reading task occurred during this part of the study. Also, no loss of cognition was reported on the part of the subject. Therefore, by training peripheral awareness in myopes, the myopia may not be reduced but perhaps attention can be improved and maybe the myopia stabilized.

Children accomplish a reduction of alpha rhythms during difficult reading by bringing the book closer. This results in increased accommodation and convergence innervation which has been shown to decrease the alpha response thereby increasing attention and comprehension of the material. Unfortunately this also results in the development of asthenopic symptoms at first and then myopia. This also results in less peripheral distractors which may impair selective attention. Therefore the child has placed his visual system at risk in order to excel at school.

Once the child's vision is impaired by blur at distance he reports to an optometrist for a pair of glasses. This creates another possible enigma, especially in the past when frames had smaller eyesizes.

If the child is left unprotected the myopia will not progress, however he will still have blur at distance. By putting on a prescription consisting of the optimum minus correction for eliminating blur at distance the mechanism for myopia progression is initiated. By then placing this in a frame the need for peripheral field constriction is facilitated by the frame itself enclosing the field and the blur in the field at the sides of the frame. This again facilitates the progression of myopia in the individual. Perhaps this is one reason why contact lenses sometimes work in arresting myopia. Correcting the myopia while not constricting the field perhaps impedes the progression.

This suggests that peripheral awareness may be very important in the training of myopia reduction. Peripheral awareness is important in attentional responses and in the myopic visual style as evidenced by this study. The interrelationship of myopia, attention and peripheral awareness has been at least demonstrated by this study.

Optometry must recognize the fact that the visual system does more than gather information; it also processes information and greatly affects other systems. Visual attention is not merely an ocular alignment. It is a learned response dependent upon the individual's visual style and resultant task attack skills.

If functional myopia is due to a centering phenomenon creating "abandonment of part of the total space world" then it must also result in a loss of efficiency. This decline spreads to affect the other systems, including attention, as this paper demonstrates.

Visual stress can therefore result in myopia and the constriction of the perceptual fields. This paper has shown that this results in decreased attention resulting in a person observing less, seeing less, remembering less, learning less, and therefore becoming less efficient as a whole person. This core pholosophy must therefore be accurate.

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