Characteristics of Spectacle Lenses
How Patients Respond to Lenses

Lenses are one of the most powerful tools in altering light energy under controlled conditions. A lens placed in front of the individual’s eyes alters the light energy entering the eyes and the visual mechanism. The lens aids in altering physiological conditions, permitting changes in perception of the world as well as the general overall physiology of the individual. The result of the action of the lens is to affect every cell in the brain, thereby creating changes expressed in the visual-motor and gross motor levels of efficiency for that individual. Lenses therefore may offer compensatory values, remedial values and affects, and vision therapy values. Key Words: aftereffects, afterimages, cylinder, minus power, plus power, prism, rehabilitation, therapy.

Every lens has a prismatic value. Because of the prism effect, objects viewed through any lens are displaced to an apparent (different) location in space. Any lens positioned in front of an eye to compensate for visual acuity deficit causes increased deficits in the perceptual status of an individual. A plano (zero prescription strength) spectacle lens in front of an eye with good visual acuity will slow the speed of light, reduce brightness levels into the visual mechanism, alter size perception, and act as a weak tint.

Necessary ultraviolet light into the eye and the brain is restricted by the use of a lens, with adverse affects. The greater the strength of the prescription (eyeglass power), the greater the peripheral distortions suffered by the eye and the central nervous system. It is a mathematical and mechanical impossibility to have perfection in both the central and peripheral portions of the compensating spectacle lens. The stronger the lens, the greater the distortion in the ability to judge size, distance, and all perceptions of personal time-space values.

Spectacle lenses do not correct any defects. The lens affords a compensation that is always inadequate for physiological deviation or deficit. Individuals who are either nearsighted (myopia) or farsighted (hyperopia) are just as nearsighted or farsighted physiologically whether or not they are wearing lenses. The basic physiological performance remains the same and now includes additional distortions created by the spectacle lens. Eventually, the visual style and resultant philosophy and per-
sonality of the individual must match the physiological performance habits.

The peripheral distortion of the spectacle lens in front of the eyes contributes to reduction in efficiency levels in muscle strength. The large muscles of the body may be tested for increased efficiency and strength levels without the lenses in front of the eyes. It must be clearly understood that the visual acuity chart is never blurred. The nerve systems and physiology of the individual human being are blurred.

The lenses serve as a powerful ‘tool’ in changing many aspects of human performance. Lenses alter light energy passing through their surfaces as well as through their internal volume substance. Lenses also alter the light energy reflected off their surfaces. Lenses in front of the eyes present the altered light energy through the eyes and the visual mechanism and induce changes affecting all 10 billion brain cells. Lenses either compress light energy, expand light energy, or deviate light energy. The altered light energy will either (a) match the habitual deviated physiological compensations within that individual (esophoria, exophoria, hyperopia, esophoria) to make the external-internal worlds look and feel “as if” they are normal, or (b) guide changes within the physiology of the individual on a rehabilitation basis; therefore, treatment or rehabilitation lenses.

AFTEREFFECTS-AFTERIMAGES

Lenses have the unique effect of providing neurological “aftereffects” as well as “afterimages” which aid in building the conscious awareness process required in rehabilitation. There are aftereffects of color referred to as afterimages. There are also afterimages of orientation and afterimages of movement. The aftereffects are attributed to specific cells within the visual system.

Aftereffects exist within the body mechanisms. Recovery from aftereffects are balancing changes that take place within the body dealing with nerve tissue. Removal of stimulus from the point of emphasized conscious awareness gradually reduces the aftereffect in a sine wave manner until the sensation is suppressed.

Afterimages due to light intensity changes are balancing changes taking place within the eyes, visual system, and the rest of the body. Creation of the afterimages takes place with altered light brightness and altered light energy patterns created by the therapy lenses and their removal from in front of the eyes. The presentation of lenses in front of the eyes alters the basic “normal” neural adapted patterning of the individual formed during the youthful developmental years and maintained throughout the years of adulthood.

Patients do not wear their compensatory lenses regardless of the strength of the prescription during therapy sessions. The afterimages include perceptual changes reported and experienced as: “the world looks brighter, bigger, colors are more vivid”; feelings and awareness of the body and postures are greatly increased. Individuals almost always use their hands to depict size changes in what they see and feel. At a later time, they become capable of verbalizing the experience. The color afterimages are easier to deal with in a study fashion. The individual will undergo seeing the colors fade in and out from one color to the other, beginning from red all the way through indigo and violet. If the study is enacted in a dark or dimly lit room, the afterimages reported in color changes will include the positive as well as the negative.

The more efficient neural perceptual system will recover at a more rapid rate. These patients usually respond to therapy at a more rapid rate and have less general physiological symptoms. The patient who is slow to recover from the afterimages reports a greater number of physiological discomfort symptoms, receives many nonspecific diagnoses from the average practitioner, experiences profound effects from the therapy lenses, and accepts intervention on a slowly gradually increasing basis. During beginning therapy sessions patients may report that the afterimages appear smaller due to the awesome increased, therefore quite overwhelming, awareness of all the details in their surroundings.

THE PRISM

Lenses afford the opportunity and ability to create the above-mentioned changes in conscious awareness as well as ongoing changes in perception. The prism is the optometric vision therapy lens of choice. The most powerful and abundant impulse activity is received
through the visual mechanism. This activity is the transformation of light energy into nerve energy which will stimulate the ten billion cells within the brain. We are therefore dealing with the central nervous system of the human.

The prism referred to is a prism lens in “dropped eye form,” having a base curve of 6.5 diopters. Flat prisms do not retain all the parameters of a base curve prism.

In vision therapy we are concerned with altering the present visual sensory impulses to guide a change in the ensuing patterns of integrating these impulses. A change in habitual patterns will provide and permit the patient to attain degrees of freedom in interpretation with greater validity in the direction of the motor response. The patient is trained to respond to changes in light energy as they exist on a continuing basis. These changes must be expressed in each visual circuit, in each visual circuit in conjunction with each side of the body, and in the two visual circuits in relation to each other and to the rest of the body.

All impulses received by the brain are integrated. Only the changes (differences) are interpreted. The intensity of the stimulus must be increased or decreased to alter the frequency of the impulses to permit interpretation. A motionless eye ceases to transmit anything but a uniform gray visual field. A static state in the environment is made dynamic, such as it is, by the constant motion of the eye. The efficiency of the dynamic interpretation is directly related to the level of efficiency of the visual mechanism. Motion is perceived in the periphery more readily than in the central visual area. There is the status of aftereffects or afterimages that exist as part of the normal function of the eye and the visual mechanism. When the steady state of the stimulus is extended over a period of time an adaptation takes place to render the stimulus being perceived as less strong. When the stimulus is removed or changed the interpretation will have an impression opposite from the prior status. This action may be observed as a passenger in a moving vehicle such as a car or train; the positive and negative afterimages of color following a strong light stimulus, radical changes from the lighted to the darkened room and vice-versa.

The most profitable means for inducing the abovementioned changes is the use of lenses by an optometrist. The lenses provide the change in patterns of integration by altering the light energy stimulating the visual mechanism. The lens of choice for presentation of altered visual stimuli in the optometric vision therapy program is the prism. The prism presents more geometric distortions of light than any other lens under controlled conditions. A stronger prism power multiplies these geometric distortions to become an effective therapy lens. The “all-or-none” principle of nerve tissue states that a stimulus gives the maximal response or none at all. A weak stimulus may stimulate only a few nerve fibers. A strong stimulus increases the frequency rate and excites all the fibers within a nerve.

The prism is constructed in a basic wedge-shaped form having a base curve. Its two surfaces are at oblique angles to each other and vary in degree of separation from its apex to its base. Thus, the thickness is varied from one end to the other, and light will be distorted to a greater degree at the apex and the base relative to the distortion in the center of the lens. Images of the objects are deviated toward the apex of the prism. At the apex of the prism lens there is minus effectivity, whereas at the base there is plus power effectivity. A cylindrical effect of minus power effectivity showing “with” motion when the lens is rotated exists at the apex of the prism lens, whereas at the same time the base displays plus power effectivity showing against motion.

An increased distance of the apex from the eye produces an elongation of the images along the axis of the lens whereas an increase of the distance of the base from the eye produces a shortening of the images. Straight lines are curved in a bow fashion toward the base of the prism. The prism will present a chromatic aberration of considerable degree. The longer wavelength of red will be deviated less whereas the shorter wavelength of blue will be deviated to a greater degree. Red will be deviated toward the apex, blue toward the base. When the prism is in front of the eyes the colors will be seen in the exact opposite locations. Blue will be seen toward the apex and red toward the base.

Constant wear of prisms over time may cause a total breakdown and abandonment of
previous visual habits. The visual system then begins to respond in a newly adopted manner.

In optometric vision therapy we are not concerned with choosing a specific fixed avenue of function for the visual system of the human being. It is our responsibility to provide all of the variables possible for as much freedom as possible in consistent improvement in scope for the total individual. This process can be implemented during each therapy session to a gradually increasing degree on a continuous basis with the aid of strong prisms placed before the eyes. The prism lenses I refer to are mounted in six pairs of frames. Two pairs consist of six prism diopters mounted with the bases in the vertical meridian. One pair has the base down on the right side and base up on the left side. The second pair has the base up on the right side and the base down on the left side. Four pairs have the prism power of 10 or 15 prism diopters each base right, base left, base up, and base down in each frame. The lenses are mounted in yoke fashion with each pair mounted in one of the four cardinal directions. When either one of the six pairs of lenses are placed in front of the eyes there is no question of the changes that take place in the frequency of the impulses that traverse each visual circuit. The powerful distortions of light presented by the prisms through the dominant visual system alters the habitual integrations of the visual system exerting changes in the sensory-motor system and vestibular antigravity system.

In effect, all systems are integrated by the central nervous system. The interpretation of both internal and external environments will definitely be changed. The patient will be aware of these changes. He may be able to verbalize some of these changes, but he may not be capable of being specific about these changes immediately.

When the lenses are removed from in front of the patient's eyes the altering integration process will continue with the aftereffects as described in an previous paragraph. To capitalize on these aftereffects in the beginning sessions the patient should be permitted the proper time to study and investigate his internal-external environment. It is most important that the patient be on his feet during the therapy session. While standing or walking the antigravity proprioceptors in the feet, leg muscles, and pelvic region are allowed to exhibit their impulses in the integrating process. All of these changes are quite powerful for any individual. The tolerance for permitting this beneficial change will build gradually over several therapy sessions. Eventually the rest period may be reduced or eliminated.

To prevent adaptation in future therapy sessions while guiding the demand for increased changes, the lenses are changed every 3 to 5 minutes during the procedure. During the earlier sessions the aftereffects of the prisms will continue with the patient from a few hours to a few days. Eventually the aftereffects will be continuous for days at a time, gradually providing consistently changing patterns of integration.

Carefully guided home therapy procedures to coincide with the learning that takes place during the office procedures adds to the importance of substantiating the ongoing process of change. It is important to remember that the removal of any neural stimulus does not provide a straight-line return to the previous level of performance of that neural system. The return to the previous level of transcending impulses is in an oscillatory manner to either side of that previous optimum level.

From the discussion above we may ascertain that there is as much, if not more, therapeutic effect in altering patterns of performance long after the judicious use of the prism has been removed. We must begin to look more at the brain and central nervous system with the application of lenses. Optometric vision therapy should be experienced only to be successful. The degree of success is directly related to the time expended by both the patient and the optometrist.

**PRISM LENS**

The prism lens retains a composite effectiveness of expansion, compression, and cylindrical (both plus and minus effectivity) action on light passing through its surface on its way into the brain. The light passing through the prism is diverted toward the base of the prism. Diverting the light energy causes a peripheral display of the varying wavelengths and frequencies that combine to make up light.

Rotating the prism results in both minus cylindrical effectivity at the apex and plus cylindrical effectivity at the base. The result is a
torque type of effect at a point halfway between the apex and the base. The apex of the prism has minus effectivity while the same prism has plus power affectivity at its base. Images seen through the prism are caused to move in the direction of the apex. The eye(s) therefore are caused to move in the direction of the apex to observe the image of the object being viewed.

**BASE OUT**

Base out prisms in front of the eyes cause the eyes to converge. The impression is usually one of double vision and a feeling of discomfort, with the sensation that breathing is compressed, the body is tensed, and space is compressed. (These are rarely used.)

**BASE UP**

Base up prisms cause the eyes to be directed downward. Directing the eyes downward induces convergence and accommodation. Weaker powers of prism base up are reported by patients to help reduce lower back aches. The effects are beneficial even though the individual wears the lenses for short periods in time.

In rare cases myopic patients, with a good degree of exophoria, will accept base up prism because it results in the same feelings as adding minus lens power. In the longer period of time base up prism will induce more general physical symptomology. Long periods of time wearing base up prism result in feelings that space is compressed, breathing is compressed, and of being stretched on a lateral basis. The patient experiences greater discomfort and distortions when looking down at the floor.

It is more difficult to keep the head neck and eye posture in the ortho, looking ahead balance. The ill effects experienced are similar to minus lenses and perceptual interpretation of flattening of space.

**BASE DOWN**

Base down prisms cause the eyes to move upward. Upward movement of the eyes causes the eyes to separate laterally. Many patients refer to the base down prism as the "laughing glasses." Usually the posture changes to up-right, head raised, eyes directed ahead or slightly elevated. Almost all patients reveal that their chest seems expanded and breathing is deeper and easier. In weaker doses base down prism therapeutically aids the esophoric, reducing convergence, and overextended stressful patient. Younger patients report rapid improvement in relaxed feelings, stop thumb sucking, and improve visual acuity without the aid of compensatory lenses.

Base down prisms are better tolerated with greater benefits physiologically at closework tasks. The patient is forced to use the lower base part of the prism. Infinity viewing causes the individual to look through the apex and its minus effectivity. The result is a compressed, restricted feeling.

**BASE IN**

Base in prism lenses are not as well tolerated in increasing the strength or power. This also applies to those individuals with high exophoria or exotropia. The ideal is 1 Δ to 1 1/2 Δ base in prism in each lens. Base in prism lenses will greatly enhance the performance of the myopic patient for both infinity and closework visual tasks.

The plus power effect of the base of the prism at the nasal edge relieves accommodation. Seemingly, base in prism of weaker power (1 Δ to 1 1/2 Δ base in, in front of each eye) aids in reducing forced action in overcoming the esophoric posture existing within the myopic eye posture. The greatest positive effect for the patient is the immediate change in perception.

The next major change reported is the calmness in body feeling with the ability to take an expanded deep breath filling the lungs.

The changes are always described as having the visual world suddenly become "organized." The base in prism shrinks/compresses the peripheral field information while at the same time emphasizing the enlargement of the central half of the visual field. Thus, the feeling of "organization" for the patient results from the change.

Most of these patients report that they do have a good peripheral visual field awareness. The difficulty seems to be in emphasizing an area of regard with respect to the rest of the visual field. It is difficult to control visual de-
tails. It is reported that everything in the visual field is there, en masse, with the same vivid emphasis and awareness of details. The profound visual awareness is overwhelming.

These factors seem to match the severity of the symptoms which are much more severe in large stores (with all the bright lights, glare, and many shiny details) and crowded places with many people moving about; patients are unable to see the floor and less stable details.

ANXIETY—PANIC DISORDER

Patients having compensated for their exophoria over the years may develop breathing symptoms; fear of heights; and discomfort in elevators, closed rooms, locked doors, and crowded rooms. They also fear edges of porches and piers, etc. where there is no hand rail. They dislike tight clothes, small autos, and face-to-face forced eye contact while conversing. Many of these patients receive Valium, Xanax, or Prozac which can create the same side effects as the symptoms reported. Some of these patients stop taking the medications after 1 or 2 days (something not recorded in the statistics).

A confusing aspect in the diagnosis of these patients for nonoptometric practitioners is the symptom of actual pain. The pain may be restricted to the glabella (between the two eyes), the facial region at the temporomandibular joint, and along the zygomatic bone leading into the ear. If the problem is truly all related to the muscles and the exophoria, the pain will leave immediately upon treatment with the 1\(^4\) or 1 1/2\(^4\) base in in front of the eyes. The pain will also return immediately upon the removal of the prism.

Presbyopic patients should be given serious consideration for the use of at least 3/4\(^4\) base in. Their complaint of reading difficulties is very often the reduced visual-motor control inducing convergence insufficiency. The usual mode of additional plus power induces more symptoms and greater difficulty in sustaining the two eyes together as an efficient team. If the patient is unable to sustain with the prism base in for comfort at infinity, the lenses should be made in a half-eye frame for close-work vision. The sustaining power is thus radically changed.

YOKED PRISMS: BASE RIGHT-BASE LEFT

Used primarily in a therapeutic manner, in varying strengths, yoked prism lenses may be used to help shift the perceptual and physical midline back to efficiency levels. Most patients with traumatic brain injuries will display midline shifts at various levels displayed and indicated by their physical postures. Many individuals have developed midline shifts as a compensation under conditions of distress. Most are not aware of the discrepancy until they receive a complete visual workup, with or without a trauma. (There are any number of midlines within the human.)

In cases of traumatic brain injury (TBI), the affected side is usually afforded some degree of sensation and awareness with the apex (minus effect) positioned on the afflicted side of the body. Although the patient is classified as paralyzed, sensations and/or stimulation will take place between the brain and specific body parts. (The lens will alter the light energy entering through the eyes, stimulating all 10 billion brain cells.) Some TBI patients may require yoked left or right prism power to permit the occupational and physical therapist to begin assisting the patient. These patients should have an additional similar prescription without the prism to prevent adaptation. Alternating the same prescription with and without the prism power aids in preventing adaptation and loss of value in rehabilitation.

CYLINDRICAL LENSES

Cylindrical lenses treat meridional aspects of vision and visual acuity. Javal's rule stated what was seen, not necessarily what should be prescribed (against-the-rule astigmatism). Treatment for youngsters showing against-the-rule astigmatism should be considered in a careful manner. Against-the-rule astigmatism is a sign of adverse stress.

Prescribing prism and the appropriate plus power for close work will remove the need and/or showing of the against-the-rule astigmatism. This also applies to the older and presbyopic patient when treated with proper guidance. The most difficult patient to treat in terms of change or enhancement is the "slightly" off axis astigmat. The axis being at
the 5 degrees and 175 degrees. Usually this axis has been prescribed before the individual is seen by the behavioral optometrist.

Cylindrical lenses, similar to Polaroid lenses, have the affinity to "fracture" the light energy processed into the eyes and the visual mechanism.

MINUS LENSES (MINIFYING)

Minus lenses compress light energy to meet the compensatory needs of the individual. All peripheral information is reduced in nature. Energy levels of the individual are more readily expended, forcing and requiring more accommodation at the eye level as well as within the gross motor system. The focal point of the lens lies within 1 m from the eye/ lens level.

Beginning with a -1.00 diopter lens on an increasing power basis, higher minus power moves the focal point closer to the eye, imposing more compression within the physiology. The minus lens may seem to help the exophoric aspect of the individual. Minus lenses in front anyone's eyes will have the affect of pulling the eyes inward in an esophoric direction. The affect of minus lenses posturally may be observed in the concavity of the thoracic region coupled with the rounded forward and inward posture of the shoulders. This altered thoracic posture will vary depending on the degree of exophoria. The myopic patient with a higher degree exophoria will have more of an upright posture with greater rigidity in the latissimus dorsi.

The majority of myopic patients should be intricately tested at the near point performance distance. It is my experience that a lens power weaker in minus lens power is more often readily acceptable. A weak Δ base in may have to be added in the prescription to add a therapeutic affect for the exophoric aspect.

PLUS LENSES (MAGNIFYING)

Plus lenses relieve and relax accommodation, they expand light energy, and they match the altered function of the hyperope to make the world seem "as if" it is normal in fine details. Many hyperopes are not comfortable with their prescription lenses, except as needed for reading letters and numbers, either at distance or near visual tasks. These individuals are happier dealing with gross details in the world, without their lenses, as opposed to the fine, small, close details, with their compensatory lenses. Sun prescription lenses bother these individuals unless the prescription is reduced by 0.25 to 0.50 diopter.

Hyperopic patients older than 40 years of age, and especially 50 years of age and older, are generally overprescribed for their close-work visual tasks. The patient's statement of difficulty in the reading process often is not a need for additional plus lens power. The addition of plus power induces a reduced convergence ability adding to the difficulty in sustaining at the near point task.

Plus power lenses are very effective as a therapy lens for patients younger than 40 years of age. The lens is effective in reducing distress in children, relieving accommodation, and changing the phoria posture to optimum (whether it is esophoria or exophoria of weak degree). Many other physiological symptoms and perceptual states are also altered favorably with the use of weak plus power lenses. The plus lenses used for close-work stress relief should be provided in either a half-eye frame or bifocal form. If the individual is prone to plus acceptance, a single-vision lens could very well guide the individual into progressive hyperopia.

Handwriting will change in the direction of improved spacing, clarity, and level (rather than uphill-downhill). The performance in reading will improve in efficiency. The print will be observed to be held further from the eyes in reading. The head will be held further from the paper in writing performance. The effort and energy required to effect the performance will be much less, with a relaxed attitude and a comfortable posture improving the performance. With improved conscious awareness of the task the means for additional learning under self-guided monitoring will be provided.

INTRAOCULAR LENS IMPLANTS:

HARD LENSES

Hard lens implants have greatly improved since their beginning. The lenses have varied in size as well as in their optics and have advanced from plano-convex in structure to varied curves and materials. The change in form of the lens shape has allowed for a thinner lens
retaining the same focus ability for the eye/brain.

The lenses are/were made in plano convex shape, the convex or steeper curve being placed posteriorly. Today lens implants are made in plano convex as well as bi convex form. The bi convex form has a steeper curve on one side in relation to the opposite side. The steeper side always, as suggested, should be placed facing the posterior of the eye. The bi convex lens may serve the proper focal length and clarity with less dioptic lens power.

Depending on the status of the tissues of the individual's eye, intraocular implants have provided clear comfortable visual acuity and vision. Aphakic spectacle lenses were uncomfortable and provided some instability due to the excessive magnification factor. Contact lenses reduced that factor to a considerable degree. The intraocular implants have further reduced the undesirable magnification factor to about 4 to 6%.

Many questions now arise in treating the aphakic patient with the intraocular implants. Their visual and refractive status at infinity viewing and testing differs considerably from the demands in lens power for closework visual tasks.

OPHTHALMOMETRY

Accurate corneal measurements must be taken before and after surgery. There is no need for the patient to suffer with 1 to 3 diopters of against-the-rule corneal astigmatism due to the cataract surgical procedure. The new surgical procedures may eliminate the corneal disruption (reported by Dr. Nevyas' research at University of Pennsylvania).

In most cases the individual does not comfortably accept the rule of thumb +2.50 sphere ADD for all close work. That power may be needed for some small fine details on occasion. For general, all-around daily tasks most of the pseudoaphakic individuals claim there is much less need for stronger plus power. (Could it be that we are finding that vision and visual acuity focusing truly takes place equally in the retina and brain?)

Many of the pseudoaphakic patients survive comfortably with +1.00 to +1.50 spherical lens power. The report generally is that the print is too small to decipher as opposed to the old familiar "it is blurred." Some of these patients claim they get along quite well, including some reading larger print, without any lenses for their close-work visual tasks. Finite testing of the near phorias, ductions, and minus to blur and plus to blur ranges are becoming important for the appropriate diagnosis of the pseudoaphakic patient.

REFERENCES