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Clinical Evaluation Of The Power Vision Program

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SUMMARY

The Power Vision Program is a course of vision therapy eye exercises designed to be used by eye care professionals and their patients as an adjunct to traditional optometric care, with an emphasis on preventing visual problems and reducing dependence on corrective lenses.

30 subjects with common visual problems including myopia, hyperopia, presbyopia, asthenopia, and astigmatism were recruited from a public seminar and enrolled in a 6 week course of vision therapy eye exercises at home and in weekly group sessions.

Eye examinations and group sessions were carried out at Sacramento Visioncare Optometric Center. All of the 30 subjects attended the group sessions and reported positive results. However, only 21 subjects were able to attend their final eye examination due to scheduling difficulties.

19 of the 21 subjects obtained improvements in unaided visual acuity; 19 subjects obtained reduction of refractive error; 16 subjects reduced their dependency on corrective lenses and no longer needed them or only wore them part of the time; 20 subjects were satisfied with the materials provided and the results obtained.

The results of the evaluation are tabulated and displayed at the end of this paper and suggest that the Power Vision Program can provide eye care professionals with a useful addition to their arsenal of treatment procedures for health-conscious patients who want to play an active role in their vision care.

INTRODUCTION

The Power Vision Program is a course of natural vision improvement techniques known as vision therapy eye exercises, including ocular calisthenics, visual biofeedback, acupressure, hydrotherapy, stress reduction, and behavior modification.

Just as many people benefit from physical exercises to improve the health, strength, and performance of their bodies, there is a growing public demand for eye exercises to improve the health, strength, and performance of the eyes and visual system. We believe that the eye care profession should offer vision therapy eye exercises to health conscious patients as part of a well-rounded regimen of eye care.

The Power Vision Program was created by Steven Beresford, Ph.D. and the late Merrill Allen, O.D., David Muris, O.D., and Francis Young, Ph.D. It was previously known as the See Clearly Method. As part of the due diligence requirements for marketing the product to the public and to other eye care professionals, the clinical evaluation was carried out at Sacramento Visioncare Optometric Center and was privately funded.

The Power Vision Program is specifically designed to improve visual acuity, reverse or slow the rate of myopic and presbyopic progression, eliminate or reduce dependency on corrective lenses, reduce refractive error, and increase the flow of nutrients to the eyes and surrounding tissues with the goal of improving ocular health.

The purpose of the clinical evaluation was to investigate the effects of the Power Vision Program on a diverse group of health-conscious people with the goal of obtaining subjective opinions of the product and determine any changes in visual acuity, refractive error, and dependence on corrective lenses.

SUBJECT SELECTION

30 subjects ranging from 14 to 80 years of age with one or more of the following visual problems were selected from a public seminar:

a) Asthenopia and/or low to moderate subjective levels of computer vision syndrome.

b) Myopes with low/moderate refractive error, defined as a spherical equivalent of not more than –3.00D, which could include a small amount of astigmatism.

c) Hyperopes and presbyopes who were using or about to use their first pair of reading glasses.

Excluded were advanced presbyopes, high myopes, high hyperopes, high astigmatics, amblyopes, contact lens wearers, and people with bodily or ocular pathology such as diabetes, glaucoma, cataract, or macular degeneration. Although many people with medium to high refractive errors had successfully used the techniques as patients at Sacramento Visioncare Optometric Center, they were also excluded.

Subjects received a standard eye examination to determine their subjective refraction and visual acuity. Due to the limited scope of the evaluation, only non-cycloplegic measurements were made. Distance acuity was measured with a 10’ Snellen chart and near

acuity was measured with a 16" Snellen chart.
Subjects also received two audio cassette tapes with programmed sequences of exercises; eyecharts designed to improve visual acuity, fusion, and ocular motility; an instruction manual; a compliance log; an eye patch; and weaker corrective lenses if needed.

Subjects were instructed to practice the exercises at home for ½ hour per day for a total of six weeks by following the instructions in the audiocassette tapes, and to wear the eye patch at home for one hour per day. Subjects were also instructed to develop the habit of doing specific exercises during normal activities such as using the telephone, during TV commercial breaks, standing in line while shopping, waiting at traffic lights, and so on, in order to convert periods of "down time" into vision improvement opportunities.

Subjects received five weekly seminars of instruction, discussion, and group practice followed by an eye examination at the end of the sixth week of home exercise, which marked the completion of the evaluation. Of the thirty subjects who participated in the evaluation, twenty one showed up for the final eye examination. Due to the limited purpose of the clinical evaluation, subjects were not followed up after the final eye examination. It should be noted, however, that the new visual habits mentioned above were intended to automatically maintain the results after the conclusion of formal training.

REFRACTIVE ERROR

Subjects were divided into three groups: those initially requiring minus lenses for distance vision (myopes), those initially requiring plus lenses for reading (presbyopes/hyperopes), and those initially requiring cylinder in addition to spherical correction (astigmatics). Subject S11 initially required minus lenses for distance vision and a plus bifocal add for reading, and is included in both the minus lens and plus lens groups. Subject S3 did not initially require lenses and is not included in the data set.

TABLE 1: Refractive Error

Of the 20 subjects initially requiring lenses, 8 required plus lenses, 14 required minus lenses, and 12 required a cylinder to correct for astigmatism. For the purpose of data analysis, each eye's refractive error is separated into spherical and cylindrical components, which are combined to give spherical and cylindrical OU values. OU(A) is the combined refractive error before training, OU(B) is the combined refractive error after training, and the change in combined refractive error is OU(B) – OU(A).

TABLE 2: Refractive Error Changes

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i) Plus Lens Group. The total combined spherical refractive error of this group was +35.00D before training and +21.75D after training. All 8 subjects showed a reduction in refractive error with an average reduction of 1.66D.

ii) Minus Lens Group. The total combined spherical refractive error of this group was –37.25D before training and –29.00D after training. The average reduction in refractive error was 0.59D. Of the 14 subjects, 11 showed a reduction in refractive error and 3 showed no change.

iii) Cylinder Lens Group. The total combined cylindrical refractive error of this group was –19.25D before training and –12.75D after training. The average reduction in refractive error was 0.54D. Of the 12 subjects, 10 showed a reduction in refractive error and 2 showed no change.

UNAIDED VISUAL ACUITY

Subjects were divided into two groups: subnormal unaided near acuity and subnormal unaided distance acuity. The subnormal unaided near acuity group consisted of 6 presbyopes/hyperopes, and 6 myopes with signs of presbyopia. The subnormal unaided distance acuity group consisted of 14 myopes and 2 hyperopes.

TABLE 3: Unaided Visual Acuity

For data analysis, Snellen fractions were converted into Snellen line numbers and the Threshold Visual Acuity (TVA), which is defined as the reciprocal of the Snellen fraction expressed as minutes of arc. The Snellen line numbers and the TVA for both eyes separately (OD, OS) and both eyes together (OU) were compared before and after training to yield the changes in unaided visual acuity. Note that the post-training binocular visual acuity was always equal to or better than the best post-training monocular acuity.

TABLE 4: Unaided Near Acuity Changes

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i) Snellen Line Changes (unaided near acuity). Of the 12 subjects, 10 showed improvement and 2 showed deterioration. The average monocular improvement was 1.41 lines and the average binocular improvement was 1.08 lines.

ii) TVA Changes (unaided near acuity). The average monocular improvement was 1.05 minutes of arc and the average binocular improvement was 0.75 minutes of arc.

TABLE 5: Unaided Distance Acuity Changes

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iii) Snellen Line Changes (unaided distance acuity). All 16 subjects showed improvement. The average monocular improvement was 2.63 lines and the average binocular improvement was 2.19 lines.

iv) TVA Changes (unaided distance acuity). The average monocular improvement was 2.18 minutes of arc and the average binocular improvement was 1.16 minutes of arc.

SUBJECTIVE FINDINGS

Of the 21 subjects who completed the evaluation, all but one expressed satisfaction with the quality of the materials provided and the results obtained, and 16 reported that they had reduced their dependency on corrective lenses to the point where they no longer wore them or only wore them part-time.

Although the subjects did not fill out a questionnaire at the end of the evaluation, most reported additional benefits in their daily compliance log such as "*eyes feel stronger*", "*can now read without glasses for the first time in my life*", "*very pleased with the program*", "*colors seem to be brighter*", "*no more computer eyestrain*", "*can see individual pine needles on a tree*", "*eyes feel much better*", "*reading is faster*", "*can read a road map again*", "*can read the newspaper without glasses*". There was a general consensus that the exercises had eliminated or significantly reduced eyestrain from reading or using a computer.

STATISTICAL ANALYSIS

Statistical analysis of the data in Tables 1 through 5 was performed using Minitab Release 14. In order to facilitate analysis and journal space limitations, only OU data was used. In the case of Rx data, the Rx of both eyes was summed to give the subject's total Rx. Only TVA data for acuity analysis was used due to non-uniformity of the Snellen chart fraction series.

It should be noted that in some cases, a large acuity improvement in only one eye is not reflected in the OU data, which is typically equal to or one Snellen line better than the best monocular acuity. Thus the total monocular acuity improvement for each group of subjects is significantly better than the total OU improvement for the group.

We use Pearson's correlation coefficient throughout the analysis. In the graphs, the 45° line through the origin represents no change and the vertical distance from the data point to the 45° line represents the magnitude of a change.

FIGURE 1: Rx Sphere Changes (myopes)

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a) Rx Sphere Changes (myopes)

1. With the outlier S20 omitted, a normal distribution adequately describes the Rx change. (P-value = 0.204).

2. No significant correlation exists between Rx change and pre-training Rx. (Correlation coefficient = -0.185 with P-value = 0.527). However, it should be noted that subjects with higher pre-training Rx will have a higher long-term potential for Rx change.

3. A highly significant correlation exists between Rx change and age. (Correlation coefficient = -0.723 with P-value = 0.003).

FIGURE 2: Rx Sphere Changes (presbyopes/hyperopes)

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b) Rx Sphere Changes (presbyopes/hyperopes)

1. No parametric model adequately describes the Rx change.

2. No significant correlation exists between Rx change and pre-training Rx. (Correlation coefficient = 0.304 with P-value = 0.464). However, it should be noted that subjects with higher pre-training Rx will have a higher long-term potential for Rx change.

3. No significant correlation exists between Rx change and age. (Correlation coefficient = -0.274 with P value = 0.511)

FIGURE 3: Rx Cylinder Changes

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c) Rx Cylinder Changes

1. No parametric model adequately describes the Rx change.

2. No significant correlation exists between Rx change and pre-training Rx. (Correlation coefficient = 0.259 with P-value = 0.416). However, it should be noted that subjects with higher pre-training Rx will have a higher long-term potential for Rx change.

3. No significant correlation exists between Rx change and age. (Correlation coefficient = -0.492 with P-value = 0.104).

FIGURE 4: Near TVA Changes

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d) Near TVA Changes

1. A normal distribution adequately describes the TVA change. (P-value = 0.515)

2. There is strong statistical evidence of a linear relationship between pre-training TVA and TVA change. (Correlation coefficient = 0.712 with P-value = 0.012). The least squares line is TVA change = –1.093 + 0.801 x pre-training TVA; that is, the greater the pre-training TVA, the greater the TVA change.

3. No significant correlation exists between TVA change and age. (Correlation coefficient = 0.222 with P-value = 0.512).

Note: S8 was deemed a highly influential outlier and excluded from the above analysis.

FIGURE 5: Distance TVA Changes

e) Distance TVA Changes

1. No parametric model adequately describes the TVA change.

2. There is strong statistical evidence of a linear relationship between pre-training TVA and TVA change. (Correlation coefficient = 0.816 with P-value < 0.0001) The least squares line is TVA change = -0.149 + 0.466 x pre-training TVA; that is, the greater the pre-training TVA, the greater the TVA change.

3. No significant correlation exists between TVA change and age. (Correlation coefficient = -0.104 with P-value = 0.712).

Note: S9 was deemed a highly influential outlier and excluded from the above analysis.

f) Miscellaneous

1) No significant correlation exists between Rx changes and TVA changes for myopes (correlation coefficient = 0.148 with P-value 0.629).

2) No significant correlation exists between Rx changes and TVA changes for presbyopes/hyperopes (correlation coefficient = -0.201 with P-value = 0.633).

HISTORICAL OVERVIEW

Several systems of eye exercises and optometric visual training procedures were developed during the first part of the 20th century and used by numerous young men to pass the eye examinations required for the armed forces during WW2. The success of these early systems inspired many investigations in the decades that followed. (1 through 51)

The best known of these investigations, the Baltimore Myopia Project, found significant improvements in unaided distance acuity in a group of 103 myopes who underwent optometric visual training, but without any reduction in refractive error. Similar studies confirmed a lack of refractive changes, which caused critics to theorize that the subjects were merely interpreting blurred images or memorizing the Snellen lines. The criticism did not correspond to the experiences reported by the subjects, which led ophthalmologist Judd Beach to comment:

"If we could devote a little time to some of these cases who do gain actual increase in acuity and try to find out what makes them tick, we might get some sort of answer to the questions which are being asked by the persons who take these sight training courses.

They know that if they see 20/10 vividly they are not getting a simple method of better distinguishing blurred images, and they are discounting statements that are made by oculists whom they feel ought to be stuffed and put in museums." (3)

Although ophthalmology has traditionally held the position that the eye is an immutable optical system whose characteristics are genetically determined, several prominent ophthalmologists gave eye exercises and optometric visual training their qualified support. As Lancaster astutely commented:

"If one studies the various publications with an open mind, searching for the things which will explain why the public wants this treatment, one will be forced to admit that buried in a mass of seemingly foolish gestures and performances are sound and fruitful ideas.

There is abundant evidence for the general proposal that exercises, repetition, practice and learning lead to better performance, to the acquisition of skill. Many ocular conditions exemplify this law.

The achievements obtained by the clumsy practices which have been developed should stimulate ophthalmologists to investigate the valuable possibilities in this field, which, I am convinced, await intelligent development. With a sounder theoretical basis, and a more intelligent execution, the good results obtained will be still more impressive." (29)

These early studies typically used lenses, prisms and various targets with the intention of reorganizing the visual system and improving acuity, which is exactly what happened. They did not use techniques that could modify refractive error. In many cases, one eye was trained with the other eye occluded and it was found that the acuity improvement in the trained eye transferred to the occluded eye, thereby demonstrating that the improvement was cerebral, not physiological. As ophthalmologist Sells reported:

"There is acceptable evidence that in motivated subjects, even myopes with greater than two diopters refractive error, visual acuity as measured with standard charts can be improved by visual training. Such improvement does not occur with or by reduction of refractive error. The results must therefore be considered perceptual." (41)

Other investigators, however, observed reductions in refractive error in common visual problems such as astigmatism, hyperopia, myopia, and presbyopia. (4,16,21,28,45) Ophthalmologist Conrad Berens reported:

"The corresponding changes in refractive error were an average reduction of 0.22D for the experimental group and an increase of 0.29D for the control group. 69% of the experimental cases had some reduction of refractive error, while 79% of the control cases had some increase." (4)

In a separate study, optometrist Philip Smith concluded:

"The improvement in acuity found in this study represents change of a magnitude that is hard to explain as correct interpretation of blurred letters by the subjects. The refractive power of the eye was observed to have been significantly reduced in the present study." (45)

It is worth noting that many investigators reported that the acuity improvements obtained by means of eye exercises and optometric visual training were long lasting and generalized, not task specific, and transferred to other situations and targets in the real world. Obviously, if the subjects were just learning to interpret blurred letters on an eye chart, this would not happen. Hence the blur interpretation hypothesis does not fit the observed facts and must be discarded.

On the other hand, large transitory improvements in visual acuity can result from hypnosis, deep relaxation, and sensory deprivation. (52 through 59) As with the optometric visual training procedures discussed above, the improvements seem to be cerebral and do not involve physiological changes, although Barber's work (53) implies that long-term physiological changes may indeed be possible.

COMMON MISCONCEPTIONS

The usual objection that critics direct toward eye exercises is that the eyes are continually changing focus as they move from object to object throughout the day and therefore don't need to be exercised. This point of view fails to take into account the limited way in which most people use their eyes. For example, typical city dwellers spend most of their time in rooms doing close work and seldom pay attention to distant objects or objects closer than the normal reading distance.

It is obviously fallacious to say that because the heart is always beating, it doesn't need exercising. Or that a person who sits at a desk all day shuffling paper doesn't need exercise because her arms are constantly moving. Clearly, for most people not engaged in heavy physical labor, repetition of normal bodily movements is no substitute for a healthy, invigorating workout. This principle almost certainly extends to the eyes, which are an integral part of the body and not separate from it in any way.

Just as the health, strength, and performance of the arms, legs, heart, and other muscular systems improves as a result of physical exercises, similar improvements occur in the eyes and visual system as a result of eye exercises. Dynamic exercises must be employed that extend the range and motion of the eyes beyond the normal realm of usage. In this way, the exercises disembed negative visual patterns and promote ocular health. We speculate that the repeated stimulation exerted by the exercises may activate the emmetropization mechanism so that the eyes undergo a transition to a higher state with sharper acuity, improved nutrition, and presumably a better shape. (60 through 64)

In our opinion, the reason why the clinical studies of optometric visual training mentioned above failed to reduce refractive error is because the appropriate exercises had not been discovered and hence were not used. Most optometric visual training procedures involve looking at a target through lenses and/or prisms. Although these procedures are intended to modify accommodation and convergence, there is no *a priori* reason to suppose that they would modify the shape of the cornea or the size of the eyeball.

Of course, even with a perfect technique, it is probably unrealistic to expect severely elongated or asymmetrical eyeballs to return to normal. Nevertheless, the fact is that the eyes contain muscles, are surrounded by muscles, and are embedded in adipose tissue, hence it seems inevitable that positive changes will take place in their shape and structure as a result of the forces exerted upon them by eye exercises, just as physical exercises can improve the shape and structure of the body.

Since those early days, many new techniques have been discovered that increase the effectiveness of the training, many of which are embodied in the See Clearly Method, which is the result of more than 20 years of research and development. The exercises are briefly described below.

It should be noted that the usual goal of optometric visual training differs from most eye exercises systems. Optometric visual training emphasizes the use of lenses and prisms to improve the efficiency of the visual system, to remediate developmental problems, or to reduce near-point stress. In contrast, the usual goal of eye exercise systems is to improve acuity and reduce dependency on corrective lenses.

The See Clearly Method takes the middle ground. We believe that the eyes often adapt to lenses that are slightly stronger or weaker than the refractive error and to any force that is repeatedly applied to them, such as forces caused by patterns of use or by eye exercises. The critical concern is that whatever lenses or forces are applied to the eyes should stimulate positive rather than negative adaptations. (7,60,61,62,64)

We must emphasize that although two of the exercises (Palming, Light Therapy) used in the See Clearly Method originated with the 19th century ophthalmologist William Bates, we do not endorse the so-called Bates method. We join other critics in categorically stating that Bates's theory of accommodation is incorrect, that some of his exercises such as gazing toward the sun are potentially dangerous, and that some of his claims were probably exaggerated. Bates was just one of many pioneers and should not be given greater credit than he deserves.

It is not our intention to digress into the myopia controversy except to comment on the statement made by the National Eye Institute:

"Reading is the most established risk factor in myopia. More recent observations have strengthened the association of the amount of near work with the rate of myopic progression. Because the sharpness of the image during reading depends on the precision of accommodation, it is significant that myopic children have poorer accommodation than others.

Researchers have long suspected that genetic factors play a role in the cause of myopia. One of the weaknesses of family studies is that it is difficult to separate out the contribution of genes in families from that of a shared environment. Do parents pass on to their children myopic genes or a love of reading?" (73)

This statement concurs with Young's conclusion (74 through 80) that the amount of near work is the most important predictive factor for myopia. Furthermore, many researchers including ourselves believe that the major cause of myopic progression is long periods of reading through full strength minus lenses, which increases near-point stress and overloads the convergence system. As Birnbaum explains:

"Prescription of a single-vision full minus lens correction for full-time use produces accommodative insufficiency, frequently with symptoms, until the patient 'gets used to the glasses.' This is generally accompanied by further increase in myopia, and the cycle begins anew." (7)

Furthermore, Young has shown (80) that sustained convergence when reading increases the IOP, which suggests that the increased pressure is the major cause of axial elongation often found in myopia. With this in mind, the primary goal of the See Clearly Method is to help people with minor visual problems such as incipient myopia or early presbyopia return to normal or near-normal vision and avoid or delay the need for corrective lenses.

In cases where corrective lenses have produced negative adaptations and structural changes in the eye, the See Clearly Method attempts to reverse these negative adaptations and structural changes as much as possible. In medium to high myopia, the See Clearly Method can often help the person read and do close work without corrective lenses, which are usually restricted to activities requiring good distance acuity, such as driving or watching movies.

The See Clearly Method also capitalizes on the fact that many patients who receive traditional eye care must "get used to" the progressively stronger corrective lenses that are usually prescribed. This fact underscores the remarkable plasticity of the visual system. The See Clearly Method uses the same principle in reverse, in which patients adapt to a series of progressively weaker corrective lenses until the maximum amount of reduction is obtained. We call this "progressive undercorrection". Patients who do the exercises over a period of several months can often significantly reduce their prescription. As the National Eye Institute reports:

"The past 5 years have yielded a flood of behavioral studies demonstrating that practice on specific perceptual tasks results in increased sensitivity to weak visual signals and increased capacity for discriminating among very similar signals, which can be sharply restricted to the region of

space in which the important signal commonly occurs. Thus the adult visual system is not immutable, can change according to behavioral demands, and has implications for potential rehabilitation." (73)

SEE CLEARLY METHOD EXERCISES

1) **Pumping.** This exercise involves changing focus between a near object and a far object, and is intended to tone and condition the ciliary muscle and increase control of the extraocular muscles, resulting in improved accommodation, lenticular flexibility, and circulation of fluids in the vicinity of the lens.

2) **Tromboning.** This exercise involves looking at an object while moving it from arm's length to the tip of the nose. This exercise is intended to produce results similar to Pumping with the emphasis on developing convergence and near focusing skills.

3) **Clock Rotations.** This exercise involves alternately looking at the numbers of a large imaginary clock and the center of the clock, and is intended to tone, condition, and improve control of the extraocular muscles and normalize the shape of the eyeball.

4) **Eye Rolls.** Here the eyes are slowly rotated in a complete or partial circle. This exercise is intended to produce results similar to Clock Rotations.

5) **Slow Blinking.** This is a stress reduction exercise that involves slowly opening and closing the eyes, and is intended to briefly shut down the visual system, thereby elevating the level of nutrients and neurotransmitters in the eyes.

6) **Fast Blinking.** This exercise involves rapidly opening and closing the eyes, and is intended to stimulate the production of tear fluid and lubricate the cornea.

7) **Squeeze Blinking.** Here the eyelids are held tightly shut as if pulling the eyeball back into the eyesocket. This exercise is intended to stimulate the production of tear fluid, lubricate and flatten the cornea, and reverse elongation of the eyeball.

8) **Blur Zoning.** This exercise consists of two variations: Edging and Centering. Edging involves running the gaze along the edges of blurred objects, whereas Centering involves studying

small details in blurred objects down to the limits of one's perception. This exercise is designed to reduce fixation disparity, improve control of the ciliary muscle, and stimulate hyperacuity.

9) **Nose Fusion.** This exercise consists of looking at the tip of the nose with both eyes at the same time and is intended to improve convergence and control of the extraocular muscles.

10) **Fusion Chart.** This exercise involves fusing two identical figures separated by a few inches on a chart and is intended to produce results similar to Nose Fusion.

11) **Fusion Pumping.** This exercise involves changing focus between the fused image on the Fusion Chart and a distant object. This is intended to combine the results of Pumping and the Fusion Chart as well as disembed accommodation/convergence conflicts and normalize reflex accommodation.

12) **Blur Reading.** This exercise involves reading extremely blurred printed material and is intended to improve ocular coordination and edge discrimination.

13) **Scanning Chart.** This exercise involves following a meandering line on a chart and is intended to improve saccades and coordination.

14) **Word Chart.** This exercise uses a multi-line chart where each line consists of words that are slightly smaller than the line above. This arrangement produces visual biofeedback and is intended to sharpen acuity by refining control of the ciliary muscle and reducing fixation disparity.

15) **Acupressure.** These Chinese exercises reduce visual stress and increase "chi" energy flow to the entire eye region, which relaxes and invigorates the eyes and the surrounding tissues.

16) **Light Therapy.** This exercise consists of sitting with closed eyes in front of an incandescent lamp, so that the warmth relaxes and invigorates the eyes and the surrounding tissues.

17) **Palming.** This stress reduction exercise involves covering the closed eyes with the palms of the hands so that no light enters the eyes. The purpose is to shut down the visual system, relax the eyes, and elevate the level of nutrients and neurotransmitters in the eyes.

18) Hydrotherapy. This exercise involves alternately bathing the closed eyes with hot and cold water, and is intended to improve the flow of nutrients to the entire eye region, thereby invigorating the eyes and surrounding tissues.

ACUITY IMPROVEMENT MECHANISMS

Research into acuity improvement by means of eye exercises and optometric visual training peaked from the late 1940s through the mid 1980s. Nowadays, interest in the subject has waned as optometry has become more involved in the use of therapeutic pharmaceutical agents to treat pathology. Nevertheless, the body of accumulated evidence shows that major improvements in acuity can take place with or without corresponding changes in refractive error.

Traditional theories of physiological of optics require good visual acuity to be contingent on a precise conjugate focus of light on the retina. Hence acuity improvement without refractive change presents a paradox. Although measurable reduction of refractive error occurred in 19 of the 21 subjects in this investigation, the amount of reduction was insufficient to account for the acuity improvements. We therefore propose the following mechanisms to account for the improvements that were observed.

1) Hyperacuity

Even in emmetropia, lenticular and corneal spherical and chromatic aberrations together with diffraction and scattering of light on the retina prevent the formation of a point image. These optical factors limit the minimum angle of resolution to about 30" (seconds of arc).

Furthermore, the retinal image must be transduced into nerve impulses to be processed by the brain. In order to distinguish two point objects, three bits of information are required: the light from each point object and the absence of light between them. Hence the neural threshold at the fovea requires three cones. The first point object stimulates the first cone, the second cone remains unstimulated, and the second point object stimulates the third cone. For this reason the neural threshold equals the cone spacing at the fovea, which is about 30".

In emmetropia or eyes corrected for refractive error, the optical and neural factors that determine the minimum angle of resolution concur at about 30". In ametropia, however, the neural threshold remains the same but the dioptric blur exceeds 30" depending on the magnitude of the refractive error.

Under many circumstances, the visual system can resolve differences that are up to an order of magnitude smaller than the minimum angle of resolution on the retina. For example, observers can reliably detect a 8" to 10" rapid displacement of a vertical bar, a 6" difference in the separation of two lines, a 2" to 4" vernier displacement, and a 2" to 4" separation of lines in a stereoacuity task. (65,66)

This phenomenon is known as "hyperacuity" and can occur in a wide variety of tasks. Although various mechanisms have been proposed, the general principle is that the edge of an object is made to partially overlap cone apertures and thus partially stimulate the cones. If the partial stimulation is sufficient to make the cones fire, the resulting signal can distinguish the position of the object. Small saccades and ocular microtremor may provide the switching mechanism for cone activation. The net result is an increase in the signal-to-noise ratio of the retinal data available for image processing by the visual cortex. This mechanism provides a simple explanation of acuity improvement resulting from edge discrimination training.

2) Perceptual Enhancement

This refers to the cerebral acuity improvement mechanism mentioned earlier and appears to involve a learning process whereby the edges and textures of blurred objects are enhanced by means of averaging or interpolating the visual data to increase the signal-to-noise ratio, thereby achieving greater contrast. This is almost certainly an act of selective attention, the visual equivalent of isolating a particular voice from the background noise in a room full of chatter. (67)

3) Reduction of IOP

Many myopes and presbyopes have elevated IOP that appears to be caused by the lens bulging against the iris, thereby restricting the flow of liquid into the anterior chamber and in some cases impeding drainage through Schlemm's canal. Underlying factors include chronic nearpoint accommodation in myopes, lenticular growth in presbyopes, and excess sugar consumption. (68,69,70)

Young's research (80) suggests that excessive IOP can elongate the eyeball and increase myopia. It follows that reducing nearpoint stress and correcting dietary imbalances may reduce the IOP and modify the shape and refractive power of the lens and eyeball.

4) Tear Fluid Contact Lens Formation

Clinical observations show that the stimulation of blinking can cover the cornea with a copious amount of tear fluid, which may form a transient contact lens due to the meniscus curvature at the eyelids, thereby changing the refractive power of the cornea. (2)

5) Extension of Accommodative Amplitude

With normal use, the ciliary muscle does not expand or contract to its maximum limits. This is especially true of city dwellers, who typically live and work in a confined visual space. It follows that exercising the ciliary muscle will increase the accommodative amplitude, extend the nearpoint and farpoint, and change the refractive status of the lens.

6) Modification of Ciliary Muscle Tonicity

Ciliary muscle tonicity determines the resting state of the lens in the absence of visual stimulation. It follows that exercising the ciliary muscle will probably modify its tonicity, thereby changing the resting state of the lens. This is an adaptive change that will probably also extend the nearpoint and the farpoint and change the refractive status of the lens.

7) Modification of Extraocular Muscle Tonicity

It is often observed that astigmatism can spontaneously change its magnitude and direction. This phenomenon is almost certainly caused by imbalances in the forces exerted by the extraocular muscles on the eyeball, causing it and probably also the cornea to change shape. It follows that correcting the imbalances will modify extraocular muscle tonicity and change the shape and refractive status of the eyeball and cornea. (16)

8) Reduction of Fixation Disparity.

A blurred binocular image cannot be precisely fixated and can lead to convergence errors and diplopia. Since reflex accommodation is largely determined by convergence, fixation disparity may also cause additional loss of focus and acuity. It follows that improving extraocular muscle coordination will refine convergence and reduce fixation disparity, enabling the eyes to focus more accurately with better acuity.

9) Increase in Lenticular Flexibility

It is well established that presbyopia is due to lenticular sclerosis. In view of the fact that physical exercises may increase the flexibility of the joints, it follows that eye exercises may increase the flexibility of the lens, thereby modifying its refractive status. (71,72).

SUMMARY AND CONCLUSIONS

The See Clearly Method is a program of eye exercises designed to improve the health, strength, and performance of the eyes, just as physical exercise programs may improve the health, strength, and performance of the body. We hold the position that the eyes are not fundamentally different from the rest of the body and obey the same basic laws of kinesiology and physical enhancement.

The effects of the See Clearly Method follow a progression similar to typical physical exercise programs where most people notice the first signs of improvement within a few weeks. The results of this evaluation are consistent with the results we have observed in more than 20 years of clinical practice. Typically, patients with large refractive errors must do the exercises for several months before they achieve a major improvement, and health-conscious patients usually deem this to be a worthwhile endeavor that represents an investment in their quality of life.

Due to the limited scope of the clinical evaluation, no follow-up was carried out to determine if the results were maintained. However, an important component of the See Clearly Method is the development of new visual habits. These are intended to accelerate improvement and automatically maintain the results by means of conditioned reflexes in which some of the exercises are integrated with normal daily activities. Most subjects reported that they successfully developed the new visual habits and that these were effective in reminding them to use “down time” to work on their vision.

In contrast to optometric visual training, the See Clearly Method includes exercises specifically designed to reduce refractive error. The effectiveness of this approach is evidenced by the substantial reduction in refractive error that occurred in most subjects. Even allowing for a $\pm$ 0.50D experimental error in the measurement of refractive error, the consistent change toward improvement lends credence that the observed reductions are a genuine phenomenon and not an artifact.

As with the Baltimore project and most other studies, a control group was deemed unnecessary in view of the fact that the refractive error or visual acuity of patients who wear compensatory lenses almost never spontaneously improves without visual training, especially over such a short period of time (see Appendix).

It is important to note the absence of statistical correlation between refractive changes and acuity improvements, which implies that other factors besides refractive changes contributed to the observed acuity improvements. We postulate that acuity improvement is a process involving several possible physiological and cerebral mechanisms, and we have shown that our results are entirely consistent with those of other investigators such as Berens, who reported:

"The most striking changes occurred in visual acuity. The changes in form field and reading speed were highly significant, but not as great. The changes in refractive error were significant, but small. Although the changes in these functions were unrelated, as seen in their correlations, they occurred uniformly in the direction of improvement for the trained group and uniformly in the direction of poorer visual performance for the untrained control group."

Our analysis (Figures 1 through 5) shows the exact same uniformity of change in the direction of improvement, although the refractive changes can hardly be described as insignificant. It is worth noting that the lack of correlation between the acuity changes in the left and right eyes suggests that the cerebral component of the acuity improvement is not a dominant factor, otherwise there would be greater interocular transfer. Hence it follows that physiological changes must be responsible for much of the improvements.

The results of this evaluation should not be regarded as definitive due to the small number of subjects. In particular, the subjective refraction measurements do not provide enough information about whether the reductions in refractive error are due to axial, corneal, or lenticular changes. We hope that other investigators will shed light on this important topic. Furthermore, although we postulate a multifactorial process to account for the observed improvements, the relative importance of each factor cannot be deduced from this study and should provide a fertile field for future investigation.

Nevertheless, the ease with which the See Clearly Method reversed myopia in 12 out of 14 subjects is noteworthy because its shows that rather than being the inevitable result of a genetic deformity, myopic progression can be avoided simply by exercising the eyes in the right way and developing new habits that minimize the impact of nearpoint stress on the visual system.

Similarly, the consistent improvement in presbyopes demonstrates that the aging process does not prevent improvements in refractive error and acuity from occurring in older people. This conclusion is supported by statistical analysis of the data, which shows lack of correlation between Rx changes and age, and TVA changes and age. Obviously, the aging process cannot be resisted indefinitely and must eventually take its toll. Nevertheless, it is reassuring to find that even elderly subjects can benefit from the exercises.

Although the results obtained in this evaluation are encouraging, we believe that they can be improved on and make the following predictions. In its present configuration, the See Clearly Method is similar in design to bodily exercise programs where people of all shapes and sizes do a common set of exercises. We predict that by tailoring the exercise sequences to specific visual problems, such as a dedicated myopia program or a dedicated presbyopia program, the results will be correspondingly better.

Second, we predict that the inclusion of hypnotic techniques involving brainwave entrainment will facilitate positive long-term changes in the shape and structure of the eyes, enabling patients with high refractive errors to obtain better results. (53)

Third we predict that some of the See Clearly Method exercises will have a positive impact on pathological conditions such as cataract, glaucoma and macular degeneration. The increased sensations of health and vitality reported by many subjects suggests that the judicious use of exercises to improve the flow of nutrients to the eyes may enhance traditional methods of treating these diseases.

In conclusion, this evaluation shows that the See Clearly Method can provide health conscious eye care professionals and motivated patients with a viable alternative to progressive dependency on compensatory lenses. The exercises are effective against asthenopia, astigmatism, myopia, hyperopia and presbyopia, and can serve as an adjunct to traditional vision care with an emphasis on prevention and the maintenance of ocular health.

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This research was funded by Vision Improvement Technologies L.L.P., of Fairfield, IA 52556. Although Vision Improvement Technologies is no longer in business and the See Clearly Method is no longer available, a similar eye exercise program is available as a free Internet download from our website at www.visiontherapy.net.

APPENDIX

Why A Control Group Was Not Needed

The most important proof of the efficacy of a treatment procedure is anecdotal evidence. If a thousand patients report positive results, this is powerful circumstantial evidence that the treatment works. In fact, almost all new off-label uses of prescription drugs are discovered in this way – by patients reporting beneficial side-effects.

To confirm anecdotal evidence and determine the precise level of efficacy, the randomized controlled trial (RCT) is widely used in drug testing. Subjects are divided into randomized groups, the composition of which are unknown to the investigators. Typical groups include a group that receives the drug, a placebo group that receives a dummy pill, and a group that receives no treatment. This type of structure can compensate for placebo effects and investigator bias.

Although a well-structured RCT is unquestionably the most desirable form of clinical investigation, this is not possible in many situations due to cost, the nature of the procedure being investigated, and ethical considerations. Unfortunately, a bias has emerged among many health care professionals that anything less than an RCT is worthless and the results of such studies are unreliable. Some health care professionals even take the extreme position that unless a procedure is subjected to a RCT it is unproven and therefore "quackery".

We believe that such a point of view is naive and damaging to the advancement of medical science. For example, no RCTs have ever proven the efficacy of corrective lenses, vision therapy, or any type of eye surgery. In spite of such glaring omissions, it is absurd to claim that the entire eye care profession is composed of quacks! Yet this is precisely what the RCT purists would have us believe.

The fact is that different proofs of efficacy can contribute to the body of knowledge surrounding a procedure and anecdotal reports should not be discounted or ignored. Instruments only measure what they are designed to measure and we must bear in mind that vision is an extremely complex process in which the inherently degraded retinal image is perceptually enhanced by the visual cortex. (66)

Hence, rather than clinging to a blind, unthinking subservience to the RCT standard it is important to achieve a deeper understanding of the underlying factors and tailor the protocols accordingly. In the present study, a control group was not used for two simple reasons.

First, it is common knowledge that people who wear corrective lenses hardly ever spontaneously improve, especially over the short duration of the study. This historical fact provides an accurate baseline against which the subjects' improvements can be judged. Bearing in mind that almost all people who wear corrective lenses deteriorate over time, the results obtained using a historical baseline are even more impressive.

Second, a control group to eliminate investigator bias is only needed if the investigator is actually measuring something. In this case, the data were obtained by means of standard optometric measurements, which simply involved recording the patients' observations. Because objective standards were adhered to – for example, a Snellen line was scored only if a majority of the letters were correctly identified – the question of investigator bias does not arise.

It is worth noting that other scientists reached the same conclusion in an investigation of medulloblastima using a statistical procedure similar to ours, and obtained results comparable to a standard RCT.*

Hence a control group was not necessary in the current investigation, either to provide a baseline or to eliminate investigator bias, and we stand by our results as being objective and reliable. In addition to the clinical data, the subjects' anecdotal reports confirm that the See Clearly Method produced a genuine improvement in vision and not a hallucinatory artifact or merely learning to "interpret blurred images".

Once again, we must emphasize that in determining the efficacy of a treatment procedure the goal is to establish a body of knowledge consisting of anecdotal evidence, clinical observations, and clinical trials – each of which should compliment the others.

Finally, we must mention that the improvements in refractive error are presented in this paper as a function of the entire visual system and not as an average value per eye. The reason is that averaging creates an artifact that we consider unnecessary and potentially misleading. For example, suppose a subject was highly amblyopic to the extent that she was essentially "blind" in the amblyopic eye. Averaging the data would create the erroneous impression that the amblyopic eye was radically improved, whereas all the improvement took place in the non-amblyopic eye. Readers who are accustomed to dealing with averages may wish to divide our data by two.

*Xiong X., Tan M., Boyett J., A sequential procedure for monitoring clinical trials against historical controls, Statistical Medicine, 2006.

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Table 1: ***Refractive Error (diopters)***

		SPHERE				CYLINDER			
S#	**Age**	**OD(A)**	**OD(B)**	**OS(A)**	**OS(B)**	**OD(A)**	**OD(B)**	**OS(A)**	**OS(B)**
S1	39	+1.75	+0.50	+1.25	+0.25	-0.75 x 105	0	-0.75 x 90	0
S2	43	-1.75	-1.50	-1.75	-1.25	0	0	0	0
S3	43	+1.75	+1.00	+1.75	+0.75	0	0	0	0
S4	16	-0.75	-0.25	-0.25	+0.25	0	0	0	0
S5	46	+2.75	+2.25	+2.50	+1.75	0	0	0	0
S6	34	-0.75	-0.75	-0.75	-0.75	0	0	0	0
S7	63	-1.00	-1.00	-1.25	-1.25	-1.75 x 172	-1.75 x 172	-1.00 x 17	-1.00 x 17
S8	47	+0.75 +3.00	+0.50 +2.75	+0.25 +2.50	0 +2.25	0	0	0	0
S9	41	-1.75	-1.50	-1.75	-1.50	0	0	0	0
S10	41	-2.50	-2.50	-4.00	-3.25	-1.25 x 77	-1.00 x 83	0	0
S11	52	-0.75 +1.00	-0.75 0	-1.75 0	-1.50 0	-0.50 x 180	-0.25 x 180	-0.25 x 150	0
S12	80	+3.25	+2.75	+4.25	+3.75	-1.00 x 105	-0.75 x 105	-1.25 x 65	-1.00 x 65
S13	46	-1.25	-1.25	-2.25	-2.00	-1.00 x 85	-1.00 x 85	-0.50 x 88	-0.50 x 88
S14	54	-1.75	-1.50	-1.50	-1.50	0	0	0	0
S15	39	+1.00	+0.50	+0.25	-0.25	-1.50 x 39	-1.25 x 39	-0.50 x 120	-0.25 x 120
S16	40	-1.25	-1.00	-1.25	-1.00	-0.50 x 112	-0.25 x 112	-1.00 x 60	-0.50 x 60
S17	46	+0.75 +2.50	0 +1.00	+1.00 +2.75	+0.50 +1.50	0	0	0	0
S18	43	-0.50	-0.50	-0.75	-0.75	-0.75 x 175	-0.50 x 175	-1.00 x 20	-1.00 x 20
S19	51	0	+0.25	-0.25	+0.25	-0.75 x 125	-0.50 x 125	-0.50 x 95	-0.25 x 95
S20	14	-1.50	-0.50	-2.00	-0.75	-1.00 x 95	-0.25 x 95	-0.50 x 85	0
S21	37	-1.00	-0.50	-1.25	-0.75	-0.75 x 90	-0.50 x 90	-0.50 x 90	-0.25 x 90

(A) = pre-training, (B) = post-training

Table 2: ***Refractive Error Changes (diopters)***

		Presbyopia/Hyperopia			Myopia			Astigmatism		
S#	**Age**	**OU(A)**	**OU(B)**	**Change**	**OU(A)**	**OU(B)**	**Change**	**OU(A)**	**OU(B)**	**Change**
1	39	+3.00	+0.75	-2.25				-1.50	0.00	+1.50
2	43				-3.50	-2.75	+0.75			
3	43	+3.50	+1.75	-1.75						
4	16				-1.00	0.00	+1.00			
5	46	+5.25	+4.00	-1.25						
6	34				-1.50	-1.50	0.00			
7	63				-2.25	-2.25	0.00	-2.75	-2.75	0.00
8	47	+6.50	+5.50	-1.00						
9	41				-3.50	-3.00	+0.50			
10	41				-6.50	-5.75	+0.75	-1.25	-1.00	+0.25
11	52	+1.00	0.00	-1.00	-2.50	-2.25	+0.25	-0.75	-0.25	+0.50
12	80	+7.50	+6.50	-1.00				-2.25	-1.75	+0.50
13	46				-3.50	-3.25	+0.25	-1.50	-1.50	0.00
14	54				-3.25	-3.00	+0.25			
15	39	+1.25	+0.25	-1.00				-2.00	-1.50	+0.50
16	40				-2.50	-2.00	+0.50	-1.50	-0.75	+0.75
17	46	+7.00	+3.00	-4.00						
18	43				-1.25	-1.25	0.00	-1.75	-1.50	+0.25
19	51				-0.25	+0.50	+0.75	-1.25	-0.75	+0.50
20	14				-3.50	-1.25	+2.25	-1.50	-0.25	+1.25
21	37				-2.25	-1.25	+1.00	-1.25	-0.75	+0.50

(A) = pre-training, (B) = post-training, Change = OU(B) − OU(A)

Table 3: *Unaided Snellen Visual Acuity*

		NEAR ACUITY						DISTANCE ACUITY					
S#	**Age**	**OD(A)**	**OD(B)**	**OS(A)**	**OS(B)**	**OU(A)**	**OU(B)**	**OD(A)**	**OD(B)**	**OS(A)**	**OS(B)**	**OU(A)**	**OU(B)**
S1	39	50	nd	25	nd	25	40	25	nd	15	nd	15	15
S2	43	20	20	20	20	20	20	60	65	60	45	60	40
S3	43	30	60	30	50	25	50	25	20	20	15	20	15
S4	16	25	20	25	20	20	20	30	20	20	15	20	15
S5	46	100	100	70	70	70	50	30	25	25	20	20	20
S6	34	20	20	25	20	20	20	25	15	35	20	25	15
S7	63	60	30	50	30	50	20	100	60	80	50	70	40
S8	47	200	100	200	100	200	100	40	50	20	20	20	20
S9	41	30	nd	30	nd	25	20	250	100	275	100	200	100
S10	41	25	nd	25	nd	20	nd	300	100	300	100	100	70
S11	52	50	40	25	20	25	20	60	30	200	80	60	25
S12	80	30	30	100	40	25	25	25	15	40	25	30	20
S13	46	20	20	25	25	20	20	50	40	70	60	50	40
S14	54	40	30	40	30	30	25	70	25	55	25	50	20
S15	39	50	30	30	20	25	20	45	25	25	20	25	20
S16	40	20	20	20	20	20	20	100	60	50	50	50	40
S17	46	30	25	70	40	40	25	25	15	25	15	25	15
S18	43	35	20	50	25	35	20	45	25	75	30	40	20
S19	51	60	30	60	30	50	25	30	15	25	15	20	15
S20	14	25	nd	20	nd	20	20	100	30	150	30	80	30
S21	37	20	20	20	20	20	20	30	25	40	25	30	20

Units are Snellen fraction denominators, ie. 100 = 20/100
(A) = pre-training, (B) = post-training, nd = no data

Table 4: *Unaided Near Acuity Changes*

		Snellen			TVA		
S#	**Age**	**OD**	**OS**	**OU**	**OD**	**OS**	**OU**
S1	39	nd	nd	-2	nd	nd	-0.75
S3	43	-3	-2	-3	-1.50	-1.00	-1.25
S5	46	0	0	+2	0	0	+1.00
S7	63	+3	+2	+4	+1.50	+1.00	+1.50
S8	47	+1	+1	+1	+5.00	+5.00	+5.00
S11	52	+1	+1	+1	+0.50	+0.25	+0.25
S12	80	0	+5	0	0	+3.00	0
S14	54	+1	+1	+1	+0.50	+0.50	+0.25
S15	39	+2	+2	+1	+1.00	+0.50	+0.25
S17	46	+1	+3	+2	+0.25	+1.50	+0.75
S18	43	+3	+3	+3	+0.75	+1.25	+0.75
S19	51	+3	+3	+3	+1.50	+1.50	+1.25

Snellen = Snellen lines, TVA = minutes of arc

Table 5: *Unaided Distance Acuity Changes*

		Snellen			TVA		
S#	**Age**	**OD**	**OS**	**OU**	**OD**	**OS**	**OU**
S4	16	+2	+1	+1	+0.50	+0.25	+0.25
S6	34	+2	+3	+2	+0.50	+0.75	+0.50
S7	63	+3	+3	+3	+2.00	+1.50	+1.50
S9	41	+2	+2	+1	+7.50	+8.75	+5.00
S10	41	+2	+2	+2	+10.00	+10.00	+1.50
S11	52	+3	+2	+4	+1.50	+1.00	+1.75
S12	80	+2	+2	+2	+0.50	+0.75	+0.50
S13	46	+1	+2	+1	+0.50	+0.50	+0.50
S14	54	+5	+4	+4	+2.25	+1.50	+1.50
S15	39	+3	+2	+1	+1.00	+0.25	+0.25
S16	40	+3	0	+1	+2.00	0	+0.50
S17	46	+2	+2	+2	+0.50	+0.50	+0.50
S18	43	+3	+5	+3	+1.00	+2.25	+1.00
S19	51	+3	+2	+1	+0.75	+0.50	+0.25
S20	14	+6	+7	+5	+3.50	+6.00	+2.50
S21	37	+1	+2	+2	+0.25	+0.75	+0.50

Snellen = Snellen lines, TVA = minutes of arc

Figure 1: *Refractive Error Changes* (*Myopia*)

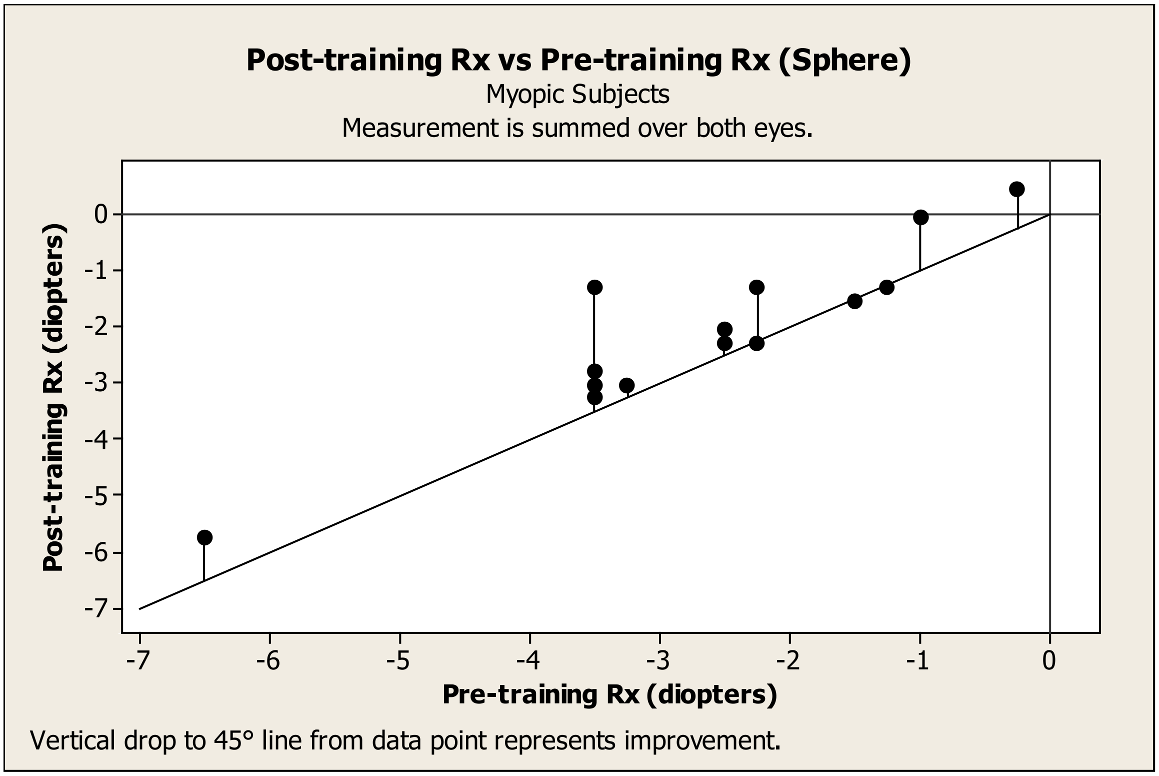


Figure 2: ***Refractive Error Changes*** **(*Presbyopia/Hyperopia*)**

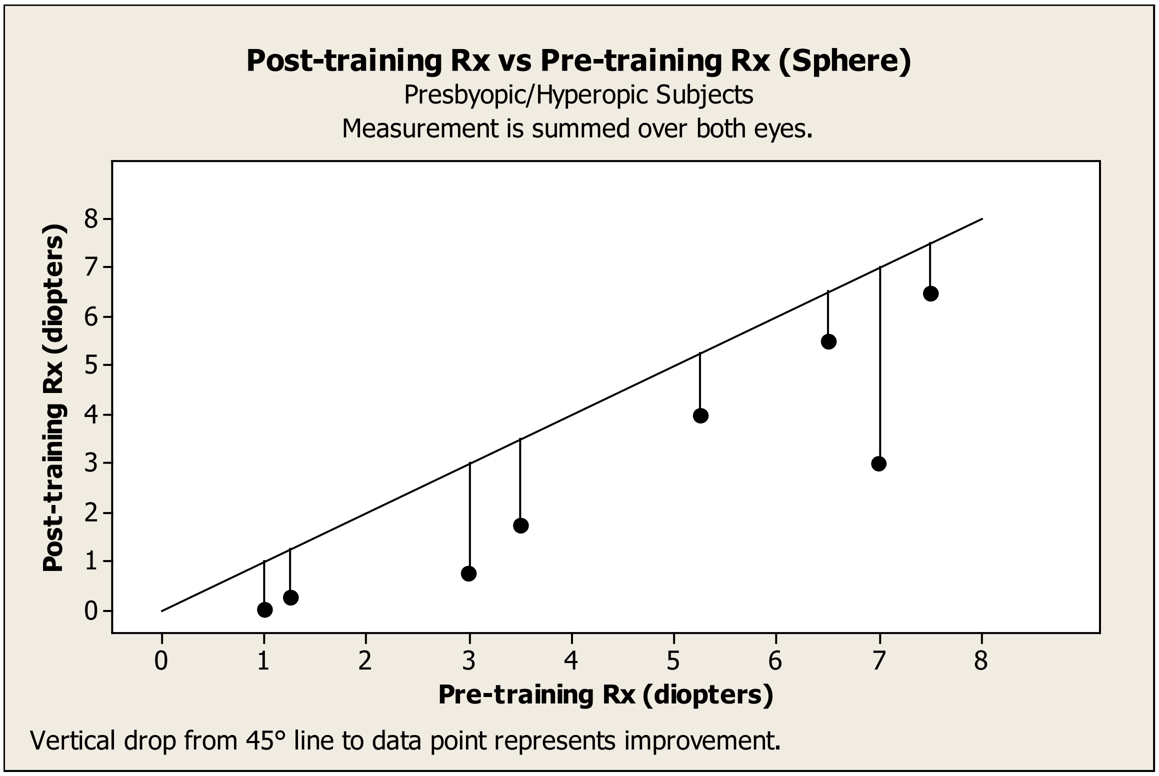


Figure 3: ***Refractive Error Changes (Astigmatism)***

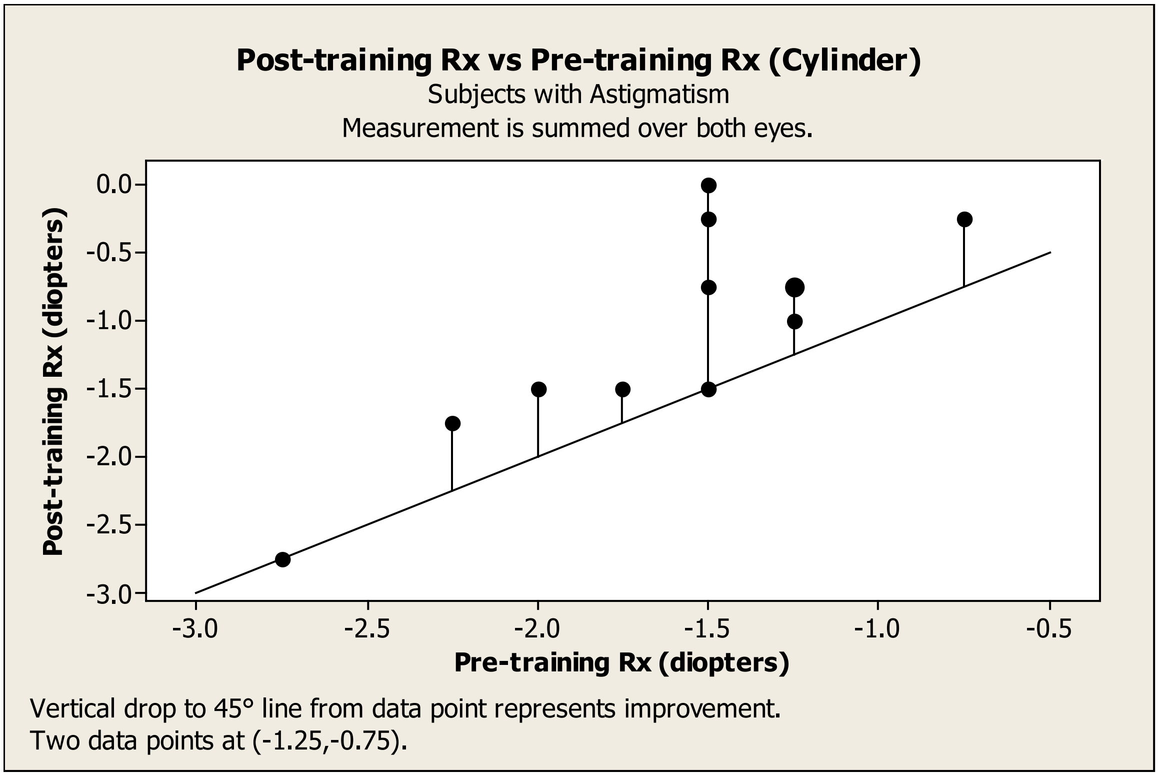
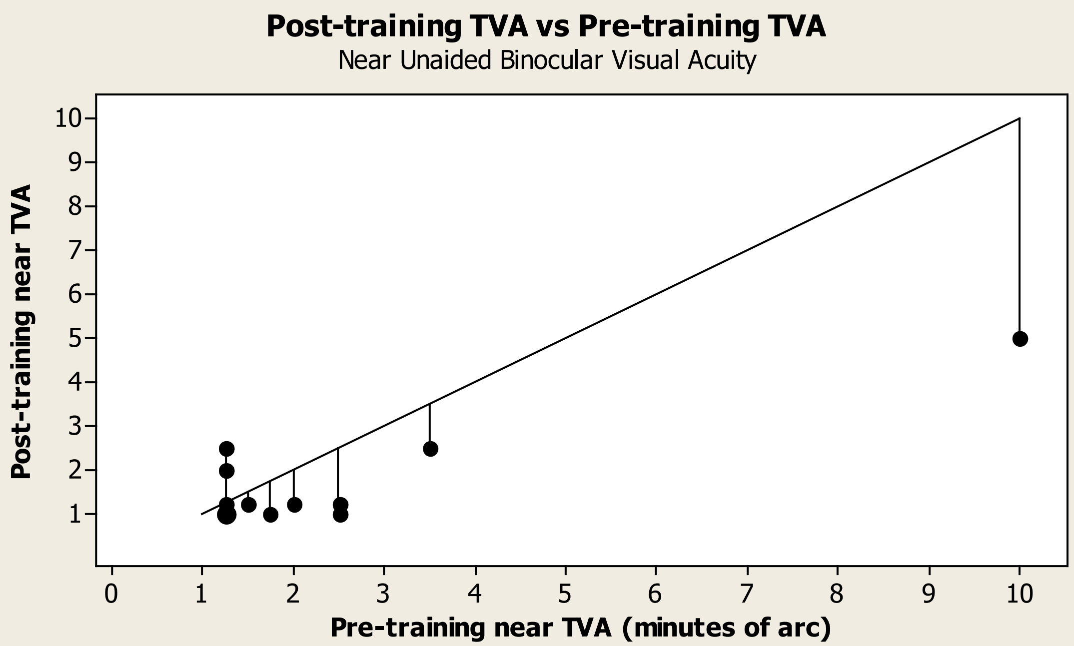
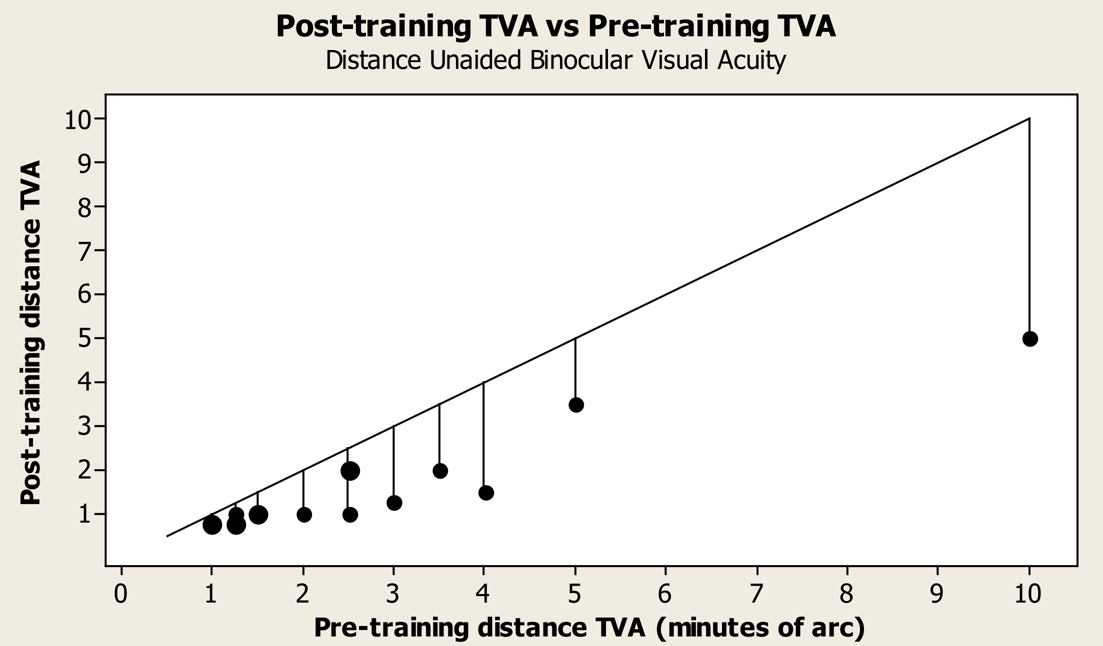


Figure 4: ***Near Visual Acuity Changes***



Vertical drop from 45° line to data point represents improvement.
Two data points at (1.25,1.00).

Figure 5: ***Distance Visual Acuity Changes***



Vertical drop from 45 line to data point represents improvement.
Two data points at (1.00,0.75), (1.25,0.75), (1.50,1.00), (2.50,2.00).