The postural effects of yoked prisms

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Abstract
The goal of this project was to quantify the postural changes induced by yoked prisms after a period of adaptive wear between two groups, one sitting and reading while the other was continually walking. The project included 36 randomly selected subjects ranging in age from 21 to 28. Testing involved measurements to quantify the immediate and short term effects of vertical yoked prism wear on the center of balance as measured by the Chattex Balance System™. Our study noted immediate significant changes in body posture when prisms were first placed on subjects. After short time adaptation, both reading and walking groups showed a return to habitual posture with no difference in adaptation between groups. No significant "rebound" or after-effect of prism wear was measured immediately after prisms removal.

Degree Type
Thesis

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THE POSTURAL EFFECTS OF YOKED PRISMS

By

Mari Ward
Tracey Yamamoto
Kimberly McDowell

A thesis submitted to the faculty of the
College of Optometry
Pacific University
Forest Grove, Oregon
for the degree of
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Advisor:
Paul Kohl, O.D.
THE POSTURAL EFFECTS OF YOKED PRISMS

AUTHORS:

Mari Ward
Tracey Yamamoto
Kimberly McDowell

ADVISOR:
Paul Kohl, O.D.
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ACKNOWLEDGEMENTS

Special thanks is extended to the Pacific University School of Physical Therapy for the use of Chattercx Balance System. Thanks to Pacific University College of Optometry Vision Therapy Clinic for the utilization of prisms and sports vision goggles. Douglas Jeske for his assistance in operations, data collection and statistical analysis. Dr. Paul Kohl for his support and contribution in the development of the research.
ABSTRACT

The goal of this project was to quantify the postural changes induced by yoked prisms after a period of adaptive wear between two groups, one sitting and reading while the other was continually walking. The project included 36 randomly selected subjects ranging in age from 21 to 28. Testing involved measurements to quantify the immediate and short term effects of vertical yoked prism wear on the center of balance as measured by the Chattex Balance System™. Our study noted immediate significant changes in body posture when prisms were first placed on subjects. After short time adaptation, both reading and walking groups showed a return to habitual posture with no difference in adaptation between groups. No significant "rebound" or after-effect of prism wear was measured immediately after prims removal.
INTRODUCTION:

As a primary care practitioner, the optometrist plays a key role in the development of visual-motor relationships through the use of lenses, prisms and visual training. The concept of utilizing prisms for visual training by optometrists is well documented in the literature.

Prisms are pieces of glass or plastic that are triangular shaped in cross-section. The most acute angle is called the apex and the opposite side is the base. Prisms can change the direction of light without affecting the vergence of the light. This causes an apparent shift in the position of any object viewed through them. This apparent shift of the object causes the eye to shift position towards the apex of the prism and an oculomotor adjustment occurs to realign the retinal image on the fovea. The use of base-out and base-in prisms have been and still are being used in vision therapy for convergence dysfunctions.

"Yoked prisms are classically defined as prisms of equal degree with both their bases placed in the same direction."[Nathanson, 1985, #1] Prisms can be oriented with bases up, down, right or left. Base down yoked prisms cause subjects to perceive their visual space to be shifted upwards causing them to feel shorter and feel as though they were walking uphill. Base up yoked prisms will cause the visual space to be shifted down. These prisms make the subjects feel tall and feel as though they were walking downhill. Bilateral prisms, with bases oriented to the right moves the visual space to the left and base left prisms causes a right lateral shift.

"The use of large magnitude yoked prisms was originated by Bruce Wolff, O.D., of Cincinnati, Ohio. Optometric authors John Streff, Richard Apell, Robert
Kraskin, Gus Forkiotis and others have reported visual behavioral changes with the use of large magnitude yoked prisms"[Kaplan, 1987, #2] Kraskin's study of yoked prisms encompasses a broad scope in vision therapy and lens application. With the emphasis on lens application, Kraskin found that as the yoked prism lens alters the light distribution, the subject can alter eye and body position. This is significant since body function and physical activity are related. Balance and gravity are key components that must be attended to before the system can be loaded by requiring a person to perform a specific visual task.[Kraskin, 1982, #3] So, when the environment is changed visually, certain changes in balance must occur before the person can function physically in their new environment. Forkiotis introduced the use of yoked prism lenses in visual training to achieve changes in habitual patterns of performance and the amount of freedom in interpretation of visual-motor responses.[Forkiotis, 1975, #4] Sheedy and Parsons studied the patient acceptance and postural adjustment of vertical yoked prisms in 1986. The emphasis in their study centered on the acceptance or rejection of the yoked prism within spectacle prescriptions. They found that patients could not differentiate between 0 prism diopter and 2 prism diopter base down yoked prisms but manifested a significant change in head and neck posture after two weeks of wearing 4 base down yoked prisms.[Sheedy, 1987, #5]

Kaplan has published a number of articles dealing with yoked prisms and the behavioral changes they induce. He conducted a clinical study on the use of yoked prisms in the Kaplan Syndrome. The Kaplan Syndrome is a behavior pattern based on the relationship of accommodation and convergence dysfunctions in which the expansion and compression aspects of yoked prisms are used to modify eso or exo deviations.[Kaplan, 1978 - 1979, #6]
Padula et al, have reported that the use of yoked prism therapy has been successful in the treatment of individuals who suffer from post trauma vision syndrome. Since visual intervention can enhance and expedite a complete recovery, it is important to incorporate motor and visual relationships into therapy. When prisms are used there is a shift in weight from one direction to another in an attempt to reestablish a balance between the visual, motor and vestibular systems. This results in a problem solving effort by the patient, to deal with the change in the spatial environment.[Padula, 1988, #7] In addition, numerous articles have been published reporting the success of yoked prisms in rehabilitating patients with postural problems due to cerebral palsy, ankylosing spondylitis, and closed head traumas.[Richer, 1986, #8][Swartwout, 1991, #9][Gottlieb, 1991, #10]

The documentation of yoked prisms for postural training is largely based on clinical impressions. The goal of this project is to quantify the postural changes induced by yoked prisms after a period of adaptive wear between two groups, one sitting and reading while the other is continually walking. It is expected that the adaptation to the prism will be more complete by the walking group than by the reading group. It is hypothesized that the physical activity of walking provides feedback, in which the body interacts with the environment, giving a whole new direction of spatial localization. The project will measure baseline, initial adaptation, time lapsed adaptation, and the sustained postural effects of yoked prisms once removed. In this experiment, to simplify interpretation only one condition of prism adaptation will be tested. The vertical aspect of yoked prisms will be explored only. Base down yoked prisms were arbitrarily chosen. For the experiment twelve prism diopters of base down prism will be used to determine the effect of the prisms on posture in this experiment. The yoked prism power accepted by the patient for full time wear is generally
less than 4 prism diopters due to the optical distortions caused by the prisms.[Sheedy, 1987, #11] Prisms with powers greater than 10 prism diopters disrupts visual space, causing the subject to consciously reorient themselves within their environment. In this experiment the attempt by the subject to reorient themselves after being subjected to the yoked prisms will be measured in terms of postural shift. The postural shift will be measured on the Chattecx Balance System™. These postural changes will be described in terms of percentages of weight transfer.

**METHODS:**

**Subjects:**

The project included 36 randomly selected subjects ranging in age from 21 to 28. All subjects were naive to the type of activity required in the experiment. Subjects were required to meet the following criteria: Visual acuity of 20/30 OU or better at both infinity and 40 cm distances; stereo acuity of 60 arc seconds on the Randot Stereotest (wirt circle). Subjects were screened for any history of strabismus, amblyopia, dizziness, vestibular disorder, chronic ear infections, fear of heights, motion sickness and vertigo. Subjects were also screened for the use of medication which could affect the central nervous system. All subjects were asked to wear tennis shoes with socks and to wear the same refractive correction (distance habitual Rx) that was used during the screening process.
Equipment:

Testing involved measurements to quantify immediate and short term prism effects on the center of balance as measured by the Chattecx Balance System™. This apparatus is located in the School of Physical Therapy at Pacific University in Forest Grove Oregon. The Chattecx Balance System™ (Hixson, Tennessee) measures and records a subject's mean center of balance with a set of foot plates, on which a subject stands during testing. This system is connected to an IBM™ AT-compatible computer controlled with MS-DOS™ (see Figure 1-2). Mean center of balance is located by measuring the absolute force the subject bears on the ball and heal of each foot. The Balance System™ produces a graphical presentation in the form of concentric circles and numerical data in the form of dispersion, x and y coordinates. The x value can be either a negative or positive value depending upon if the subject leans toward their left or right side. The y value can be either a negative or positive value depending on if the subject leans backward or forward. The dispersion value indicates the amount of postural sway of an individual from his or her mean center of balance. A large dispersion index indicates a large amount of postural sway in a given test and a small amount indicates a slight sway.[Chattecx Corporation, 1991, #12] The lenses used in the experiment were plano and 12 prism diopter, with a 6.75 diopter corrected base curve and mounted on "Visitor" Velcro training glasses. The lenses were 66 mm in diameter, round, clear, plastic furnished by GTVT; Lynwood, Washington. A yellow fixation light was placed at a testing distance of 20 feet in front of the Chattecx balance apparatus and at eye level of the subject. The room illumination was kept constant.
Testing:

The first step in determining a baseline measurement was to obtain a natural foot placement by drawing around the subject's shoe as they stood naturally on an open file folder. Each subject's foot outline folder was placed on the platform of the apparatus. The foot plates were then aligned with each folder.

The spectacles were carefully placed over the subject's prescription, either spectacle glasses or contact lenses. The subject was then positioned on the foot plates on the platform. Each subject was instructed to align their feet accordingly on every trial. A practice trial was run with each subject being instructed to close their eyes, at which time plano lenses were then attached to the goggles. The standard, repeated instructions were "When I say the word NOW, open your eyes, look at the light on the wall, standing as still as possible. We will take measurements for approximately 40 seconds during which time, you need to continue looking at the target and stand as still as possible with arms at your sides." At the completion of the measurements, instructions were then given to close their eyes at which time, the plano lenses were removed. The final instructions were to "Open your eyes, look down and step off the platform. Walk across the room and sit in the chair. Take a deep breath, stand up and then return to the platform."

The study consisted of two sections. The first section; (reported by Douglas Jeske) baseline testing, was to determine the immediate effect of 12 base up and 12 base down prism when compared to no prism (plano condition). This first section also presented multiple trial conditions to help
ascertain subject variability. The second section, which this study focuses on, tests the effect of prism wear when different activities are accomplished.

Initial baseline testing started with three 40 second trials, where the subject wore plano (no prism) glasses. Data was recorded during the 0-10 and 30-40 seconds interval during each of the trials. After the three trials with the plano lenses, two trials with 12 BD and 12 BU were run and recordings at 0-10 and 30-40 secs. intervals were accomplished. The BD and BU trials were randomly presented. After each of the BD or BU trials, a plano (no prism) trial was presented. In total, eight trials (2; 12 BD, 2; 12 BU and 4 plano) were run during this segment.

At the end of the baseline readings the subjects were instructed to keep their eyes closed and 12 BD yoked prisms were placed on the goggles. The instructions were then given "Open your eyes, look down, carefully step off the platform and please continue to the next segment of the testing."

The next segment of the testing consisted of breaking the group into two randomly selected groups each with 18 subjects. One half of the subjects went to a reading area and read for 19 minutes, while the other half was led to another part of the building and instructed to walk for 19 minutes. The reading group was set at a desk with a 60 watt near point lamp used along with overhead fluorescent lighting. They were instructed to read and not browse through the reading material of their choice. The walking group was told to keep moving within the designated area and to interact with their environment. The designated area consisted of a clinic reception room connected by a long hallway to a student lounge. The subjects were not allowed to interact with other subjects during this portion of the test.
At the end of the activity period, the participants were then re-tested. Each subject had seven trials administered to them; four trials (three readings per trial) with the base down yoked prisms and three trials (two readings per trial) with plano lenses. The first set of data consisted of the subject walking with eyes open up to the platform, stepping on the platform and recordings were taken at 0-10 and 30-40 seconds with 12 BD prisms still on the subject. The 0-10 and 30-40 seconds readings coincided with the time intervals as the baseline testing. The second, third and fourth sets began with the subjects stepping back onto the platform and closing their eyes (as in the baseline collection) before the start of the readings. Between the trials, the subject was asked to step off the platform and to shake their legs, step back on the platform and close their eyes for three seconds as in the initial baseline testing. Finally, to assess the immediate after effect of removing the 12 BD prisms, three sets of readings through plano lenses were taken at the same 0-10 and 30-40 secs. intervals. These final three plano readings used the identical instructions as the initial set of baseline plano readings.

RESULTS:

The data from all of the 36 subjects was used for analysis. Data was analyzed using a two tailed paired T-test with a chosen significance level of \( p < .05 \). Some data was analyzed using an analysis of variance with a Scheffe F test used for significance testing, with a .05 level of confidence chosen.

The data collected for the initial three plano trials, recorded at 0-10 seconds and 30-40 seconds for each of the trials, were compared for both within and between subjects differences using an ANOVA with a Scheffe F test with a .05 level of confidence. The 0-10 and 30-40 seconds readings showed no significant difference within subjects for any of the initial three plano
readings, for y axis (front to back sway), x axis (side to side sway) and in
dispersion (variances from midline). However, for the between subjects testing
during the 0-10 and 30-40 seconds readings, a significant difference was found
for the initial three plano readings in the y axis, x axis and in the dispersion.
This indicated that each subject reacted differently to the plano lenses during
the 0-10 and 30-40 seconds but was internally consistent for the plano trials.

A paired T-test comparing the group means for the baseline plano
readings for the 0-10 seconds and the 30-40 seconds readings showed a
significant difference in both the between and within subjects for the Y values
only, for both time intervals. This indicates that the subjects' postures varied in
the front to back direction as a group and individually between each time
period. Since significant differences between the 0-10 and 30-40 seconds
intervals were found for Y values, all data was analyzed for each time interval
separately.

A paired T-test was used to compare the immediate effect of pre-activity
12 BD prisms to the baseline plano condition. There was a significant
difference in the y axis (front to back sway) and dispersion (variances from
midpoint) readings for the (0-10 and 30-40 seconds) time intervals.
Comparison of x values (side to side sway) for the baseline plano to the pre-
activity 12 BD condition for 0-10 and 30-40 seconds intervals, showed no
significant differences. This indicated that significant change in front to back but
not side to side posture occured for each of the two time intervals. There was a
significant correlation (.912) between the 0-10 and 30-40 seconds trials (see
Table 1).

Data was analyzed for postural changes after wearing the 12 BD prisms
for the two separate activities of sitting while reading and walking. Paired T-
tests were used to compare post-activity posture with prisms on, to the baseline
plano posture. No significant differences in posture were found for either the reading or walking groups; the exception being the dispersion values for the 30-40 seconds time interval for walkers. This indicates that front to back posture readjusted to the original plano condition after just 20 minutes of either reading or walking (see Table 2).

When the postures of the readers and walkers were compared to each other, using an unpaired T-test with a .05 significance level, after the 20 minutes of activity while wearing the 12 BD prisms, no significant difference was found for any of the parameters for both time intervals. While no significant differences were found, the group means for the Y axis were consistently more positive (forward tilt) with the walkers than readers after wearing the 12 BD prisms (see Table 2). Thus, there is a hint of a more complete adaptation to their original posture for the walkers than the readers. It should be noted the the variance for both groups was high.

When data was analyzed to compare Y axis post-activity BD to Y axis pre-activity BD, using a paired T-test, for the 0-10 and 30-40 seconds intervals, a significant difference was found after the 20 minute adaptation period. This indicates that subjects changed posture from the backward tilt immediately induced from wearing of the BD prisms. Thus, the significant alterations in Y axis posture found immediately after application of the BD prisms was short lived, with significant changes in Y axis posture.

When post-activity Y axis plano findings (data when BD prisms were removed after reading or walking) were compared to the post-activity BD data, using a paired T-test, no significant difference was found for both the readers and walkers for both time intervals. This indicates that there was not a significant immediate after effect or rebound effect after removing the BD prisms.
When the same post-activity plano findings were compared to the baseline plano data for readers and walkers, for both time intervals, using a paired T-test, again no significant difference was found for all aspects of posture, except for the dispersion value for the 30-40 seconds interval for the walkers. This indicates that the posture of the subjects had readjusted to the original posture while wearing the base down prisms and stayed there when the prisms were removed. The subjects stay at the "habitual" posture, even though the BD prisms were removed. It's almost as of the person says, "I'm at my normal posture - no need to change".

When data was analyzed for frequency of response to stimuli an interesting picture emerges. Calculations of percentage of postural responses in either a forward or backward direction was analyzed for each testing condition. Of the 36 subjects, 29 of the 36, (81%) showed a shift in the negative (backward) direction after the BD prisms were first applied (0-10 seconds interval). During the 30-40 seconds interval, 24 of the 36, (67%) shifted in the negative y (backward) direction. The change in findings from the pre-activity 12 BD verses post-activity 12 BD during the 0-10 seconds interval were that, 30 of the 36, (83%) moved in the positive y (forward) direction and that during the 30-40 seconds interval, 27 of the 36, (75%) shifted in the positive y direction (forward) indicating an adaptation back to the original posture. The amplitude of postural changes were not statistically significant, but, a large majority of the subjects showed these changes, thus indicating that it was not just a few individuals with high readings causing this difference, but in fact, a preponderance of subjects moving in the same direction. (see Table 3) The baseline plano 1,2,3 verses the post-activity plano for both the 0-10 and 30-40 seconds intervals showed 18 of the 36, (50%) subjects leaning in the positive y (forward) direction. As can be seen upon the removal of the prisms, the post-
activity plano left 50% of the people in a forward tilted posture while the other 50% in a backward tilted posture, not the overwhelmingly forward or backward response as when the prisms were first applied or when readaptation occurred.

**Discussion:**

The between trial initial baseline plano measurements showed little difference in results as the subjects stepped on and off the machine, thus no significant postural difference was shown within subjects. There was a significant difference in the baseline plano values between subjects. This showed that each individual's posture was different from others but each of the subjects was consistent in their own responses to stimuli.

When using 12 BD yoked prisms, the subjects had a significant shift in the y-axis through all the time intervals tested for the baseline condition when compared to the habitual plano condition. This shows that the prisms had an initial effect on the subjects front to back posture. Since there was no significant difference seen in any of the x axis values for the baseline data it can be said that the subjects did not vary significantly in their lateral posture while using the vertical prisms. The dispersion values within subjects for the baseline were significantly different for the plano lenses as well as for the 12 BD prism lenses indicating that there was a constant need for the subjects to be recalibrating their equilibrium while standing on the apparatus (see Table 4, Graph 1).

The goal of the study was to quantify the postural changes induced by yoked prisms after a period of adaptive wear between two separate activity groups. It was expected that the adaptation to the prisms would be more complete by the walking group than by the reading group. It was proposed that the physical activity of walking provides a feedback when the body interacted with the environment providing a quicker and more complete adaptation to the
prisms. A paper by Claude A. Valenti discusses how "the body motor system is an expression of how adequately the visual system has calibrated space." [Valenti, #13] The visual system and the muscles of the body play an important role in assisting the oculomotor system in spatial localization.

The walking group showed no significant difference in the x or y axis for either time interval (0-10 seconds or 30-40 seconds) when comparing the initial baseline plano 1,2,3 trials and the post activity 12 BD trials. This demonstrated that the subjects adapted to the prisms, back to the original front/back posture. Initially there was a shift backward when the prisms were first placed on the subjects, but after the period of activity this effect was nullified as the subjects returned to their baseline plano posture. There was a significant difference seen in the dispersion of the walking group. This indicated that the subjects variability changed.

The reading group showed no significant difference in x, y, or dispersion values for either time interval between the baseline plano 1,2,3 trials and the post-activity 12 BD trials. This also was indicative of adaptation of the subjects to the prism.

When the walking and reading groups were compared, no significant difference was found between the two groups in the x, y, and dispersion values for either time interval. It can be concluded from the results of the post-activity BD trials that the visual motor activity of reading and sitting was enough to induce an adaptive effect without the added proprioceptive feedback induced by the walking activity. A large standard deviation was found in the y values for both the reading and walking groups. The standard deviation for the walkers however, was consistently larger than the readers (see Table 2). Since the standard deviation was larger for the walkers, this means that there was more variability in the findings. The means for the y values in the post-activity 12 BD
data were found to be consistently more positive (indicating a more forward posture) with the walking group than the reading group, indicating a more complete return to the pre-adapted plano posture, but not a significant one.

The baseline plano lenses when compared with the post-activity plano lenses showed no significant difference for the x and y values in either the walking or the reading group. Since there was no significant difference in the posture of the subjects when the 12 BD prisms were removed compared to before the 12 BD prisms were applied, no after effects of the prisms can be presumed from this study.

CONCLUSION:

The use of high magnitude yoked prisms do create an immediate postural shift when applied. Prisms produce short term postural changes, but after a relatively short period of wear subjects returned to their habitual standing body posture. Therefore, prisms must be changed frequently to produce new body posture. Due to the individual variability between subjects, the degree of statistical significance of the data was dampened. However, Individual means did show significant changes with the application of the yoked prisms.

There was a significant change in posture when the BD prisms were first placed on the subjects for the initial time period. Also there was a significant difference between the 0-10 and 30-40 time intervals with the initial use of the BD prisms. Since there was no significant difference between the readers and walkers, the subjects adapted to the prisms equally well, regardless of the amount of proprioceptive feedback involved. Visual motor feedback and postural feedback even while sitting seemed to be sufficient to cause an adaptation to the prisms. Therefore, patients who are non-ambulatory may
expect to have similar amounts of postural shifts created by the prisms as those who are able to move more efficiently through their environment.

In our study, the main aspect assessed was standing body posture in which subjects must quickly equilibrate in order to remain standing. This thesis did not include measurement of changes of head and neck posture but emphasized the overall full standing body posture. The head and neck posture may or may not adapt in conjunction with the entire body posture through prismatic wear. In order to fully understand the effect of prisms on head and neck posture, an additional measuring device should be incorporated. In future studies, the effect of increased wearing time should also be investigated.
ENDNOTES


12. Chattecx Balance System™ Chattecx Corporation a part of Chattanooga Group, Inc. 4717 Adams Road, P.O. Box 489, Hixton TN 37343

BIBLIOGRAPHY

Chattecx Balance System™ Chattecx Corporation a part of Chattanooga Group, Inc. 4717 Adams Road, P.O. Box 489, Hixton TN 37343.


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APPENDIX

Paired T-test

Table 1  
Baseline Plano 1,2,3 vs 
Pre-Activity 12 BD data sets

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<td>Dispersion</td>
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* significant finding
Table 2

ANOVA Descriptive Statistics
Post-Activity Base Down Affect

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<th></th>
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### Table 3

**Descriptive Statistics**

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Graph 1

POSTURE VERSUS CONDITION

POSTURE

0-10 SECS
38-40 SECS

CONDITION

B PL B 12BD PA 12BD PA PL
Figure 2

Chattex Balance System™