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Negligible Impact on Posture from 5-dioptre Vertical Yoked Prisms

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Abstract

Purpose: Yoked prisms are used by some optometrists to adjust posture, but evidence to support this practice is sparse and low level. The aim of this research was to investigate whether vertical yoked prisms have an impact on posture in healthy adults.

Methods: Posture was assessed objectively in 20 healthy adults, by recording a range of joint angles or body segment locations at the ankle, hip, torso, neck and head during participant observation of a straight-ahead target, and subsequently with eyes closed. Recording occurred before, during and after wearing goggles with control plano lenses, 5 dioptre base up and 5 dioptre base down yoked prisms. In each viewing condition, the goggles were worn for 30 minutes. Interaction effects of lens/prism condition by time on joint angles and body orientation were determined.

Results: In the eyes-open and eyes-closed conditions, no significant lens/prism x time interaction effects were found at the torso, neck, hip or ankle ($p>0.1$). However, in both eyes-open and eyes-closed conditions a significant lens/prism x time interaction was found at the head ($p=0.031$ and 0.006 respectively), with head extended (tilted backward) by up to 2.5 degrees more while viewing with base down prisms than with plano lenses.

Conclusions: In healthy adults, 5 dioptre base down yoked prisms were not associated with a change in body posture. A small effect on head orientation and not at other locations suggests a minimal effect on posture. Further research in a larger sample and in individuals with abnormal posture is needed to verify this finding.

Introduction

Yoked prisms are prisms of equal power and equal orientation in front of each eye, such as with their bases up (apices down). In the 'base up' example, the light passing through the prism is deviated toward the base (up) and the perceived image is shifted downward, toward the apex. Since the image shift is identical for each eye, there is no induced diplopia, and the image shift may have the effect of a binocular change in gaze direction and/or an accompanying change in head position to view the target in its shifted position. In addition to an image shift, the prism causes magnification of the image toward the apex, so yoked prism wear is accompanied by displacement and distortion of images in the visual scene.[1]

Image shift and distortion affect perceived location and orientation of self and the visual scene, and could potentially be accompanied by compensatory postural changes. The effects of yoked prism on visual perception, head posture or behaviour (e.g. pointing to a target) may be apparent while the prisms are worn or after they have been removed.[2] The former is a direct effect of the prisms with visual cues. The latter may occur following a period of visuo-motor adaptation, in which case the effect is known as prism adaptation[2] or an after-effect of the prisms. An after-effect may also occur when visual cues due to the prisms are removed by eye closure or prism removal.

Redding and Wallace (1988) found a prism adaptation effect in the form of a head shift in compensation for yoked prism-induced horizontal shifts of the visual scene.[3] Birnbaum (1993)[4] suggested that the upward image shift created while wearing base down yoked prisms is accompanied by "upward gaze shift associated with divergence, expanded peripheral awareness, relaxation, outward and backwards body thrust, and increased nearpoint working distance" with equal and opposite effects due to base up yoked prisms. These suggestions were based in part on Kraskin's view that "The real value of yoked prism…is the influence on [body] orientation" and that "The specific influence of yoked prisms (and related eye movement) on the pelvis" is a tilt upward or downward with base down or up respectively, and left or right with base right or left respectively.[5] Kraskin further proposed a link between yoked prism, posture and

refractive error, suggesting for example that the centre of gravity shifts forward in myopia[6] and that such a shift could be corrected by yoked prisms.[5]

Based on the theory that a change in posture accompanies a prism-induced gaze shift, yoked prisms are sometimes prescribed for the treatment of postural anomalies,[4-8] and to adjust posture in individuals with no postural anomaly.[4-6] Evidence for the effectiveness of yoked prisms as a means of modifying posture has been limited by methodological issues in many of the previous studies. Potential sources of bias in previous studies include partially or entirely subjective assessment of posture and performance, or a lack of masking of participants or researchers.[9-13]

Gizzi et al (1997)[10] used an objective method (moving platform posturography) to measure posture in healthy individuals without prisms, immediately on wearing 15 dioptre base right yoked prisms and after wearing the prisms for 1 hour. Statistically significant shifts in posture toward the prism base (right) were reported at both time points, but multiple comparisons were made with no mention of a correction factor for these. If such a factor were applied, the differences may not have been significant. The authors did note that average changes in posture were less than 1 degree, and that a change of this kind seems unlikely to have a clinically significant impact on patients with significant body posture anomalies.

Despite these findings and the methodological issues noted above, yoked prisms have been proposed as a means of adjusting posture in patients with or without postural anomalies.[4-6, 8,14,15] In a recent case report,[16] vertical yoked prisms were prescribed for an athlete with lower back pain to resolve 'anterior visual midline shift syndrome' (in which an object below eye level is perceived to be at eye level). The prisms were prescribed to be worn for daily periods, and a range of therapeutic exercises were also prescribed. The authors state that "The addition of prism glasses was believed to alter the athlete's vision", eliminating the midline shift and correcting any postural anomaly. However, any positive change may have been at least partly due to the therapeutic exercises. The authors conclude that further research into the effectiveness of this combined approach is warranted.

As has been noted previously,[17] the use of yoked prisms to adjust posture, without a good evidence base, suggests a need for further research in this area. The aim of the present study was to measure objectively the impact of vertical yoked prism on head and body posture in healthy adults with normal vision. Impact was measured in terms of direct effects (while the lenses were worn and with eyes open) and after effects (with eyes closed or after prism removal).

Methods

Twenty (20) participants aged from 19 to 49 (mean 26.4, SD 7.92) years were recruited by invitation from the staff and student population of the School of Optometry and Vision Science, University of New South Wales and Neuroscience Research Australia. All participants had normal vision (Snellen acuity 6/6 or better each eye, no manifest strabismus), self-reported normal ocular and systemic health, with no postural abnormality. Seventeen of the participants were naive to the possible effects of yoked prisms on posture; three participants were investigators. Our rationale for using normal subjects was that we were testing the assumption that yoked prisms have an impact on posture in healthy individuals without postural abnormality.[4-6]

Ethical approval for the study was granted by the University of New South Wales Human Research Ethics Committee, and the study was conducted in accordance with the Declaration of Helsinki. Informed consent was obtained from participants after the nature and possible consequences of participation had been explained.

Participants wore plastic safety goggles (Uvex Safety, Parramatta, Australia) with a clip-in lens housing. Three clip-in frames were made to fit the housing, with 5 prism dioptres base up, 5 prism dioptres base down and plano lenses. For simplicity, all three will be referred to as 'lenses'. Magnification at the centre of each lens differed by less than 0.05% across the three lens types, and the lenses had identical base curves. The goggles could be worn over the participants' habitual distance spectacles, if any (no participants wore multifocal lenses). The order of presentation of the three lens conditions for each participant was decided arbitrarily by an experimenter just before

testing began and therefore was not truly randomised. However, review of the resulting order applied in each case indicated that the conditions were not administered in a consistent order. All participants were masked to the type of lens they were fitted with.

Body segment orientation and joint positions were calculated using co-ordinates from active infra-red markers tracked in x, y and z planes using a 'CODA' Motion Analysis system (Charnwood Dynamics Ltd., Rothley, UK) at a sampling rate of 200Hz. Markers were placed on each participant at the following locations (see figure 1): fifth metatarsal head of the left foot, lateral malleolus of the left ankle, left femoral epicondyle, left greater trochanter, both posterior superior iliac spine processes, spinal processes of the 6th thoracic and 7th cerebral vertebrae, 2cm to the left and right of the inion (back of the head) and superior margin of the left orbit. The participant's task was to stand still for 30 seconds while viewing a cross marked on a wall in the participant's straight-ahead line of sight, at a distance of 1.40m. Within each of the three lens conditions, marker co-ordinates were measured before ('PRE', no goggles or lenses; the control condition) lens wear, immediately upon lens wear ('ON'), at 10, 20 and 30 minutes of wearing the lenses, and immediately after lens removal ('OFF'). A total period of 30 minutes prism wear was chosen on the basis of previous work[18,19] in which a significant effect of yoked prism was found after short periods.

At each of these time periods, co-ordinates were recorded for 30 seconds with eyes open and 30 seconds with eyes closed. The *eyes closed* condition was included to determine whether any effect found in the *eyes open* condition was dependent on visual input, or reflected a change in posture independent of visual input, perhaps due to a recalibration of body alignment.[20] Between PRE and ON, the participant had eyes closed while the goggles with lenses were put on. The participant was instructed to open their eyes at the beginning of recording and to close their eyes 30 seconds after recording began, with recording continuing for a further 30 seconds with eyes closed. Within each lens condition, during the 10-minute periods between measurements, the participant wore the goggles and lenses and was encouraged to undertake a mix of activities including walking (around the laboratory or along a corridor), reading and using a computer. Between the three lens conditions, the participant wore no goggles or

lenses during a 10-minute 'wash-out' period intended to ensure no residual effect of previous lens wear.

To ensure consistent foot position throughout test sessions, before the first recording each subject was instructed to stand in a comfortable position with bare feet spaced hip-width apart, on a large paper sheet, viewing the target. While in this position, a researcher drew around the subject's feet and at each recording trial the subject was instructed to place the feet within these outlines.

Analysis

The mean joint angle or segment orientation at each of the five body and head locations was computed from marker positions and averaged over the first 1 and 5 seconds and the full 30 second duration of each recording. Joint angles and segment orientations were defined as follows:

- Ankle angle: acute angle between the foot segment (5th metatarsal head to lateral malleolus markers) and the leg segment (lateral malleolus and femoral epicondyle).
- Hip angle: acute angle between the thigh (femoral epicondyle to greater trochanter segment) and the pelvis segment (greater trochanter to left PSIS).
- Neck angle: acute angle between the torso segment (6th thoracic vertebrae to 7th cerebral vertebrae) and the head segment (7th cerebral vertebrae and marker to the right of the inion).
- Torso orientation: vector joining the left and right PSIS and the 7th cerebral vertebrae, relative to the vertical.
- Head orientation: vector joining the three head markers, relative to the vertical.

Initially, joint angles and body segment orientation measures were compared between the three time frames of each recording (averaged over 1, 5 and 30 seconds) using a repeated-measures general linear model to look for changes in measurements during the recording, e.g., a change in posture during the first few seconds only.

A small number (32 of 1820, or 1.8%) of data points were missing due to hidden markers or incomplete trials. In order to avoid the loss of these data (thus reducing our sample, these missing data were estimated using imputation procedures.[21] We first confirmed that the missing data were 'missing completely at random',[21] then the missing values were estimated using an established iterative process.[22] We conducted two-way repeated measures ANOVAs on the resulting data set to determine any interaction effects of lens type (plano, prism base up and prism base down) and time (before, during and after lens wear) on ankle angle, hip angle, neck angle, torso and head orientation, with Bonferroni adjustment for multiple comparisons. We were interested in comparing each yoked prism condition to the plano condition. The analysis described above was conducted on data collected while eyes were open and while eyes were closed.

Results

No significant difference was found in any of the joint angle or segment orientation outcome measures between 1, 5 and 30 second recording durations ($p > 0.05$), indicating constant joint angles and segment orientations throughout the 30 second recording period. For this reason, data at only one of these recording durations (5 seconds) were used in subsequent analyses.

In the *eyes open* condition, no significant interaction between time and lens condition was found at the torso, neck, hip or ankle (p= 0.36, 0.32, 0.56 and 0.52 respectively), indicating that any effect of 5 dioptre vertical yoked prisms on posture over a 30-minute period is not significantly different from the effect of plano lenses at these locations. However, at the head, a significant interaction between time and lens condition was found (p=0.031). Figure 2 shows head orientation at each time period in the plano, base up or base down lens conditions. Bonferroni corrected pairwise comparisons showed a difference between plano and base down at 10 (2.2 degrees, p=0.009) and 30 minute periods (2.5 degrees; p=0.002) of lens wear. These differences indicate that at these time periods the head was more extended (chin up and head back) when wearing base down lenses than wearing plano lenses. No significant difference was found at PRE (p=1.0), ON (p=1.0) or 20 minute periods of lens wear (p=0.34), nor when the lenses

were removed (OFF; p=1.0). No significant difference was found between plano and base up at any time period (p>0.2).

In the base down condition differences over time were found between Pre and 10 minutes (4.1 degrees, p<0.001), Pre and 20 minutes (p=0.008), Pre and 30 minutes (4.3 degrees, p=0.001), On and 10 minutes (4 degrees, p<0.001), On and 20 minutes (3.1 degrees, p=0.001), On and 30 minutes (4.1 degrees, p<0.001), 10 minutes and OFF (2.5 degrees, p=0.004), and between 30 and OFF (2.6 degrees, p=0.019).

Similarly, in the *eyes closed* condition, no significant lens x time interaction was found at the torso, neck, hip or ankle (p=0.67, 0.15, 0.11 and 0.69 respectively), but a significant interaction was found at the head (p=0.006; see figure 2b). Bonferroni corrected pairwise comparisons indicated a significant difference between plano and base down lenses at 30 minutes of lens wear only (2.4 degrees, p=0.01), with no difference between plano and base up lenses at any time period (p>0.2). Differences over time during base down lens wear were found between PRE, 10 (3.3 degrees, p=0.01), 20 (2.8 degrees, p=0.02) and 30 (3.6 degrees, p<0.001) minutes. In addition, head orientation differed between the ON time period (immediately on wearing the prisms) and the 10 and 30 minute time periods (2.0 and 1.6 degrees respectively; p=0.006 in both cases). Head orientation also differed between the 30 minute and OFF time periods (2.0 degrees, p=0.016).

Head orientation was similar between the PRE and OFF time periods in the eyes open and eyes closed conditions (p>0.4) indicating that any effect during lens wear was not sustained after lens removal.

Discussion

Our results indicate that 5 dioptre vertical yoked prisms have no significant impact on posture at the neck, torso, hip or ankle, and that 5 dioptre base down prisms have a significant but not lasting effect on head extension. Sheedy and Parsons (1987)[13] found head extension of 1.15 degrees on average at the end of two weeks of 4 dioptre base

down prism wear, compared with baseline measures without prisms at the beginning of this period (detail provided by Sheedy, personal communication). Our finding suggests that this effect occurs very soon after lenses are worn and does not require a two week adaptation period. Sheedy and Parsons (1987) also found that all but one of 24 subjects preferred not to wear the 4 dioptre prisms, and that the one subject who accepted this prism reported that it relieved a back problem. This suggests that the prism might have altered body posture, but in the present study no change in body posture was found with either 5 dioptre base up or down prisms.

Our sample did not include people with postural abnormalities, and it could be argued that a significant impact on body posture may have been found in subjects with abnormal posture. For example, Wong et al (2002)[23] measured body posture in four young females with abnormal spine curvature, and found significant alterations in spine alignment after three minutes' wear with 10 dioptre yoked prisms base up or base down, with opposite effects on the spine in the two different base directions. No significant effect was found with 5 dioptre yoked prisms in any base direction, suggesting the possibility that stronger prism than the 5 dioptres used in the present study may have yielded a significant impact on body posture. Patient tolerance of a higher prescription, however, is unlikely, given previous findings.[13]

A rationale for the clinical use of vertical yoked prism is that posture is changed in response to image shift or distortion.[4-6] The present study adds to previous work in which direct or after-effects of yoked prism on posture have been tested in people without postural abnormalities. [9,24] Michel et al (2003)[24] measured posture using platform posturography in 14 healthy subjects before and after 20 minutes wearing prisms that induced a 15 degree leftward or rightward visual field shift (equivalent to 27 dioptre yoked prisms base right or left, respectively). They found significant changes in posture following prism adaptation (after-effects), with the body tilted laterally (in the direction of the prism base) and forward (with either prism direction) after the prisms had been worn and then removed. These effects were mainly found in measurements with the eyes closed, and not with eyes open, suggesting that any change in posture due to a prism after-effect is controlled with the help of visual cues received on prism

removal. In the present study, a direct effect of base down prisms on head extension was apparent with eyes open or closed, but was not sustained after lens removal, indicating that the direct effect was maintained without visual cues (eyes closed) and was lost when normal visual cues were available (on removal).

As discussed earlier, Sheedy and Parsons (1987)[13] found a small degree of head extension after two weeks of 4 dioptre yoked prism base down wear, suggesting that yoked prisms might have had a greater effect on head and body posture in the present study if they had been worn for a longer period. In a previous study,[18] we found an effect of 5 dioptre base down yoked prisms on gait after only 7 minutes, which suggests that an effect on posture would be expected within a short period, but it remains possible that we would see an effect after a longer period of prism wear.

It is possible that the small effect of yoked prisms on head extension and lack of effect on body posture found here is due in part to our sample of only 20 participants. However, our p-values show that any differences in body posture were not close to significance, indicating that much larger samples would be needed to show any effect, and that any such effects would be small. Even the significant differences we found represent changes in head orientation of only a few degrees, with questionable significance for clinical application.

The minimal effect of yoked prism on head extension found in this study does not support the prescription or use of yoked prism to induce postural change in individuals with normal posture. However, further research to test direct effects, after-effects and tolerance of yoked prisms in a larger sample and in participants with postural anomalies is needed to verify whether their clinical application can be justified.

References

1. Ogle KN (1950) Researches in Binocular Vision. Philadelphia: Saunders.

2. Facchin A, Beschin N and Daini R (2014) Not prism prescription, but prism adaptation rehabilitates spatial neglect; a reply to Bansal, Han and Ciuffreda. Brain Inj 1-2.

3. Redding GM and Wallace B (1988) Head posture in prism adaptation during hallway exposure. Percept Psychophys 44(1): 69-75.

4. *Birnbaum MH (1993) Optometric Management of Nearpoint Vision Disorders Boston: Butterworth-Heinemann.*

5. *Kraskin RA (1982) Lens Power in Action: Yoked Prisms 1(12): 45-48. Optometric Extension Program.*

6. *Kraskin RA (1982) Lens Power in Action: The Visual Process 1(9): 33-36. Optometric Extension Program.*

7. Kaplan M and Carmody DP (1997) Extent of use of prisms by optometric practitioners. J Optom Vis Dev 28: 86-90.

8. Tea YC (2008) Back to the basics, part 1: Prime yourself to prescribe prism. (www.reviewofoptometry.com/content/d/patient_care/i/813/c/15234/)Accessed 23rd January 2015.

9. Padula WV, Nelson CA, Padula WV, Benabib R, Yilmaz T and Krevisky S. (2009) Modifying postural adaptation following a CVA through prismatic shift of visuo-spatial egocenter. Brain Inj 23(6): 566-576.

10. Gizzi M, Khattar V and Eckert A (1997) A quantitative study of postural shifts induced by yoked prisms. J Optom Vis Dev 28: 200-203.

11. Carmody DP, Kaplan M and Gaydos AM (2001) Spatial orientation adjustments in children with autism in Hong Kong. Child Psychiatry Hum Dev 31(3): 233-247.

12. Kaplan M, Carmody DP and Gaydos A. (1996) Postural orientation modifications in autism in response to ambient lenses. Child Psychiatry Hum Dev 27(2): 81-91.

13. Sheedy JE and Parsons SD (1987) Vertical yoked prism – patient acceptance and postural adjustment. Ophthal Physiol Opt 7(3): 255-257.

14. Richer SP and Hall T (1986) Mobility spectacles for a patient with ankylosing spondilitis. Am J Optom Phys Opt 63(11): 927-930.

15. Slavin SH and Gorsky L (1996) Yoked prism application, posture and gait movement *In* Barber A *ed* Vision Therapy Tools of Behavioral Vision Care: Prisms. Santa Ana, CA: Optometric Extension Program 77-105.

16. Robey JH and Boyle K (2013) The role of prism glass and postural restoration in managing a collegiate baseball player with bilateral sacroiliac joint dysfunction: A case report. Int J Sports Phys Ther 8(5): 716-728.

17. Barrett BT (2009) A critical evaluation of the evidence supporting the practice of behavioural vision therapy. *Ophthalmic Physiol Opt.* 29: 4–25.

18. Errington JA, Menant JC, Suttle CM, Bruce J, Asper LJ. The effects of vertical yoked prisms on gait. Invest Ophthalmol Vis Sci. 2013 Jun 10;54(6):3949-56.

19. Huang MA and Cuiffreda KJ (2006) Short-term adaptation to vertical yoked prisms. Optom Vis Sci 83(4): 243-248.

20. Redding GM, Rossetti Y and Wallace B. (2005) Applications of prism adaptation: a tutorial in theory and method. Neurosci Biobehav Rev 29: 431-444.

21. Little RJA, Rubin DB (1989) The analysis of social-science data with missing values. Sociol Methods Res 18(2-3): 292-326.

22. Dempster AP, Laird NM, Rubin DB (1977) Maximum likelihood from incomplete data via EN algorithm. J R Stat Soc B Methodol 39(1): 1-38.

23. Wong MS, Mak AFT, Luk KDK, Evans JH and Brown B. (2002) Effect of using prismatic eye lenses on the posture of patients with adolescent idiopathic scoliosis measured by 3-D motion analysis. Prosthet Orthot Int 26: 139-153.

24. Michel C, Rossetti Y, Rode G and Tilikete C. (2003) After-effects of visuo-manual adaptation to prisms on body posture in normal subjects. Exp Brain Res 148: 219-226.

Figure captions

Figure 1

Graphic representing head and body locations of infrared markers used to record location and calculate joint angles and body segment orientations (see Methods for description). Note that due to camera location, leg markers were placed on the left side only. The front head marker was off centred to the left. Grey colour of one marker on the head indicates that this marker was on the front of the head.

Figure 2

Line plots showing mean head orientation in degrees (angle between the vector formed by the three head locations shown in figure 1 and vertical) as a function of the period of time before, during and after yoked prism or plano lens wear with eyes open (A) and eyes closed (B). Error bars indicate standard error at each time period and for clarity are shown as positive or negative values, but not both.
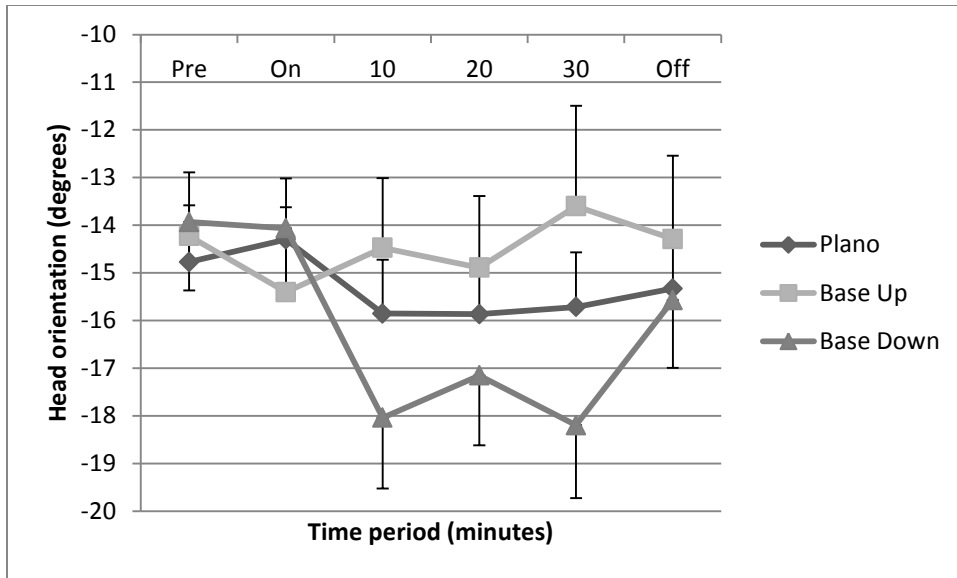
Figure 1

Figure 2A

Figure 2B