

# Case Study

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**Case Number Four:  
Visual-Training and case related myopia correction for a semi-professional mountain-biker**

by  
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**Abstract:**

Visual performance in sports activity is essential to achieve the utmost results. Depending on the type of sport a different approach in visual-training and ametropia correction has to be taken. Visual-Training can enhance the performance of an athlete. The effect depends on the visual abilities before visual-training was performed. This case report presents the ametropia-correction and visual-training procedure in a semi-professional mountain-biker.

**Key words:** *Visual-Training, Orthokeratology, Sports-Vision*

## **Introduction**

In most cases people performing sports as a hobby or even professionally are not aware of the factor of adequate visual performance in their sports activity. Most people have their eyes checked for a good visual acuity if at all.

Of course in sports not only the static visual acuity is of importance. According to Coffey and Reichow<sup>1</sup> the following visual tasks have to be checked prior vision training is performed:

### **Visual sensitivity**

In this context is referred to as the ability to resolve details or contrast in the retinal image. It contains therefore static visual acuity, contrast sensitivity and the ability to discern minuscule changes in retinal image size.

### **Dynamic visual acuity**

Is defined as a measure of sensitivity to visual detail when there is relative movement between the target and the observer. There are two possible situations depending on the type of sports. First the person is not moving but the target moves and secondly the target is still but the person is moving.

### **Accommodative and vergence facility**

Is the skill of rapidly adjusting the eyes to targets in different locations in space. Especially far-near or near-far movements which include accommodation and vergence at the same time.

### **Vergence stability and control**

Is the ability to hold the eyes in a perfectly aligned position. Only with this skill it is possible for a person to achieve perfect stereopsis and therefore quickly and correctly locate objects in space. Vergence stability and control is essential in a situation where the sports-person is already suffering from fatigue.

### **Binocular vision**

During sports activities as in daily life phorias can cause asthenopia and slow reaction time. These anomalies have certainly to be reduced or eliminated with respective visual therapy. There are two opinions concerning large vergence reserve. Studies<sup>2</sup> have shown that elite athletes have relatively small vergence reserves measured at a distance of 6m. It seems that small vergence reserves enhance the vergence stability and therefore allow the athlete a more precise and stable spatial perception. Other theories suggest large amounts of vergence reserve to enhance flexibility of the vergence system and allow faster adjustments of the vergence system.

### **Visual spatial perception**

It has been found that there exist two types of reaction on non-accommodative related vergence. The SILO and SOLI types. Induced by base-out prisms a person can either perceive an object becoming smaller and moving closer or it becoming smaller and moving further away. The SILO-Type person is more aware of the vergence whereas the SOLI-Type is more aware of the unchanged retinal image size and therefore reports the opposite effect.

### **Visual processing speed**

Is measured with tachistoscopic procedures where a image is shown to the person for a very short time, only.

### **Visual reaction and response speed**

Visual reaction speed is defined as the elapsed time between the onset of a visual stimulus and the initiation of a motor response to that stimulus. Response speed is the elapsed time between the onset of visual stimulus and the completion of a motor response to that stimulus.

## Eye-hand coordination

Two types of eye-hand coordination can be noted and trained. One is the speed of reaction and the other the precision of reaction.

## Peripheral vision

Is essential in team sports. In these situation a person must be capable of fixating an object like a ball but at the same time perceive what his teammates and his opponents around him are doing.

Depending on the type of sport some of the above skills are more or less important. The table in Appendix I gives a overview of the importance of the different tasks for a certain number of sports

## Case Report

At 29. June 1999, R.B., a 19 year old white male (salesman) presented to our contactlens-practice for a first time contactlens fitting.

He was wearing glasses since two weeks. His last exam with an ophthalmologist was 1. June 1999. Three years ago he was diagnosed with non insulin dependant diabetes. He denied to take any medications and claimed to have stable blood-glucose levels with a special diet. He also suffered from seasonal allergy and took Tilavist eyedrops (containing nedocromil-sodium, a mastcell stabilizer) for relieve. He reported no family history of any eye- or systemic disease. He was oriented to time, place and person.

His uncorrected visual acuity was 20/30 at distance OU. Uncorrected near acuities were: 20/16 (.3M) @ 40cm OU. Best-corrected visual acuity with glasses was 20/16 OU. The refraction was  $-0.75$  OD and  $-0.75 -0.50 @170^\circ$  OS at a corneal apex to lens distance of 14mm OU. Pinhole acuity at distance was 20/16 OU. Color vision testing with pseudoisochromatic plates showed no color vision deficiency OU. Pupils were equally round and reactive to light, no afferent pupil defect was noted OU. Confrontation fields were full to finger count OU. Extraocular muscles were unrestricted in all gazes, and cover test demonstrated orthophoria at distance and near. Due to the law of practice in Switzerland no Goldman Tonometry could be performed. Anterior segment evaluation by slit lamp examination revealed a quiet bulbar and palpebral conjunctiva OU. An even tear film with tear break up time of 15 seconds OU. Clear lashes OU. The corneas were clear OU. Irides were brown OU. The anterior chamber appeared clear without cells or flare and the anterior chamber angles were estimated by the Van Herrick method with the slit-lamp as 4 nasally and 4 temporally OU. Both lenses were evaluated by slit-lamp with undilated pupils and have been noted as clear with no opacities in any region

The evaluation of the posterior segment by slit lamp with 90D lens and undilated pupils revealed normal optic nerves with a cup-to-disc ratio of .3/.3 OU. The neuroretinal rims were healthy and intact. Retinal vessels appeared normal with an arterial-venous ratio of 2/3 OU. Both eyes presented with clear maculas without foveal reflexes. No NVD, NVI or NVE was noted OU.

Keratometry readings were as follows:

OD: 41.50/42.50 @  $9^\circ$ . mean numeric eccentricity .48

OS: 41.50/42.50 @  $180^\circ$ , mean numeric eccentricity .50

The patient was a semi-professional mountain biker. He wanted to wear contacts because of his sports activity.

Up to april 2002 several different lens-types were fitted with more or less success. The problem with all lenses was the dirt and dust in the eyes while biking. The patient lost several lenses due to this problem.

Finally it was decided that Ortho-K lenses were fitted. Since April 2002 the patient is wearing his Ortho-K lenses with good success and no longer complaints of problems during sports activity.

Lens parameters:

Manufacturer: Swisslens SA, Switzerland

OD: Ortho-K 8.30 plano 11.00 -.1e Boston XO blue

OS: Ortho-K 8.15 plano 11.00 -.1e Boston XO blue

Due to his aim to become more successful in sports the patient agreed to perform a detailed binocular eye exam and a following sports-vision-training.

The exam was performed using the OEP 21-Step Programme as a guideline for examination and reevaluation. In addition a biptor screening test and van Orden Star drawings were performed. The results are noted in Appendix II. The diagnosis upon these measurements was: basic esophoria.

Due to the absence of computerized sports-vision-training equipment the training was performed with simple mechanical devices.

### **Training Programme**

The training had two aims. First to treat the basic esophoria and second to train a maximum vergence speed and flexibility to allow good spatial orientation and stereopsis for sports.

The training sequences noted in Appendix III were introduced over a period of six months.

### **Discussion**

According to Scheiman<sup>3</sup> the endpoint of training is reached if the following tasks can be performed:

- 1) accurately diverge using Brockstring to 10ft
- 2) fuse to about 20BO and 10 BI at 10ft
- 3) complete 12cpm of accommodative facility with +/- 2.00 lenses
- 4) fuse Eccentric Circles using convergence with 12cm separation and divergence with 6cm.
- 5) fuse card 12 using convergence and card 6 using divergence with the Aperture Rule
- 6) maintain clear single binocular vision with the Eccentric Circles while slowly rotating the cards
- 7) maintain clear single binocular vision with the large Eccentric Circles and other targets at distance

In the case of patient R.B. all these requirements were achieved after the visual-training sessions, except point 2 and 7 which were not performed due to the lack of equipment.

Also all measurements of binocularity have been redone at the end of the training. The results are noted in Appendix IV. The eso deviation at near from the first measurement turned into a exo deviation at near in the final examination. Since the cover tests were ortho in the initial and final exam the assumption was made that the patient did not suffer from a true basic esophoria. Nevertheless there was a significant change in the positive relative accommodation towards the ideal. And also the negative fusional vergences were found to be in normal bounds after the training. In addition the final van Orden Star drawing was very well structured which can lead to an explanation of better eye-hand coordination.

### **Conclusion**

An ideal visual-training in this situation would have been with inclusion of eye-hand coordination and eye-foot coordination plus a training for dynamic visual acuity with a moving target. As mentioned before the appropriate computerized training equipment was not at hand at this point of time. Therefore dynamic visual acuity was trained using a trampoline and a sta-

tionary visual acuity chart. To train eye-foot coordination brockstring training was performed with the patient standing on a balance board.

Subjectively the patient was extremely happy with his success. He reported less difficulty in estimating speed and distance and suffered from less falls and injury in the season following the vision-training.

## Bibliography

1. Sports Vision, D.F.C. Loran et al, 1995
2. B. Coffey and A.W. Reichow, 1990, Optometric evaluation of the elite athlete: the pacific sports visual performance profile. *Problems in Optometry*, 1(2), 32-58
3. *Clinical Management of Binocular Vision*, Mitchell Scheiman et al., Second Edition, 2002

## Appendix I

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**Table 2.1** Theoretical profile of the visual skills involved in a broad spectrum of sports

	Visual acuity	Dynamic visual acuity	Ocular-motor skills	Eye-hand coordination	Depth perception	Accommodation/vergence facility	Central-peripheral awareness	Visual reaction time	Visual adjustability	Visualization
Archery	4	1	3	5	2	3	5	1	5	2
Baseball hit and cricket	4	5	5	5	5	5	5	5	5	5
Baseball pitch	3	2	3	4	3	3	5	1	3	5
Basketball	3	3	4	5	5	3	5	5	5	5
Bowling/bowls	2	1	3	5	3	2	4	1	3	4
Boxing	2	2	5	5	3	3	5	5	5	4
Cricket wicket-keeper	4	5	5	5	5	5	5	5	5	3
Cricket bowler	3	2	3	4	3	5	5	1	3	5
Cricket fielding	4	5	4	4	4	4	3	3	3	2
Cycling (road racing)	5	5	5 <sup>a</sup>	4	5	2	5	5	4	5
Darts	4	1	3	5	3	3	5	1	1	3
Diving (spring board and platform)	2	3	2	3	3	1	5	2	3	5
Football <sup>d</sup>	4	5	5	5	5	3	5	5	5	5
Golf	3	1	4	5	5	3	5	1	3	5
Gymnastics	1	3	3	5	5	3	5	5	5	5
Handball	4	5	5	5	5	3	5	5	5	3
High jump	3	3	4	3	5	3	5	4	3	5
Hockey (goalie)	4	5	5	5	5	5	5	5	5	3
Hurdles	4	4	4	4	4	3	4	3	3	5
Kayaking	4	4	4	5	5	3	5	5	4	5
Mountaineering	5 <sup>b</sup>	3	2	5	5	3	5	5	3	5
Pool/snooker/billiards	2	1	4 <sup>a</sup>	5	5	2	3	1	4	5
Race car driving	5	5	5	4	5	2	5	5	5	5
Racquetball/squash	4	5	5	4	5	4	5	5	5	5
Running	1	1	2	1	1	1	4	3	1	4
Shooters (clay pigeon, skeet, trap, hunting, long gun)	5	5	4	5	5	5	5	5	4	5

Table 2.1 Continued

	Visual acuity	Dynamic visual acuity	Ocular-motor skills	Eye-hand coordination	Depth perception	Accommodation/vergence facility	Central-peripheral awareness	Visual reaction time	Visual adjustability	Visualization
Shooters (range, fixed distance)	4	2	3	5	2	3	5	1	1	2
Skiing	5	5	5	5	5	3	5	5	5	5
Soccer <sup>d</sup>	3	4	5	5 <sup>c</sup>	5	3	5	5	5	5
Soccer goal-keeping	4	5	5	5	5	5	5	5	5	3
Swimming	1	1	1	1	1	1	4	3	1	4
Tennis/table tennis	4	5	5	5	5	5	5	5	5	5
Track - high jump	1	3	3	4	4	3	3	4	4	4
Track - pole vault	1	3	3	5	5	3	4	4	4	5
Volleyball	4	5	5	5	5	3	5	5	5	5
Weightlifting	1	1	1	2	1	1	1	1	1	5
Wrestling	2	1	1	3	2	1	3	5	5	4

<sup>a</sup> A pattern ESO deviations or V pattern EXO deviations can significantly affect performance in these sports.

<sup>b</sup> Contrast sensitivity may be crucial (to the point of being life-saving) in this sport.

<sup>c</sup> Eye-body (foot-head-chest) coordination.

<sup>d</sup> Including American football, Australian rules football, Canadian rules football, Gaelic football, rugby league and rugby union.

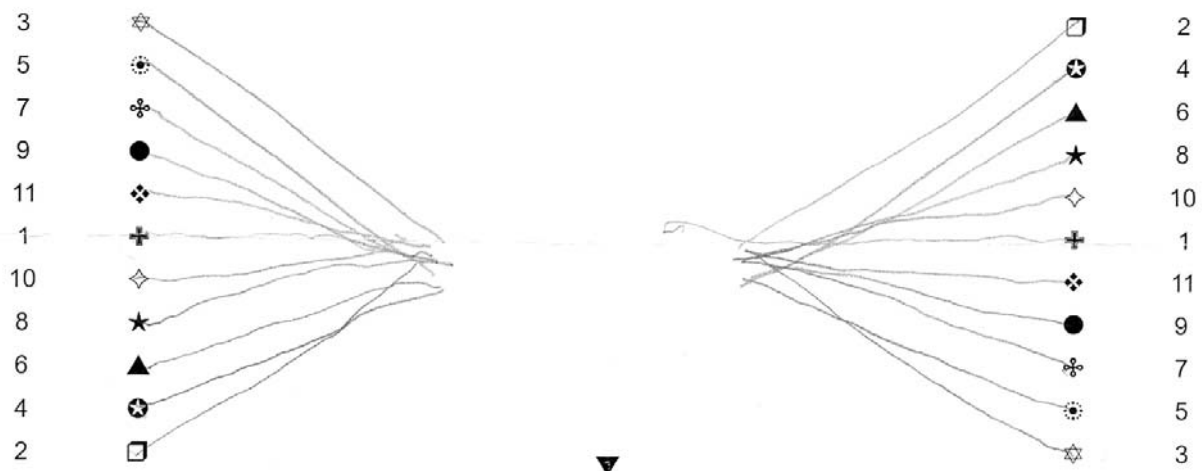
## Appendix II

### Test results 11. april 2002

### Description:

Hirschberg:	ortho	normal
Cover far:	ortho	normal
Cover near:	ortho	normal
Pursuits:	full and smooth	normal
Saccades:	no over- or undershoots in all directions	normal
NPC (w/ target):	3/5	normal
<b>Results @ 6m:</b>		
Horizontal phoria:	2D eso	Eso deviation
Vertical phoria:	ortho	normal
Smooth vergences, positive:	12/24/16	high
Smooth vergences, negative:	6/13/16	high
<b>Results @ 40cm:</b>		
Horizontal phoria:	1D exo	normal
Vertical phoria:	ortho	normal
Smooth vergences, positive:	12/25/18	low
Smooth vergences, negative:	4/14/6	very low
Positive relative accommod.:	-1.00	low
Negative relative accommod.:	+2.25	normal
MEM Retinoscopy:	+0.50	normal
AC/A:	3/1	normal
Vergence facility:	not tested	
Accommodative facility:	not tested	

Name: \_\_\_\_\_ Datum: M.4.02



### Appendix III

Training sequences introduced to the patient over a six month period in chronological order:

- Marsden ball: pursuits monocular
- Brock string: binocular
- Walking-reading: w/ Hart chart for near, binocular
- Palming
- Marsden ball: pursuits binocular
- Divergence/Convergence training with o/o card
- Accommodation rock with  $-2.00$  lens: monocular
- McDonald peripheral chart: binocular
- Pursuits in free space: binocular
- Fusion hearts (Tranaglyphs)
- $\pm 2.00$  flipper on near Hart chart: binocular
- Marsden ball w/ bouncing stick (eye-hand coordination)
- Floating eight
- Vergence Line
- Red/black printed letter chart: w/ red/green glasses for suppression control
- Using periphery while throwing a ball
- Pursuits on moving marble
- Divergence/Convergence training on ABC chart
- Horizontal Saccades on letter chart
- Making pictures in space
- Reading book rotations
- Accommodation inhibition with different minus lenses: monocular
- Chalkboard numbers (training of peripheral vision)
- Star fixation pursuits
- Life savers
- Accommodation inhibition without lenses
- Throwing dices (visualisation)
- Near-far saccadic fixations
- Brock string 3m without beads
- Accommodative push-up and push-away technique
- Phone-Number visualisation
- Letter-saccades in reading text, near-far alternately
- Jump vergence with tranaglyphs
- Bar reader w/  $\pm 2.00$  flipper

- Marsden ball visualisation
- Framing objects
- Vergence training on loose excentric circles
- +/- 2.00 flipper on near-far Hart chart with red/green glasses
- Word visualisation

**Appendix IV**

Endpoint results 30. January 2003

Description:

Hirschberg:	ortho	normal
Cover far:	ortho	normal
Cover near:	ortho	normal
Pursuits:	full and smooth	normal
Saccades:	no over- or undershoots in all directions	normal
NPC (w/ target):	3/5	normal
 Results @ 6m:		
Horizontal phoria:	3D eso	eso deviation
Vertical phoria:	ortho	normal
Smooth vergences, positive:	18/20/12	high
Smooth vergences, negative:	10/12/8	high
 Results @ 40cm:		
Horizontal phoria:	10D exo	exo deviation
Vertical phoria:	ortho	normal
Smooth vergences, positive:	18/18/9	normal
Smooth vergences, negative:	18/30/12	normal
Positive relative accommod.:	-2.75	normal
Negative relative accommod.:	+3.75	normal
MEM Retinoscopy:	+0.50	normal
AC/A:	3/1	normal
Vergence facility:	15cpm	normal
Accommodative facility OD:	16cpm	normal
Accommodative facility OS:	16cpm	normal
Accommodative facility Bino:	15cpm	normal

Name: \_\_\_\_\_ Datum: 21.5.03

