An overview on the practice of Sports Vision

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The changed face of sports from the old conservative amateur approach to a dynamic professional business has created many opportunities. The unprecedented interest of the media and the globalization of television and the Internet have made sports a major marketing tool. Like elsewhere in the world athletes and coaches are investigating all the different legal (and sometimes illegal) options available to them to provide them with that edge over their competitors. Judging from all the enquiries I am receiving from optometrists there is indeed a keen interest to be involved in this discipline with the biggest market being the recreational athlete.

It is now almost a 100 years since the first publication on sports vision appeared in literature. The role of vision in sports performance is a subject that has always attracted considerable attention. The modern origin of sports vision was founded in 1924 by Abel[1] and Fullerton[2] who studied the visual abilities of the famous baseball player, Babe Ruth, and concluded that his superior vision was the reason for his exceptional hitting ability. Bannister and Blackburn[3] suggested that rugby players with greater inter-pupillary distances had better depth perception and therefore enhanced performance. Winograd[4] investigated the relationship of timing and vision in baseball by using the Keystone Telebinocular instrument to test visual aspects such as stereopsis and far point lateral imbalances. He found significant differences between college baseball players and non-athletes. Another early study that quite often referred to is that of Graybiel, Jokl and Trapp [5]who reported on several Russian studies done during the 1950’s. These studies reported significantly lower amounts of heterophoria in tennis champions compared to non-tennis players. In the same article theyalso reported on a study that indicated that tennis players had better depth perception than football players. Similarly when the peripheral vision of javelin and discus throwers was blocked, they performed significantly poorer and that their ‘movements became clumsy’.

Since these early studies that originated in the disciplines of sports science and sport psychology, others have appeared on the relationship between vision and sports performance. Optometry and ophthalmology can be regarded as late comers in the world of sports vision. Miller and Ludvigh [6]in 1962 provided an ophthalmological perspective on the relationship between dynamic and static visual acuity. In 1970, Gavriysky [7]emphasised the importance of vision as a primary element in sports. This publication was one of the firsts to refer to vision as having physical, physiological and perceptual components and related these to sporting results. It certainly deserves much more recognition but is seldom quoted. Probably the first publication relating to sports vision that appeared in optometric literature is a study in 1960 by Stull[8] who investigated eye and hand dominance and coordination of basketball players. The author who was the director of athletics at the California State Polytechnic College used six college basketball players and analysed them as to the type of shot, eye used, position of the ball at start and release, position of eyes at release as well as other body position factors. He concluded that the players did change their pattern in shooting baskets when forced to do so with the non-dominant eye. He further concluded that experienced players may prefer monocular vision rather than binocular sighting. Bauscher [9]and Martin[10]were amongst the first to report on visual screenings on athletes. Bauscherscreened 368 athletes in the years 1964-1966 using a visual screening battery including visual acuity, refractive error, pathology, tropia, lateral and vertical phorias and depth perception. He concluded that 28% of the athletes screened had inadequate vision for maximum athletic performance but did not elaborate on the norms used to reach these conclusions. Martindid a similar study on 809 athletes in college and professional sports and found 22% of them failed the screening but also neglected to discuss the norms for failing. Martin10 also reports on what might have been the first sports visual training programme. This was done for the Boston Red Sox baseball team at their spring training camp in 1964. He stated that of the 135 players tested, 18% failed and 13 needed spectacles for the first time while six players needed their spectacles to be improved. He also stated that “five players had such high degrees of muscle imbalances and lack of depth perception that it would be most difficult to adequately prescribe a visual therapy programmme which would enhance their play”.

Barnett [11]believes nobody did more to establish sports vision in optometry than Garner. Garner [12]discovered that players on the Penn State football team left their spectacles in the locker room before going out to participate in a game. This encouraged him to institute a five-year vision testing programme (1970 to 1975) for some 3000 athletes this included Little League baseball players, high school, college, and professional athletes. He presented his results to the American Optometric Association and revealed that nearly 27% of these athletes failed the visual examination. An undisclosed number of athletes had never had a vision test previously. This study stimulated a major awareness of the role that optometry could play in sports performance and opened the floodgates for optometric publications on sports vision. In 1980, Sherman [13] published a literature overview that supports the role of vision in sports, particularly aspects such as static visual acuity, dynamic visual acuity, depth perception, stereopsis, accurate triangulation, eye movement and speed, peripheral vision and visualization. He concluded, “All these visual abilities are trainable and enhanceable by optometric visual training”. Sherman also referred to the unique role that optometry can play in providing sports vision. He stated that the optometrist routinely provides vision care to athletes at different levels and this care should include corrective eyewear, protective eyewear and visual training to reinforce the role of optometry in enhancing sports performance.

The greater involvement of optometry and ophthalmology in sports vision research during the 1970’s was also guided by two other aspects. First of all the significant progress made in the development of soft contact lenses resulted in contact lenses becoming the primary visual correction for athletes. According to Lieblein [14]a survey done by Bausch & Lomb in 1977 found that 86% of professional baseball, football, basketball and ice hockey players needing vision correction used contact lenses. More than 50% of them used soft contact lenses. During the late 1980’s a series of articles appeared describing considerations for fitting athletes for specific sports [14, 15].

The second aspect concerned awareness of the risk of eye injuries in sport and about the role primary care practitioners play in the prevention of such injuries through education and the provision of protective eyewear. Vinger [17],in a study on ocular injuries in ice hockey players, and Vinger & Tolpin[18] in a study on racket ball players drew attention to the incidence of serious eye injuries in sport. They were amongst the first to recognize that eye injuries in sports pose a substantial but preventable risk. Estimates on the type and number of ocular injuries due to sports have largely been retrospective in nature and based on emergency room statistics or on information collected at large eye hospitals in the USA. These estimates may be as high as 100,000 eye injuries each year [19, 20]. With the emphasis on prevention of such injuries, several studies reported on the use and development of eye protection standards [21] and also resulted in a position statement by the International Federation of Sports Medicine [22]. This report provides guidelines for routine visual examinations, the identification of eye injury risk factors in sports and the factors to consider when prescribing corrective and protective eyewear for sports. Vingerprobably has done more than anybody else to promote eye safety in sports and he was the driving force behind most of the efforts to test and develop eye protectors and produce universally acceptable safety standards. His original study published in the well-respected Duane’s Clinical Ophthalmology in 1985 has later been updated by Vinger [23] himself.

Notwithstanding all these positive developments, sports vision still lacks general acceptance in sport science and other related disciplines. This is the result of several critical reports and studies questioning the efficiency of visual training programmes and the transfer of these visual skills to athletic performance. In 1989 Leibowitz et al [24] wrote a report to the USA Olympic Committee condemning the use of visual training to improve athletic performance. Wood and Abernethy [25] and later Abernethy and Wood [26] also expressed serious concerns on the usefulness of visual training. Nevertheless, one only needs to surf on the Internet to realize how many people worldwide are offering sports vision services. The problem is that most of these services are based on anecdotal reports and testimonies rather than scientific, dependable studies and procedures. Quite often studies will show an improvement in visual skills such as pursuits or even eye hand co-ordination after training on instruments such as the Wayne’s saccadic fixator but no evidence can be provided that it actually resulted in better sports performance. Furthermore the standardization of testing protocols and norms remains an ongoing process. The early emphasis in sports vision was more on the creation of enhancement techniques rather than establishing tests that could be replicated. The development of the Pacific Sports Vision Performance Profile in response to the request of the United States Olympic Committee provided sports vision specialists with the first real comprehensive profile (Coffey and Reichow, 1990) [27]. Since then organizations such as the International Academy of Sports Vision also endeavored to create internationally acceptable protocols (Planer, 1994) [28]. In 2008 Buys & Ferreira [29] published a paper that provided scientific credibility to the establishment of norms and protocols. Although several national optometry associations do have sports vision sections, the need is still for institution based sports vision research centres.

Vision is often seen as the ability to perceive, select and to interpret information presented to the system. But when investigating the role of the visual system in sports performance, it is important to understand the interaction between environmental demands on the system, optical properties of the eye and the functional properties of the visual perceptual system. Our research [30, 31] does suggest that the visual information processing system, and more specific visuomotor control, is far more important than the visual information gathering system when considering sports performance. Thus superior athletes differ from the normal population in their ability to use visual information to control motor action rather than simply relying on visual perceptual skills. An ineffective gathering system may however limit proper visual processing and should therefore not be ignored. According to Milner and Goodale [32] the traditional distinction between the 'what' and 'where' in the visual system should make way for a 'what' and 'how' approach. Thus the emphasis should be to develop the 'how' abilities of athletes by developing visual training programmes for specific needs.

According to Abernethy [33] visual performance in sport is an interaction between two systems: the hardware and software visual systems, as a computer analogy of information gathering and processing. In sports performance the hardware components of vision or what I prefer to call the visual information gathering system, are the non-task specific abilities such as ocular health, visual acuity, accommodation, fusion, depth perception, peripheral vision, colour vision and contrast sensitivity (Ferreira, 2002) [34]. The software or cognitive aspects [visual information processing system] include visual perception, visual concentration, visual response time, central-peripheral awareness and visualization. The structurally-fixed components or the hardware of the visual system may set the potential limit to visual performance in sports, but once these deficiencies have been addressed, it is the visual-perceptual or software skills that separate the experts from non-experts (Williams, et al, 1999) [35]. These proficiency-related differences in perception have been explained by the experienced athlete’s superior task-specific knowledge base and their ability to select, process, encode, organize and retrieve information more effectively from memory than inexperienced performers [35]. Skilled performers use their superior knowledge to control the eye movement patterns necessary for seeking and picking up important sources of information.

Reichow and Stern [36] formulated the following definition for optometry*: “Sports vision encompasses performance oriented comprehensive vision care programs involving the education, evaluation, correction, protection and enhancement of the athlete. Each of the above areas should be addressed in a performance-oriented manner. This means that the practitioner should consider all his or her services from a performance standpoint. Improved visual performance resulting in enhanced athletic performance must be the ultimate goal of sports vision regimens”.* This definition is still applicable and optometry is the only profession that can provide the full range of services. We can provide corrective eyewear, protective eyewear, evaluate visual skills and provide visual enhancement programmes. When providing corrective eyewear the emphasis should be on what is practical and prevention of eye injuries should also be part of your decision. It is important to know and understand the visual demands for the different sporting codes. It should be obvious that glasses will not be applicable in contact sports such as rugby. Even in non- contact sports such as squash it frequently happens that athletes may collide with each other and glasses may again be a bad option. Speaking of racket sports Vinger [23] did find that most injuries are caused by the opponent’s racket than anything else. I am still surprised to see how many people still play squash with rimless spectacles. Even a sport like angling resulted in severe eye injuries where the sportsman ends up hooking himself in the eye when pulling hard to release his line that got stuck on something under the water. In protective eyewear the focus should again be on providing protection against eye injuries but also consider protection against environmental factors such as glare, wind, dust and UV. One question that comes up frequently is what tint to use and may this be different for different sports. Notwithstanding the fact that you may have companies selling sport specific products such as glasses for golf, research has shown that tint selection remains a matter of personal choice. In a study by Moore and Ferreira [37] amongst professional cricket players we discovered that players lens of choice was “whatever the sponsor provides them with”. By knowing your sport and matching the patient’s needs with what is available, providing corrective and protective eyewear should be something that every optometrist should be able to do.

The domain of visual skills and performance enhancement often requires teamwork with sports scientists and psychologists and it is here where we need to make a big mind shift away from “n house therapy” to a specific adaptations for imposed demands [SAFID] approach. It is clear that studies that concentrated mostly on eye movement skills such as pursuit tracking movements, number of fixations and saccadic movement patterns provided contradictory evidence suggesting that eye movement pattern in itself does not provide sufficient evidence to explain the differences between experts and non-experts [35] These discrepancies made researchers to question the role of visual skills and led to the believe that these differences result from experts’ enhanced contextual based knowledge and their ability to recall structured sport situations more efficiently from long term memory. The problem with almost all these studies is that they assumed that visual information processing or perception relates to foveal function or focal attention and ignored the role of peripheral vision. Some authors did however suggest that peripheral vision may be more critical than foveal gaze and suggested the need for innovative research to include the role of parafoveal and peripheral perception. Computer based training is also not the solution since it does not meet the requirements of as SAFID based approach.

The answer lies in the latest innovations in technology and how this can be integrated into visual training. The use of instruments such as mobile eye trackers, strobe specs and virtual reality have changed the world of visual training for ever. With the use of motor analysis systems and mobile eye trackers, it is now possible for researchers to determine the relationships between an athlete’s motor behaviour and gaze control within specific task environments. Gaze behaviours may be grouped into three gaze control categories namely those found in targeting; interceptive timing and tactical tasks. One of the most significant findings is that experts do not keep their eyes on the target but in sports such as soccer and tennis they would rather focus on peripheral cues. [Go to YouTube and watch Ronaldo play soccer with a mobile eye tracker]. To do this experts are making much less head movements indicating a strong peripheral preference. This is what Vickers [38] calls the quiet eye. She defines the quiet eye as “a final fixation or tracking gaze that is located on a specific location or object in the visuomotor workspace within 3°or less of visual angle for a minimum of 100ms. The onset of the quiet eye occurs prior to the final movement of the task, and the offset occurs naturally when the gaze deviates off the location or object by more than 3° of visual angle for a minimum of 100ms”. She also claims that the quiet eye can be used as an “objective measure of optimal perceptual motor coordination” as elite performer’s exhibit optimal control of quiet eye in relation to final movement.

Nothing beats the introduction of virtual reality as a visual training instrument. The latest innovation is called immersion. In contrast with old systems where you were merely a spectator the immersion systems now put you on the field of play. [Watch videos on YouTube]. It simulates game situations and require athletes to make real decisions in real time. It also provides direct and immediate feedback on the quality of their gaze control and therefore decision making. It has simply taken visual information processing to the next level and provides a whole new experience of visual enhancement training.

Another new but totally different aspect of sports vision is the involvement with children through physical literacy programmes. Todays’ youth, being it generation Z or generation Alpha are lacking basic general motor skills that forms the basis of all fine motor development. Being digital natives and subsequent sedentary life style they are not able to perform basic skills such as balance, co-ordination, agility and speed. These are the basic elements of physical literacy and there is a global concern on the general physical development of these children. It is therefore not surprizing to see how many children are now send off to occupational therapists. This is a great challenge for optometry to develop training programmes for children that combines physical training with basic visual training. Doing visual therapy on children that lack’s physical literacy will only produce short term results.

Sports vision should form an integral part of any optometry practice. Providing corrective and protective eye care simply requires a specific mind set. Getting involved in visual skills testing and training may however require as total shift away from “in office” training to a more SAFID based approach using the latest technologies available.

REFERENCES:

 1. Abel O, Eyes and baseball. *Western Optometry World* 1924 **12**(1) 401-402.

 2. Fullerton C, Eye, ear, brain, and muscle tests on Babe Ruth. *Western Optometry World* 1925 **13**(4) 160-161.

3. Bannister HA, Blackburn JM. An eye factor affecting proficiency at ball games. *British J. of Psychology* 1931 **21** 382-384.

4. Winograd S. The relationship of timing and vision to baseball performance. *Res Q Am Assoc Health Phys Educ* 1942 **13** 481-493.

5. Graybiel A, Jokl E, Trapp C. Russian studies in vision related activity and sports *Res Q Am Assoc Health Phys Educ* 1955 **26** 212-223.

6. Miller JW, Ludvigh E. The effect of relative motion on visual acuity *Surv Ophthalmol* 1962 **7**(2) 83-116.

7. Gavriysky A. Vision and sporting results *J Sports Med Phys Fitness* 1970 **10**(2) 260-264.

8. Stull R Study of hand and eye dominance and coordination of basketball players *J Am Optom Assoc* 1960 **32**(4) 293-298.

9. Bauscher W. Vision and the athlete *Optom Wkly* 1968 **59**(19) 21-25.

10. Martin WF. What the coach should know about the vision of athletes *Optom Wkly* 1970 **61**(25) 538-560.

11. Barnett D. Winning with sports vision *Eyecare Business* 1988.

12. Garner AI. Visual aid prescribing for the athlete*. Calif Optom* 1977 **3**(6) 18-19.

13. Sherman A. Overview of research information regarding vision and sports *J Am Optom Assoc* 1980 **51**(70) 661-666.

14. Lieblein JS. The athlete’s choice: contact lenses. *Contact Lens Spectrum* 1986 **1**(9) 55-58.

15. Carlson NJ. The kick off: meeting patients’ athletic needs with contact lenses *Contact Lens Forum* Sept. 1989 15-16.

16. Shoji PJ. CLs for water sports enthusiasts *Contact Lens Forum* May 1990 26.

17. Vinger PF. Ocular injuries in hockey *Arch Ophthalmol* 1976 **94**(1) 74-76.

18. Vinger PF, Tolpin DW. Racket sports an ocular hazard *J Am Med Assoc* 1978 **239** 2575-2577.

19. Strahlman E, Sommer A. The epidemiology of sports related ocular trauma *Int Ophthalmol Clin* 1988 **28**(3) 199-202.

20. Larrison WI, Hersch PS, Kunzweiler T, Shingleton BJ Sports related ocular trauma *Ophthalmology* 1990 **97**(10) 1265-1269.

21. Gallaway M, Aimino J, Scheiman M. The effects of protective sports eyewear on peripheral visual field and a peripheral visual performance task *J Am Optom* *Assoc* 1986 **57**(4) 304-310.

22. Vinger PF, Knuttgen HG. Eye injuries and eye protection: a position statement by the International Federation of Sports Medicine *Sports Vision* 1989 **5** 5-6.

23. Vinger PF. The eye and sports medicine In: Duane TD. & Jeager EA. eds. *Clinical Ophthalmology* Philadelphia: Lippincott-Raven 1997 1-103.

24. Leibowitz HW, Vinger PF, Landers DM. *Can vision training improve athletic* *performance?* 1989 Report to the US Olympic Committee.

25. Wood JM, Abernethy B An assessment of the efficacy of sports vision training programs. *Optometry and Vision Science* 1997 **74**(8) 646-659.

26. Abernethy B, Wood JM. Do generalized visual training programmes for sport really work? An experimental investigation. *J Sports Sciences* 2001 **19** 203-222.

27. Coffey B, Reichow AW. Optometric evaluation of the elite athlete: The Pacific Sports Visual Performance Profile. *Problems in Optometry* 1990 **1**(2) 32-58.

28. Planer PM. *Sports vision manual*. Harrisburg, International Academy of Sports Vision 1994.

29. Buys, JC & Ferreira, JT [L]. 2008The development of protocols and norms for sports vision evaluations. *SA Optometrist* 67(3) 106-117

1. Venter SC, Ferreira JT. A comparison of visual skills of two different high school age group rugby players. SA Optom, 2004 63(1) 19-29
2. Ludeke A, Ferreira JT. The difference in visual skills between professional and nonprofessional rugby players. SA Optom, 2003 62(4) 157-163
3. Milner DA & Goodale MA. The visual brain in action. 1995. Oxford University Press, Oxford pp 219
4. Abernethy B. Training the visual-perceptual skills of athletes. *American Journal of* *Sports Medicine*.1996 **24**(6) 89-92.
5. Ferreira, JT. Sports vision as a hardware and software system. *Eyesite.*July 2002 pp 40
6. Williams AM, Davis K, Williams JG. *Visual perception and action in sport*. Routledge, London 1999.
7. Reichow AW, Stern NS. Optometric trends in sports vision. *Optometric Extention* *Program Foundation. Curriculum II*. 1986 **59**(7) 355-368.
8. Moore, L & Ferreira, JT. Eyewear and ocular protection patterns against solar factors in cricket players. Eyesite August 2005 pp 43.
9. Vickers, J.N. (2007). *Perception, Cognition and Decision Training. The Quiet Eye in Action.* Champaign, IL: Human Kinetics.
10. Whitehead M. Physical throughout life, The International Physical Literacy Association. May 2014.

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MCQ

1. Original studies on Sports Vision were done by:
	1. Optometry
	2. Ophthalmology
	3. Sport Science
	4. Psychology
2. Studies showed that when peripheral vision of javelin and discus throwers was blocked they performed:
	1. Better
	2. Worse
	3. The same
3. Optometry is the only profession to provide all sports vision related services:
	1. True
	2. False
4. Visual skills training should:
	1. Focus on hard ware skills
	2. Focus on soft ware skills only
	3. Be done on computers
	4. None of the above
	5. All of the above
5. In racket sports the most injuries are caused by:
	1. Own racket
	2. The ball
	3. Opponent’s racket
6. Every sport requires a very specific tinted lens
	1. True
	2. False
7. Hard ware system or visual information gathering system comprise of the following elements:
	1. Visual acuity
	2. Accommodation
	3. Eye tracking
	4. Colour vision
	5. All of the above
8. Soft ware system or visual information processing system comprise of the following elements:
	1. Eye hand coordination
	2. Peripheral vision
	3. Visualization
	4. Contrast sensitivity
	5. Only a, b. c
9. Physical literacy refers to the development of basic motor skills such as:
	1. Agility
	2. Balance
	3. Co-ordination
	4. Speed
	5. All of the above
10. Eye tracker technology showed that expert athletes tend to keep their eye on the ball all the time.
	1. True
	2. False