

VISUAL ASSESSMENT OF SPORTS PROFESSIONALS

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ABSTRACT

Sports can be classified according to where it has been played like indoor and outdoor, according to whether it is contact or non contact and if it involves movement i.e. dynamic or static. Some sports are played as team and others individually. All these sports require some amount of visual skill and potential. Sports vision can be defined as an eye care service provided to sports personals to enhance their visual skills for better sports achievement. This includes the assessment of their visual skills and improvement of visual abilities along with training and counselling.

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INTRODUCTION

Unlike in the past, sports are now not only a part of leisure and physical activity but also a profession. Therefore improving the performance of the professionals has become more important. Visual requirement is an important part of any sports; thereby the necessity of proper visual assessment of the sports professionals becomes very significant. This paper tries to emphasise different visual assessment tools of sports professionals.

Sports can be classified according to where it has been played (indoor or outdoor), according to if it involves movement (dynamic or static), according to body touch (contact or non-contact) and according to number of player/s (team or individual). All these sports require some amount of visual skill and potential. Sports vision can be defined as an eye care service provided to sports personals to enhance their visual skills for better sports achievement. This includes the assessment of their visual skills and improvement of visual abilities along with training and counselling.

Table 1. Games requiring special visual skills¹

Sports	Important visual skill
Cricket/Baseball	Anticipation(Batting) Aiming(Bowling) Eye hand coordination(fielding)
Football/soccer	Peripheral awareness Eye hand coordination
Archery	Visual acuity Glare recovery
Table Tennis	Oculomotor skill Eye hand coordination
Tennis	Anticipation Eye hand coordination
snooker	Depth Perception
Hockey	Accommodation vergence facility
Downhill Skiing	Dynamic visual acuity Eye hand coordination Contrast sensitivity Dynamic visual acuity

Process of visual examination in sports vision

Visual examination process involves screening, assessment and training. To achieve the on field goal, the first step of

examination is visual acuity and contrast sensitivity. A small amount of residual refractive error can hamper the performance of an athlete. In contrast, the higher spatial frequencies, is vital for optimum visual performance⁽²⁾. We need to asses and improve these qualities if needed. Then the assessment of stereo vision and depth perception is initiated. After examining Binocular status of the eye the next step is to assess the coordination of brain with eye i.e. visual mechanics. These procedures can be demonstrated in a form of pyramid.

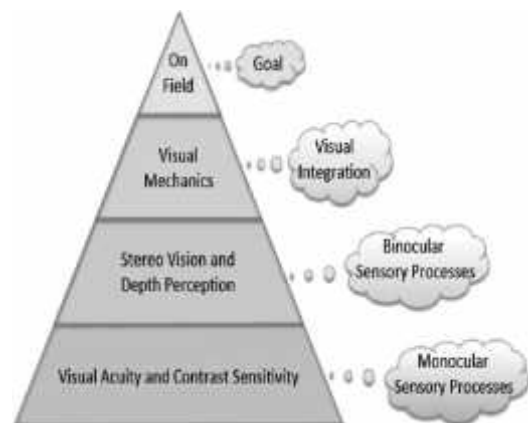


Fig1 Sports vision pyramid

Visual Acuity Assessment

There are mainly two types of visual acuity assessments:

- (i) Static visual acuity assessment.
- (ii) Dynamic visual acuity assessment.

Static visual acuity (SVA)

Static visual acuity is “the ability to see a non moving target at a fix distance”⁽³⁾.The SVA can be measured by numerous

charts such as Snellen's chart, Bailey-Lovie LogMAR charts, and Landolt C optotypes. The Log MAR visual acuity charts are most preferred for athletes. The most repeatable and standardized method of measuring visual acuity is through the repeatability of the measurement and allows more precise specification of visual acuity.⁴



Fig 2 Static visual acuity chart

Nondynamic sports like archery, golf, shooting, snooker requires a sharp static visual acuity for crisp performance as the target is set at a fixed distance to aim. Although the expected level of visual acuity depends on the visual task demands of each sports situation, at least 20/15 (6/4.5) static visual acuity in both eyes is a desired standard for competitive athletes.⁵



Fig 3 Aiming in archery at a fixed distance

Dynamic visual acuity (DVA)

A significant amount of research investigated the physiologic parameters of resolving visual targets in motion, referred as dynamic visual acuity.^{6,7}

There are various fast moving games such as cricket, football, baseball, tennis, basketball where either the target is in motion or the player. In cricket the batsman have to focus the running bowler as well as the ball. The fielders have to constantly look at the batsman's stance and switch their position as soon the ball has been hit. So, beside a good static visual acuity an excellent dynamic visual acuity is essential. A game like tennis as it is played with coloured ball with a definite background increases the need of proper dynamic visual acuity.

Dynamic visual acuity can be tested with targets moving laterally on a screen, on a rotating disc, or using projected letters imaged by rotating mirrors, with either letters or numbers as stimuli.⁸ Few DVA measurement instruments are available, among them Wayne Robot Rotator with visual acuity chart is the most common used one. It has been shown that dynamic visual acuity can be improved with training.⁹



Fig 4 Wayne Robot Rotator for dynamic VA

Refractive error correction

Athletes with vision or vision-related problems can be corrected in a variety of ways depending upon the problems. This includes spectacles, contact lens and refractive surgery. The most important first step in treatment is to compensate for any refractive errors so as to maximize acuity. If refractive errors have been compensated or corrected, specialized vision training can also be provided to remediate any other problems the athlete.

Table 2: Guidelines for refractive compensations in athletes¹⁰

Refractive status	Consider prescribing at
Myopia	-0.25 D or more
Hypermetropia	+1.00 D or more
Astigmatism	±0.5 D or more
Anisometropia	±0.5 D or more

Contact lens for refractive correction

Contact lens can be boon to sport professionals as it requires less handling while playing sports. There are many advantages of contact lenses over spectacles, but it needs to be explained to the professionals. Some of the main advantages are as follows:

1. Wider field of vision (15% more than glasses).
2. Real image size. (minimal magnification or minimisation)
3. No spectacle aberration.
4. No fogging or sliding down the nose.
5. No dust or dirt interfering with vision.
6. Less chance of injury as opposed to glasses.
7. Improved performance and confidence on the field thereby providing a psychological advantage over glasses.
8. Custom design lenses, e.g., lenses to compensate for atypical corneas shapes.

Ortho-K is a specialized contact lens used for reduction, modification and elimination of refractive error by programme programmed application of these lenses. Overnight OrthoK are worn at night to provide good unaided vision during the day. These lenses can be used by deep sea divers and mountain climbers as it provides handling free good visual acuity.

Refractive surgery

Surgical procedure is another option for athletes with refractive errors this includes LASIK and customized LASIK surgery. In this surgical procedure shape of the cornea is permanently altered, thereby correcting ametropia. Post surgery an individual undergone LASIK has to wear protective goggles for six months after surgery. Otherwise the

athlete could experience flap dislocation or trauma to the operated eye.

Standard LASIK surgery produces a minimal decrease in contrast sensitivity probably caused by an increase in higher order ocular aberrations. However, the improvement in visual acuity far outweighs this drawback. With the improvement in smoother blends and transition zones produced by LASIK, problems involving glare and haloes at night have been greatly reduced. With the advent of custom cornea or wave-front mapping prior to LASIK surgery, problems with spherical aberrations have also been greatly reduced. Wave-front mapping technology literally reflects a fingerprint pattern of an individual eye and uses this fingerprint to guide the LASIK procedure. As a result, wave-front mapping actually enhances contrast sensitivity by reducing higher-order ocular aberrations. It is believed that since these aberrations are removed, the athlete might actually have better visual acuity and contrast sensitivity than would be obtained by the use of glasses or contact lenses.

Contrast Sensitivity Testing

Contrast sensitivity provides a measure of the visual sensitivity to various sized objects at different contrasts. The measurement indicates the least amount of contrast required detecting a visual stimulus⁴. For example a cricket player is subjected to changing lights conditions during day and night games or a tennis player is subjected to sky and court contrast during the play. Picking up the ball in various lighting conditions is influenced by contrast sensitivity.

Pelli Robson and Mars charts are commonly used to measure contrast sensitivity in athletes. Mars charts have some advantages over Peili Robson charts as follows:

Depth perception and stereopsis

Depth perception is the ability to judge relative distance between two objects and stereopsis is to perceive accurate movement in 3 dimensional apace.

Stereopsis is the result of retinal disparity and is not an innate ability but develops in the first six months of life. Games like golf and archery if there is a difficulty in judgement of depth, the player may over estimate or under estimate the target. Howard Dolman device is used to evaluate depth perception and stereo acuity at a distance of 6 meter.



Fig 5 Howard Dolman device

Eye Tracking / Oculomotor Skill Assessment

Eye tracking means keeping the eye on the ball. The assessment of oculomotor function can include evaluation of pursuit eye movements, saccadic eye movements, and the steadiness of fixation^{11,12,13},

Smooth Pursuit eye movements: Smooth pursuit movements are tracking movements of the eye as they follow the moving object.¹⁴

Saccadic eye movements: Saccades are sudden, jerky conjugate eye movements that occur as the gaze shifts from one object to another.¹⁴

Pelli Robson charts

1. In triplets, each letters contributes 0.05 log units.
2. Each triplet contributes 0.05*3=0.15 log units.
3. Dimention of pelli Robson chart(86*63)cm.

4. Not easily portable.



Mars charts

1. In triplets, each letters contributes 0.04 log units.
2. Each triplet contributes 0.04*3=0.12 log units.
3. Dimension of Mars chart (23*35)cm.
4. Easily portable.



Fixation: Fixation refers to the ability to look at an object and maintain gaze on it.¹⁵

Faster games like table tennis and badminton needs quick and correct oculomotor skill. Fixation is needed while serving the ball or the shuttle to properly place it in opponents area. Saccadic eye movements are important in sports like cricket, baseball, football where the field of view is wider and you need to change your gaze within a fraction of second.

These oculomotor motor functions are very difficult to assess clinically. A subjective assessment of pursuit eye movement and saccadic eye movement function using an observational method (e.g.: North-eastern state University college of optometry Oculomotor test)¹⁶ used for screening procedure.

Peripheral Awareness

The visual field is the entire extents of the external world that can be seen without a change in fixation.¹⁷ Many of the sports require highly developed peripheral awareness. The normal monocular visual field extends to 50-60 degrees superiorly, 60 degrees medially, 70-75 degrees inferiorly and 90-110 degrees temporally. The binocular field is made up of overlapping monocular fields extending to about 200 degrees horizontally and 130 degrees vertically.

Cricket batsman must be aware of the fielder while taking, football players should be aware of oncoming tacklers, hockey goalkeepers who must be simultaneously aware of the positions of opposition players. For the skier's and motor racer peripheral awareness is most important for their safety purpose.

Peripheral awareness can be assessed with the Peripheral Awareness Trainer (available from Wayne Engineering, Inc.). This device tests peripheral asses the stimuli and response times for eight different visual field locations. The trainer is mounted at eye level on the wall and the athlete is instructed to always fixate a centre spot on the device.



Fig 6 Peripheral Awareness Trainer device

Speed of recognition measurement

Speed of recognition terms as the ability to process visual information rapidly has been considered an essential elements for the fast action sports¹⁶. The speed with which an athlete can recognize an object is very important in many sports. The process speed can be measured psychophysically and has been referred to as inspection time (IT)^{18,19}.

Rapid recognition will make the player's performance quicker, more accurate, and more efficient. In cricket and baseball as early as the batsman recognise the ball at the time of delivery it allows extra time to shift the stance and hit ball in desired area.

Speed of recognition can be tested and trained using a Tachistoscope, which is a projector which can be used to flash a series of numbers, symbols, or pictures on a screen for some periods. The athlete must identify the stimulus presented in the brief flash and react.



Fig 7 Tachistoscope

Eye - body coordination assessment

Dynamic sports needs rapid shift of balance by using the hands, legs and feet. In some sports, such as tennis, cricket, hockey, and baseball, football objects move at very rapid speeds and it is important that the player coordinates the eyes and body to hit the ball at the appropriate area. In swimming the coordination of eye and body is must in butterfly, backstroke and breast stroke.

The Wayne Saccadic fixator is a device that measures the time taken to make a motor response to a visual stimulus. The board is placed 10 feet (3 meters) .The athlete stands on the board and moves it in the direction of the light presented on the saccadic fixator board. Lights are presented at 3, 6, 9, and 12 o'clock



Fig 8 Wayne Saccadic Fixator

Dominance assessment

The phenomenon of ocular dominance was first discovered by G.Battista Della porta²⁰.

- Uncrossed eye-hand dominance (i.e. right eyed and right handed or left eyed and left handed).
- Crossed eye-hand dominance (i.e. right eyed left handed or left handed right eyed)
- Central dominance (i.e. central eyed and right handed or central eyed and left handed).

Games like shooting and archery gives great advantage to the player to use his dominant eye In a study done in 2005 by

Yoshio Sugiyama stated that analysis indicated the right eyed subject has significantly better performance using the right hand stance than the left hand stance whereas left eyed subjects showed the opposite.²¹

The most common method used to determine eye dominance is assessing sighting eye preference. The athlete is asked to fixate a distance target at (6/12) letter. He or she is then asked to hold a tube or a card with an aperture held at arm's length. One eye is closed or covered at a time, and the athlete is asked if he or she can still see the target. The eye that can still see the target is the dominant eye.



Fig 9 Ocular dominance testing

Other Assessments

Colour Vision Assessment

It is very important to identify team members and opponents during a game. Jersey colour can help to determine team a players it is a advantage for the player to have good colour vision. A number of colour vision tests are available; two commonly used ones are the AO Pseudoisochromatic plates and the Ishihara plates.

Night Vision / Glare recovery assessment

Proper night vision and quick glare recovery can improve an athlete's performance, especially for night games played under artificial lights. A lofted ball may get lost in the light. Visors and glare protection glasses may be helpful in these situations.

The instrument commonly used to assess night vision and glare recovery is the American Automobile Association's Night Sight Meter. This unit gives data on night vision, glare vision, and glare recovery time.



Fig 10 American Automobile Association's Night Sight Meter

DISCUSSION

This paper tries to discuss various visual assessment tool in sports vision. While every individual requires good vision for the activities of daily living, the visual function demand for sports professional are significantly greater. They need best of vision and visual related functions for optimal performance in sports. The eyes can be assessed for all the visual functions and each component can be enhanced as per the need of the sport played.

Visual acuity and contrast sensitivity are the most influencing factor in improving most of the sports performance. Vision should be assessed with Bailey-lovie Log MAR chart for reliability and repeatability. It can be improved to better than 20/20 with the help of training. Similarly contrast sensitivity can be assessed by Peilli Robson chart and Mars chart. Contrast can be improved by the various tints. Depth perception is also a most considerable ability which can assess by Howard-Dolman device. The demand of the motor mechanism purely depends upon the sporting condition and it can be improved by vision training.

The other sports vision assessment techniques include night vision/glare and colour vision. To play under floodlight is a challenging task for any player to identify the correct location of the ball against the background. Even there are games which are played with different coloured balls so the proper colour detection becomes essential.

Visual assessment of sports professionals become important, thereby necessitates the role of optometrists for this purpose.

CONCLUSION

In a nutshell, it can be concluded that assessment of sports vision skills is an important aspect of training of sports professionals, which can be enhanced as required. Various studies have confirmed that proper assessment of visual skill is necessary and optometrists can play a major role in examining, evaluate and provide training.

It is an overview of how an optometrist can approach the examination and what are the requirements of sports patients. Practionars has to have the basic knowledge of the sport which the sport patient belongs to, otherwise it will be difficult to understand the requirements and goal of the athlete. Sports vision can be taken as a speciality by optometrists and upgrade the profession. There is also a huge room for researches, which will further upgrade the skills and knowledge of optometrists.

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