Visual Performance Evaluation of the Athlete
Lecture objectives

➢ Review the role of vision in sport
➢ Understand how the case history can help identify a performance limiting issue
➢ Discuss the application of the Vision Pyramid
➢ Learn how to set up a relevant visual performance evaluation of the athlete
➢ Review the visual skills that make up a comprehensive visual performance evaluation
Overview:
- Who are your athletic patients?
- Role of Vision in Sports
- Vision Pyramid

Developing a SPV Evaluation
- Perceptual Elements
- Demands of the Sports
- Knowledge of Sport/Activity

Case History

Testing Batteries
- Visual Acuity
- Contrast Sensitivity
- Dynamic Visual Acuity (DVA)
- Refraction  Ocular Alignment
- Ocular Dominance
- Stereo Acuity
- Accommodation & Convergence
- Ocular Motor Function
- Peripheral Vision
- Speed Recognition
- Visual Motor Skills
- Peripheral Hand-Eye Response
- Visual Coincidence Concussion
- Baseline Testing
Overview

**Agenda:**

- Who are your athletic patients?
- Role of Vision in Sports
- Vision Pyramid
Many patients are engaged in physical activities that involve vision:

- Child Athletes
- “Weekend Warriors”
- First Responders
- Military

Evaluating the vision needs of patients is integral to their safety, health, and performance.
Role of Vision in Sports

➢ **Sight**
   The clarity of the image on the retina and an intact retina

➢ **Motor**
   Pursuit & saccadic eye movements, accommodation, vergence and fusion

➢ **Information Processing**
   Quick interpretation and visual perceptual processing
Another good approach to organizing and prioritizing visual factors

Vision functions could be placed at the appropriate position on the pyramid

Courtesy of Drs. David Kirschen and Dan Laby
Developing a SPV Evaluation

Agenda

• Perceptual Elements
• Demands of the Sports
• Knowledge of Sport/Activity
Developing a Testing Battery

1. Determine:
   • “Essential" skills
   • “Beneficial" skills

2. Establish Testing Battery
   • Determine which tests are needed to assess essential and beneficial skills
   • Eliminate superfluous testing
Perceptual Mechanism

The test battery needs to assess the **perceptual mechanism** elements that cut across most sports:

- Acuity
- Contrast sensitivity
- Refraction
- Ocular alignment
- Depth Perception (stereopsis)
Identifying the Demands of the Sport

The remainder of the test battery will be determined by the demands of the sport

- Accommodation and Vergence
- Oculomotor function
- Reaction-time-related issues
- Peripheral reaction/response
- Coincidence-anticipation
- Other areas specific to sport demands
Knowledge of Sport/Activity

- Personal participation
- Patient observation / interaction
- Expert interaction (OD, coach, trainer, etc...)
- Personal observation
- AOA Sports & Performance Vision Guidebooks are available, as a benefit of membership at aoa.org/spv
Case History
Case History—Your eyes may be holding you back if:

- You show little improvement in sports, even with practice
- You make the same mistake time and again in competition
- You have difficulty judging ball rotation or knowing where the ball or other players are
Case History—Your eyes may be holding you back if:

- Do you experience loss of concentration during sports performance?
- Do you ever notice decreased peripheral vision during sports performance?
- Do you ever notice sensitivity to lights, or difficulty recovering vision after looking into bright lights?
Inconsistence Performance
SPV Testing Batteries

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SPV Testing Batteries:

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- Speed Recognition
- Visual Motor Skills
- Peripheral Hand-Eye Response
- Visual Coincidence
- Concussion Baseline Testing
Visual Acuity

Optotypes
- Snellen-type letters
- Landolt rings
- Computerized

Ideal Testing Strategy
- End point of 20/15 if possible
- Use habitual Rx that athlete uses during sport
- If they have an Rx that is not used for sport, test with and without correction
Most studies since 1924 have found better static VA in athletes compared to non-athletes.

Several studies have found a mean acuity of 20/15 or better; consider the “minimal desired visual acuity for a competitive athlete.”

It is not uncommon to find some athletes performing at a high level despite having reduced VA’s. Consider the task demands.
Contrast Sensitivity

Test options
- Vistech,
- Vector Vision,
- Right Eye,
- Senaptec,
- M&S

Ideal Testing System
- Must test to threshold
- Must control lighting and calibration
- 3+-choice double staircase algorithm
The general results suggest elevated CSF across all spatial frequencies for athletes.

It has been demonstrated that contact lenses can degrade CSF if the lenses are not optimal.

CSF should also be assessed with any performance tints used for competition.

Consider assessing the tints in natural light.
Dynamic Visual Acuity (DVA)

- Dynamic Visual Acuity (Method?)
  - Rotators, horizontal sweeps?
  - Tachistoscopic presentation?

- Many multi-tasking equipment (such as Senaptec, Right Eye etc) test DVA
Dynamic Testing

- Can be used for Visual acuity, Stereo acuity and contrast sensitivity testing
- Cannot predict based on typical static vision testing in office
- Believed by some to be a more true predictor of visual function during athletic competition
- No standard agreement on definition or methods to test:
  - Does the target move (horiz/vert/rotary/z-axis)?
  - Does the optotype change size dynamically?
  - Does the athlete move?
DVA Methods?
Variability in measurement parameters has created significant difficulty in determining performance characteristics.

Most studies found better DVA in athletes compared to non-athletes.
Refraction

Refraction:

- Retinoscopy
- Auto Refractor
- Subjective Refraction
AAU Junior Olympics

- 31% wore eyewear routinely
- 13.2% wore contact lenses to school
- <1% wore protective eyewear
Ocular Alignment

- Alignment needed for normal binocular vision – stereopsis
- Can be evaluated with any of a series of tests (cover tests, Maddox rod, fixation disparity)
- Optometrist must be aware of benefits and complications of each test

(Cont’d on next slide)
Ocular Alignment (cont’d)

- Consider effect of phoria on binocular function – few athletes have constant tropic misalignments

- Alignment should be tested in all gazes or gaze appropriate for each sport (up gaze for volleyball or batting stance for baseball)
Early studies found lower amounts of heterophoria in athletes (especially at far), but more recent studies have not confirmed these findings.

Some suggest that measurement of fixation disparity may be a better assessment of the accuracy and stability of eye alignment.
Ocular Dominance

- Controversial topic
- Many tests for dominance exist, with poor agreement between tests as to dominant eye
- Study found that 33% of right eyed people are cross dominant
- Testing methods:
  - Sighting tube
  - Triangle test
  - Plus fog

(Cont’d on next slide)
Many factors can influence result of ocular dominance test (handedness, shoulder/arm abnormalities, etc.)

Some have suggested that crossed eye-hand dominance may be beneficial in activities such as baseball batting and golf putting.
Ocular Dominance (cont’d)

- Classically considered only either right or left by the pointing test
- Some tests allow for intermediate forms as well as central eye dominance
Ocular Dominance (Cont’d)

- In the majority of sporting events – players will need to use both eyes together for maximal function
  - Exception: Sports that require sighting with one eye (shooting)
  - Otherwise – we should work toward maximal function in each eye (monocular function) and maximal binocular function to optimize performance
Stereo Acuity

Test Type
- Contour
- Random Dot
- Howard-Dolman apparatus

Testing System
- Testing at Far (e.g. 3m or more) vs. Near
- Testing to threshold
- Effect of timing on stereo acuity result
Studies have demonstrated that binocular vision can improve performance on certain tasks compared to one-eyed performance.

Research comparing static stereopsis performance has had mixed results with athletes, some differences due to differences in testing procedures used.

The lack of correlation between depth perception and athletic performance may be due to the static nature of the testing.
Accommodation & Vergence

➢ Haynes Distance Rock Test
  • Assesses speed and accuracy of accommodative/vergence facility
  • No control for binocularity/suppression
  • Published normative data for elite-level athletes; no comparative studies

➢ Hart Chart
Accommodation & Vergence

WARNING: Time factors for accommodation & vergence response (latency ~400ms)
Oculomotor Function

➢ Useful to test when the visual system can use the oculomotor system in a performance task

➢ Challenge for the ECP
  • Determine which performance tasks involve oculomotor tasks
  • Which aspects of oculomotor functions are the most critical
    • Fixations (The Quiet Eye™)

Bahill AT, LaRitz T (1984)
Oculomotor Function

Which aspects of oculomotor functions are the most critical

- Saccades
  - Latency
  - Accuracy
- Pursuits
  - Latency
  - Accuracy

Bahill AT, LaRitz T (1984)
Oculomotor Function

Qualitative

• Observe eye movements when the athlete is fixating, making saccades between 2 objects or smoothly pursuing a target
  • Look for speed and accuracy, over and under-shoots

Quantitative

• Eye movement recordings—Visagragh
  • Right Eye equipment can track accuracy of oculomotor function similarly to Visagragh but without the use of glasses
• Quiet Eye system

Whittaker SG, Eaholtz G (1982)
McHugh DE, Bahill AT (1985)
Studies have found that athletes do NOT have shorter latencies for initiating pursuit or saccadic eye movements.

However, if the target trajectory is predictable, the latency period can be reduced through a learning effect.

Studies comparing the speed of pursuit eye movements have found mixed results.
Peripheral Vision

- Extent of visual field
- Form recognition in periphery
- Peripheral awareness/reaction
Extent of Visual Field

➢ Study results indicate that athletes have a larger extent of horizontal and vertical visual fields than non-athletes

➢ However, it was NOT found to be a sensitive discriminator of skill level within a sports population (Varsity vs. JV collegiate football)

➢ While extent of periphery seen cannot be increased, the ability to quickly and accurately respond to stimulus in the periphery can be enhanced.
Form Recognition in Periphery
Study results indicate that athletes have better form recognition at more peripheral locations than non-athletes

Peripheral Awareness/Reaction
Only normative data have been published for measurements of peripheral awareness/reaction using the Wayne P.A.T.T. in athletes

Technology, such as Neurotracker and Senaptec, use multiple object tracking to help athletes become aware of peripheral targets to enhance cognitive reaction time
Speed of Recognition

➢ **Challenge for the ECP**
  • Determine which performance tasks involve speed of recognition
  • Determine which tests best evaluate speed of recognition
  • Determine which metric in the performance task is best to evaluate improvement with training

➢ **Tachistoscope Presentation**

➢ **Perceptual Training Systems**
There have been mixed results when comparing speed and span of recognition in athletes to non-athletes (speed is better; span is the same).

The use of number sequences for recall may be the confounding factor, and this may be overcome by the use of more ergonomically appropriate targets (sport-specific; spatial info).
Inspection Time (IT)

- IT is the psychophysical measurement of visual processing time, with shorter inspection times allowing accurate decisions to be made from shorter stimulus durations.

- Most studies have found that experienced athletes can evaluate relevant visual information more rapidly than inexperienced observers.
Visual-Motor Skills to Evaluate

➢ Useful to test in sports requiring quick motor reactions to visual information

➢ Challenges for the ECP
  • Determine which performance tasks involve visual-motor reaction time
  • Determine which tests best evaluates visual-motor reaction time
  • Determine which metric within the performance task is best to evaluate improvement with training
Possible testing equipment (w/quantification)

- Simple reaction time
  - Visual stimulus is presented at a random time and a motor action is required (e.g., a button push)
  - Can measure reaction & response times
- Choice reaction time
  - A stimulus is illuminated in a random position
Visual-Motor Reaction Time

For a given sport, determine which reaction time is most important and determine which performance modality is most important

- eye-hand
- eye-foot
- balance response
Literature Support

Motor Response Time
- Simple motor response times have been demonstrated to be faster in athletes than non-athletes

Visual-Motor Reaction Time
- Simple visual-motor reaction time studies have had mixed results.
  - Several studies found faster RT’s in athletes in various sports, and it was a good discriminator of expertise level.
  - Other studies have not found this correlation
Simple eye-foot visual-motor reaction time studies have found faster RT’s in athletes in various sports, and it was a good discriminator of expertise level.
Eye-Body Reaction/Response

Normative data have been published for measurements of eye-body reaction/response speed using the Wayne Balance Board in athletes as well as Quick Board.
Peripheral Eye-Hand Response

➢ Useful to test when the visual system must direct a choice motor response to peripheral information

➢ Challenges for the ECP
  • Determine which performance tasks involve peripheral eye-hand response
  • Determine which tests best evaluates peripheral eye-hand response
  • Determine which metric within the performance task is best to evaluate improvement with training
Peripheral Eye-Hand Response

➢ A few of many equipment options
Using different evaluation methods and equipment, the results of eye-hand coordination in athletes has been demonstrated to be better than non-athletes in most studies.

- **Light Levels**
  
  Using different evaluation methods and equipment, the results of eye-hand coordination in athletes has been demonstrated to be better than non-athletes in most studies.
Visual Coincidence – Anticipation

➢ Useful to test when the visual system can anticipate the arrival of an object
➢ Challenge for the ECP
  • Determine which performance tasks involve anticipation skills
  • Determine which tests best evaluate anticipation skills
  • Determine which metric within the performance task is best to evaluate improvement with training
Visual Coincidence—Anticipation

- Possible testing equipment (w/quantification)
  Reaction time testing equipment modified to make the task predictive rather than random

- The metric for performance would be a decrease in the reaction time for the task

- Testing Equipment:
  - Wayne Speed Track
  - Bassin Anticipation Timer
  - Senaptec Synchrony
Performance on the Bassin Anticipation Timer did not correlate with batting performance in baseball or softball.

Timing accuracy was found to improve with increasing target velocity, decreasing range of movement, and length of runway.
Concussion Baseline Testing

➢ Allows for comparison of results after a suspected head injury has occurred
➢ Utilized for return-to-play decisions as well as goals for therapy if athlete suffers from visual sequelae
➢ Testing Methods:
  • King Devick (or DEM if preferred due to automaticity)
  • Near Point of Accommodation
  • Amplitude of Accommodation
Summary

- Every patient presents with an opportunity to assist them with their recreational endeavors
  - It is up to you to utilize this opportunity and provide a sports-vision experience

- Familiarize yourself with the sport
  - The sport will guide your evaluating procedures

- Communicate with the athlete how the test relates to their sport

- Have fun!
Discussion

➢ Review the role of vision in sport
➢ How can you use the case history to identify a performance-limiting issue?
➢ What visual skills are critical in:
  • Baseball
  • Hockey
  • Golf
  • Tennis
  • Basketball
➢ Discuss the application of the Vision Pyramid