TESTING AND IMPROVING
SPORTS VISION

Presented by
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Performing a Comprehensive Sports Vision Examination
WHO ARE YOUR ATHLETES?
The individual who can process more visual information in a shorter period and make the proper response will have an advantage in competition.
As athletes tap out their potential in other aspects of their performance, like speed, power or strength, what will they turn to next to increase their performance?

The trend seems to be that they will turn to vision training.
Understanding the Role of Vision in Athletics

- **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
Your eyes are 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
Your eyes are 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?
INCONSISTENCY IN PERFORMANCE
Areas of Sports Vision

- Refractive compensation
  - Spectacles vs Contact Lenses (CRT?) vs Refractive surgery
- Assessment/remediation of functional visual inefficiencies
- Assessment of sport-specific visual abilities
- Enhancement Vision Training
- Consultation
THREE PARTS

- Visual Task Analysis
- Visual Skills To Evaluate
- Visual Skills that are “Improvable”
Knowledge of Sport/Activity

- Personal Participation
- Patient Observation / Interaction
- Expert Interaction
- Personal Observation
- AOA Sports Vision Section (SVS) Guidebooks*Available online FREE to SVS members, as a benefit of membership, at www.aoa.org
Environmental Analysis in Sports

- Ocular Hazards
- Ocular Protection
- Facial Protection
- Head protective wear (visibility & mechanical forces)
- Lighting & glare
- Temperature
Environmental Analysis in Sports

- Humidity
- Altitude
- Dust & Foreign Body Potential
- Sweat
- Fogging
- Precipitation
- Environmental Variability
Sports Vision Evaluation

- Visual Acuity
  - Snellen Acuity
  - Landolt c’s
Most studies since 1942 have found better static VA in athletes compared to nonathletes.

However, it is not uncommon to find some athletes performing at a high level despite having reduced VA’s.

– Consider the task demands
Sports Vision Evaluation

- Visual Acuity
  - Contrast Sensitivity
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...
Sports Vision Evaluation

Dynamic Visual Acuity
(Method?)
- Rotators, horizontal sweeps?
Variability in measurement parameters has created significant difficulty in determining performance characteristics.

Most studies found better DVA in athletes compared to nonathletes.

Standardized methodology is needed.
Sports Vision Evaluation

- Refraction
  - Retinoscopy
  - Auto Refractor
AAU JUNIOR OLYMPICS

- 31% wore eyewear routinely
- 13.2% wore contact lenses to school
- <1% wore protective eyewear
Sports Vision Evaluation

Fixation
Disparity
– Method?
Sports Vision Evaluation

- Ocular Alignment
  - Distance Cover Test
  - Near Cover Test
  - Maddox Rod Test
  - Thoriington Card
  - Fixation Disparity
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.
Sports Vision Evaluation

- Dominant Hand / Dominant Eye
  - Implication of Crossed Dominance
    - 41% Crossed in General Population
    - 40% Crossed in Athletic Population
    - 4% No Eye Preferred
    - Left Handed - Higher Incidence Crossed
There have been many theories concerning the advantages/disadvantages of crossed eye and hand dominance in sports performance. Coren & Porac found that the dominant eye processed visual information ~14msec faster than the nondominant eye, fueling speculations.
The preponderance of evidence suggests that there is no relationship between eye dominance patterns and batting performance.

The only sports where ipsilateral dominance offers an advantage is in “sighting” sports such as target shooting (quicker skill acquisition).
Leading Off Pole Vault

Łukasz Kruczek of Poland gets a bird's-eye view of Sapporo during training for a World Cup ski jumping competition.

Photograph by Kazuhiro Nogi / AFP
Sports Vision Evaluation

- Eye Teaming & Spatial Localization
  - Lateral Disparity vs. Random Dot
    - AO Vectographic Slide
    - Mentor BVAT
    - Random Dot
Sports Vision Evaluation

- Eye Teaming & Spatial Localization
  - Speed of Stereopsis
    - Timed Random Dot
    - Mentor BVAT
Sports Vision Evaluation

Eye Teaming & Spatial Localization
– Howard Dolman Apparatus
Literature Support

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.
Dynamic Stereaoacuity

- It has been suggested that the lack of correlation between depth perception and athletic performance is due to the static nature of the testing.
- Dynamic stereopsis assessment procedures have been suggested to discriminate differential performance relating to sports.
Sports Vision Evaluation

- Vergence Function
  - Vergence Ranges
  - Vergence Facility
- Accommodative Function
  - Near-Far Facility (Haynes)
Only 2 published studies have compared vergence ranges in athletes to nonathletes.

One study found no statistical difference in performance, and one found narrower ranges in athletes (speculated to correspond to more accurate spatial judgments via EOM action).
There have been mixed results on studies of NPC ability and sports performance. It is theorized that the more dynamic nature of the testing assess vergence function more “globally” than static procedures.
There have been mixed results on studies of vergence facility using prisms and sports performance.

It has been suggested that a near-far method of assessment more closely simulates “real world” accommodative-vergence facility demands.
Literature Support - Accommodative Facility

Studies using lenses to assess accommodative facility in athletes found no difference in performance compared to nonathletes.

Similar to vergence facility, it has been suggested that a near-far method of assessment more closely simulates “real world” accommodative-vergence facility demands.
Sports Vision Evaluation

- Oculomotor Function
  - Subjective Qualitative Assessment
  - Projected tests (DEM, King-Devick)
  - Objective Eye Movement Recording (Ober Visagraph)
Literature Support - Shorter Latencies/Trainable?

- 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 be reduced through a learning effect (e.g., initiating the correct pursuit eye movement to track a baseball pitch).
Sports Vision Evaluation

Speed of Recognition
– Tachistoscope Presentation

Limitation of Eye Movements
There have been mixed results when comparing speed and span of recognition in athletes to nonathletes (speed is usually better than span).

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).
Inspection Time

It is the psychophysical measurement of visual processing time, with shorter inspection times allowing accurate decision 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 SKILLS TO EVALUATE

- Motor Response Time
- Visual-Motor Reaction Time
Simple motor response times have been demonstrated to be faster in athletes than nonathletes.
Literature Support - 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.
Sports Vision Evaluation

Eye Foot Speed
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.
VISUAL SKILLS TO EVALUATE

Eye-Hand Coordination
Using different evaluation methods and equipment, the results of eye-hand coordination in athletes has been demonstrated to be better than nonathletes in most studies.
Lighting Levels

The level of ambient room lighting has been shown to effect performance on the Wayne Saccadic Fixator and the Acuvision.

- Lower ambient illumination improves performance
VISUAL SKILLS TO EVALUATE

- Visual Coincidence-
  Anticipation Skills
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 the runway.
VISUAL SKILLS TO EVALUATE

- Peripheral Vision
  - Threshold 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).
Literature Support – Form Recognition in Periphery

Study results indicate that athletes have better form recognition at more peripheral locations than nonathletes.
Only normative data have been published for measurements of peripheral awareness/reaction using the Wayne P.A.T.T. in athletes.
VISUAL SKILLS TO EVALUATE

- Eye-Body Coordination
- Vision & Balance
- Field Dependence-Independence
- Visualization
VISUAL SKILLS TO EVALUATE

- Ocular Health Procedures
Other considerations for the Rx

- Timing of first prescription
- Value of overminusing
- Prescribing for twilight
- Prescribing for specific distances
- Prescribing modalities:
  - Spectacles
  - Contact lenses
  - Refractive surgery
Spectacle Considerations

- ANSI standards and the sport
- Wrap designs
- Contact sports
- Weather and atmospheric conditions
- Prescribing tints
- Considerations for presbyopes
VISUAL TASK
VISUAL TASK

- Filters & Visual Information Processing
- Driven by information provided from visual input (VA, CSF, Stereopsis, etc.)
- Specific skills affected by filters:
  - Visual Discrimination
  - Visual Figure-Ground
Filters and Lighting Variations

- Incandescent lighting
- Fluorescent lighting
- Sodium lighting
- Daylight (clear vs. cloudy)
- Outdoor night lighting
Filters and Performance Factors
VISUAL SKILLS
THROUGH FILTERS

- Visual Acuities
- Refractive Status
- Contrast
- Sensitivity
- Dynamic VA
VISUAL SKILLS THROUGH FILTERS

- Phorias & Vergences (stance & facility)
- Fixation Disparity
- Speed & Accuracy of Depth Perception
VISUAL SKILLS THROUGH FILTERS

- Visual-Motor Reaction Time
- Eye-Hand Coordination
VISUAL SKILLS THROUGH FILTERS

- Vision Anticipation Skills
- Speed of Recognition
Polarizing filters

- Suppresses reflected light (horizontal)
- Best with reflected glare (water, road surfaces)
- Transmit a maximum of 50% (usually ~40%)
- Act as neutral filters for unwanted reflections
- Sports applications
  * Fishing, water sports, driving/cycling (wet surfaces)
  * May remove important details in skiing, golf, etc.
FILTER TYPES & SPORTS

- Photochromic filters
  - Transmission characteristics actively change
  - Usual range is 20% to 80% transmission*
  - Usually neutral or brown tint
  - Sports applications
    * Changing light levels (e.g., golf, tennis)
FILTER TYPES & SPORTS

Neutral grey filters
- Filters wavelengths equally
- Keeps colors more “natural”
- Sports applications
  * When subtle color differences matter
  ...  
  * Golf, mountaineering, skiing
  * Mountaineering: blocks yellow light in whiteout
FILTER TYPES & SPORTS

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  ...  
  * Golf, mountaineering, skiing
  * Mountaineering: blocks yellow light in whiteout
Red range filters

- Enhances objects in the red spectrum
- Sports applications
  * Orange clay shooting
  * Skiing (contrast changes of reflected light)
FILTER TYPES & SPORTS

Yellow range filters
- Transmits only longer wavelengths
- Ocular media scatters short wavelength light more - improves contrast by eliminating some of this “internal glare”
- May enhance contrast differences (contours)
- Sports applications
  * Shooting sports, Snow sports, Driving, Flying
  * Blue backgrounds (tennis, baseball, golf, etc.)
Specialty filters - Mirror Coatings
- Limits glare and increases absorption
- Reduces Infra-Red - reducing heat build-up
- Sports applications
  * Snow Sports
  * Water Sports
  * Cycling/Running
FILTER TYPES & SPORTS

Specialty filters - Anti-reflective coating

- Minimizes reflections - especially back surface
- Sports applications
  * Racquet sports
  * Fishing
  * Shooters/Archery
LENS DESIGN FACTORS

- Goggle designs
  - Ski goggles
  - Swimming goggles
  - Diving masks
Factors to consider:
- Gaze positions (ex: upgaze for cyclists)
- Speed of eye movements (re-orientation)
- Length of competition
- Environment (humidity, temperature, altitude, debris, wind, UV exposure)
- Replacement possibilities
- Tint possibilities
CONTACT LENS CONSIDERATIONS

- Material: water content
- Diameter
- Handling Characteristics
- Stability
- Replacement: ease and frequency
  - spare lenses on sidelines
  - solutions on hand
  - 1-day lenses
Importance to Wearers- MAX EYES

Ocular Health in Performance Vision:
- Reduce UVA, UVB
- Reduce visual fatigue
- Eliminate potential "Device" hazard
- Minimizes blue light hazard
COMPLIANCE ISSUES

- 100% non-compliant with at least one step
- 95% either don’t disinfect or clean regularly
- 94% don’t keep case clean
- 53% fail to wash hands
EMERGENCY KIT FOR THE ATHLETIC TRAINER

- Non-preserved saline
- Lubricating drops
- Several clean contact lens cases
- DMV lens removers
- Fluo strips
- Sterile swabs
- Anesthetic?
Sports Eye Injury Prevention

- Educate the general public
- Proper coaching for safe play
- Modify regulations
- Promote proper eyewear
Sports Eye Injury Prevention

- Comprehensive patient care
- Regular visits
- Thorough case history
- Legal/ethical responsibility to identify & warn
- Verify habitual sports/recreational eyewear:
  - Appropriate for risk(s)
  - Meets relevant standards
  - Inadequate condition
Prevalence (all trauma)

- 2.5 million cases per year in U.S.
- 40,000-45,000 cases of permanent visual impairment
- Accounts for 20% of unilateral blindness; 7% of bilateral
- 70% male
- Sports related ocular trauma=100,000+ per year
Sports Eye Injury Prevention

Pre-existing conditions that increase risk:
- Post-refractive surgery
- High myopia
- Visual field defects
- IOL implants
- Other surgical procedures to eye tissues
- Amblyopia and Strabismus?
Eye Injuries Associated With Sports

Prevent Blindness America

The use of protective eyewear for the face and eyes could effectively reduce the frequency and severity of sports related eye injuries by 90%.
Determination of Risk – Classification of Various Sports

- By Physical Contact:
  - Contact/Collision
  - Limited Contact
  - No Contact
High Contact/Collision Sports

- Basketball
- Hockey (Field and Ice)
- American Football
- Soccer
- Rugby
- Water Polo
- Wrestling
- Boxing
Limited Contact

- Baseball
- Skiing (Snow & Water)
- Squash/Racquetball/Handball
- Volleyball
- Windsurfing/Surfing
- Kayaking
- Cycling
- Gymnastics
Noncontact

- Archery & Riflery
- Crew/Rowing
- Track & Field
- Golf
- Running
- Sailing
- Swimming & Scuba Diving
- Tennis, Badminton & Table Tennis
- Weight lifting
Sports Eye Injury
Demographics

- True incidence is unknown
- No reliable, fast & complete data collection systems in place
- Must rely on incomplete data from various data gathering systems
- Data does show a major public health problem
Sports Eye Injury Demographics

- Eyes = 0.25% of body surface
- Eyes account for ~2% of sports injuries
- ~10% of patients have had an eye injury
- 10% of all ER-treated eye injuries are sports
- ~27% chance of hospital admission in ER-treated eye injury (compared to 2% rate)
## Injuries in Sports by Age

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Sports</th>
<th>Percentage</th>
<th>Age Group</th>
<th>Sports</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-14 year olds</td>
<td>Basketball</td>
<td>34.0%</td>
<td>15-24 year olds</td>
<td>Basketball</td>
<td>16.5%</td>
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<tr>
<td></td>
<td>Baseball</td>
<td>7.2%</td>
<td></td>
<td>Baseball</td>
<td>15.5%</td>
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<tr>
<td></td>
<td>Swimming &amp; pool sports</td>
<td>12.5%</td>
<td></td>
<td>Racquetball &amp; Ct. sports</td>
<td>8.1%</td>
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<tr>
<td>25-64 year olds</td>
<td>Basketball</td>
<td>19.6%</td>
<td></td>
<td>Total injuries all ages</td>
<td>39,297</td>
</tr>
<tr>
<td></td>
<td>Swimming &amp; pool sports</td>
<td>14.9%</td>
<td></td>
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<tr>
<td></td>
<td>Racquetball &amp; Ct. sports</td>
<td>6.7%</td>
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</tbody>
</table>
One Eyed Athlete

- Risk of Blindness for the One Eyed Athlete $1.75 \pm 0.30 / 1000$

- Risk of Blindness for the General Population $.11 / 1000$
One Eyed Athlete

- More than 150x more likely to go blind
- Trauma causes more than 50% of this blindness
Pre-Participation Physical Exam

Clearance can be divided into 3 categories:
- Unrestricted
- Clearance after further evaluation/rehabilitation
- Not cleared for all or certain sports

Does condition(s) limit participation due to:
- Increased risk of injury
- Puts others at risk of injury
- Can it be treated to allow safe participation
VT Techniques Related to Sports Performance

- Relate technique to sports tasks
- Stress awareness of response & strategy
- Achieve quality of response initially
- Push speed of response when ready
- Build automaticity of response
- Discuss strategies to assist transfer of skills to the playing field
THANK YOU FOR YOUR TIME AND INTEREST

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