Vision Enhancement
From Average Joes to the Pros
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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

Areas of Sports Vision
- Prevention/management of eye injury
- 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"

Eye Trauma vs Sports Vision Doctors

- Usually are mutually exclusive
- Vast majority of teams/programs only have an eye trauma doctor
- Almost all need both

CSF

- Contrast Sensitivity was found to be a more important indicator of flight performance in fighter pilots than visual acuity
Visual Analysis

- Contrast Sensitivity Function
  - Most use grating patterns
    - ViStech
    - Vectorvision
    - Multiple computer generated designs

- Want to assess binocularly with correction that is habitually worn during sport
  - If wearing CLs, should check monocular

Literature Support

- 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.
  - Be very specific about who fits your athletes with contact lenses
  - CSF should also be assessed with any performance tints used for competition.

Visual “Correction”

- Prescribing (cont)
  - Contact Lenses (CLs)
    - In general, I will primarily fit...
      - Daily disposables
      - Tighter fitting lenses
      - Low to moderate water content lenses
      - Multiple trials until I get optimum clarity and comfort
      - Possibly over-minus for sport
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
FILTER TYPES & SPORTS

- 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.

- 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.)
FILTER TYPES & SPORTS

- Specialty filters - Mirror Coatings
  - Limits glare and increases absorption
  - Reduces Infra-Red - reducing heat build-up
- Sports applications
  - Snow Sports
  - Water Sports
  - Cycling/Running

Performance Contact Lenses

- 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
NIKE MAXSIGHT Sport-Tinted Contact Lenses

Tomorrow’s New Tool for Peak Visual Performance … MaxSight – Ultimate Performance Eyewear

MAXSIGHT – Light Architecture

Light Architecture
- Reduced Chromatic Aberration
- Enhanced Target Recognition
- Contrast Enhancement: Luminance & Chromatic
- Enhanced Target Visibility
- Perceived Brightening Effect
- Improved Shadow/Glare Recognition
- Visual Comfort
- Reduced Fatigue/Stress
- UV & Blue Light Filtration

Refractive Surgery

Military Research

New standards of Care
How do we know we can improve vision and performance?

What Is Neuroplasticity?
- Neuroplasticity is defined as a change in neural pathways and synapses due to changes in experience, environment, neural processes, or changes resulting from bodily injury.
- It occurs both on the cellular level due to learning and on the cortical map level in response to injury.
- Its role is widely recognized in development, learning, memory, and rehabilitation.
- The visual cortex retains the capacity for perception-dependent neuroplasticity following perceptual learning of both the physical structure (anatomy) and the functional organization (physiology) throughout life.

Is Perceptual Learning Effective?

Vision
- Prof. Huxlin, U. Of Rochester, Ophthalmology
  - treatment for visual scotomas following stroke
  - Dr. Durrie, Kansas U Medical Center, Ophthalmology
  - treatment for low myopia

Hearing
- Prof. Beverly A. Wright, Communication Sciences and Disorders, Northwestern U.
  - treatment for auditory dysfunctions

Somatosensory
- Prof. Moseley, Physiology, Anatomy & Genetics, U. of Oxford
  - treatment for chronic pain and tactile dysfunctions
Perceptual learning has been extensively researched and published: Found effective in amblyopia, low myopia and presbyopia.

Besides acuity and contrast sensitivity improvements, training gains were generalized to higher functions:
- Rapid matching of object properties, such as shape and color
- A gain of 185 msec for a 50% accuracy in stereo acuity

Vision enhancement training in professional baseball players using Gabor images.
The Effects of Perceptual Learning on Visual Processing Functions in Professional Baseball Players

RESULTS

Participants: 10 professional baseball players

Pre-training performance:
- Static distance visual acuity (VA)
- Dynamic near visual acuity
- Contrast sensitivity
- Reaction time

Post-training performance:
- Significant improvement in all parameters

Improvement:
- Static distance visual acuity
- Dynamic near visual acuity
- Contrast sensitivity
- Reaction time

P values:
- R = 0.01
- L = 0.002
- B = 0.03

Despite initial superior vision, athletes achieved significant improvement (37% average).

When comparing to a study among young people (3), we see how athletes started with "Supervision," slightly better than that of non-athletes after training. Non-athletes were able to reach the vision performance level of professional athletes.

P value p < 0.0000

Improvement in crowded acuity

The task:
- Large effect of interference (masking) before training
- Minimal effect after training
- Improvement of about 100% for short time windows
- Development of fast processing that enable overcoming the interference posed by sequential presentations

P value < 0.0000

Improvement in reaction time

The task:
- Threshold in both stimuli and interval
- Improvement after training

P value = 0.0073
Large effect of improving reaction time (shortening by about 200 msec)

Faster image processing speed allows the athletes to see better so they can act faster

P value < 0.00000

Improvement in reaction time

The task:

Stroboscopic Technology

Nutrition?
University of Georgia Researchers Show Link between Dietary Zeaxanthin Consumption and Improved Reaction Time

- The study found that after 4 months of supplementation with an Eyepromise brand eye health supplement (zeavision), the group of young, healthy participants experienced statistically significant improvements including a 10% improvement in reaction time (at least 20 mg zeaxanthin)

Sports Eye Injury Demographics

- Incidence (Prevent Blindness America)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Sport</th>
<th>2003</th>
<th>2012</th>
<th>2013</th>
<th>2015</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Basketball (20.8%)</td>
<td>Basketball (20.4%)</td>
<td>Basketball (18.6%)</td>
<td>Basketball (20.3%)</td>
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</tr>
<tr>
<td>2</td>
<td>Baseball (14.9%)</td>
<td>Water Sports (14.2%)</td>
<td>Water &amp; Pool Activities (16.6%)</td>
<td>Water &amp; Pool Activities (17.7%)</td>
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</tr>
<tr>
<td>3</td>
<td>Water Sports (9.4%)</td>
<td>Baseball / Softball (11.5%)</td>
<td>Guns – Air, Gas, Spring, BB (11.7%)</td>
<td>Guns – Air, Gas, Spring, BB (7.7%)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Racquet &amp; Court Sports (7.8%)</td>
<td>Guns – Air, Gas, Spring, BB (11.5%)</td>
<td>Baseball / Softball (12.4%)</td>
<td>Baseball / Softball (6.8%)</td>
<td></td>
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Vision and Concussions