Sports Vision Performance

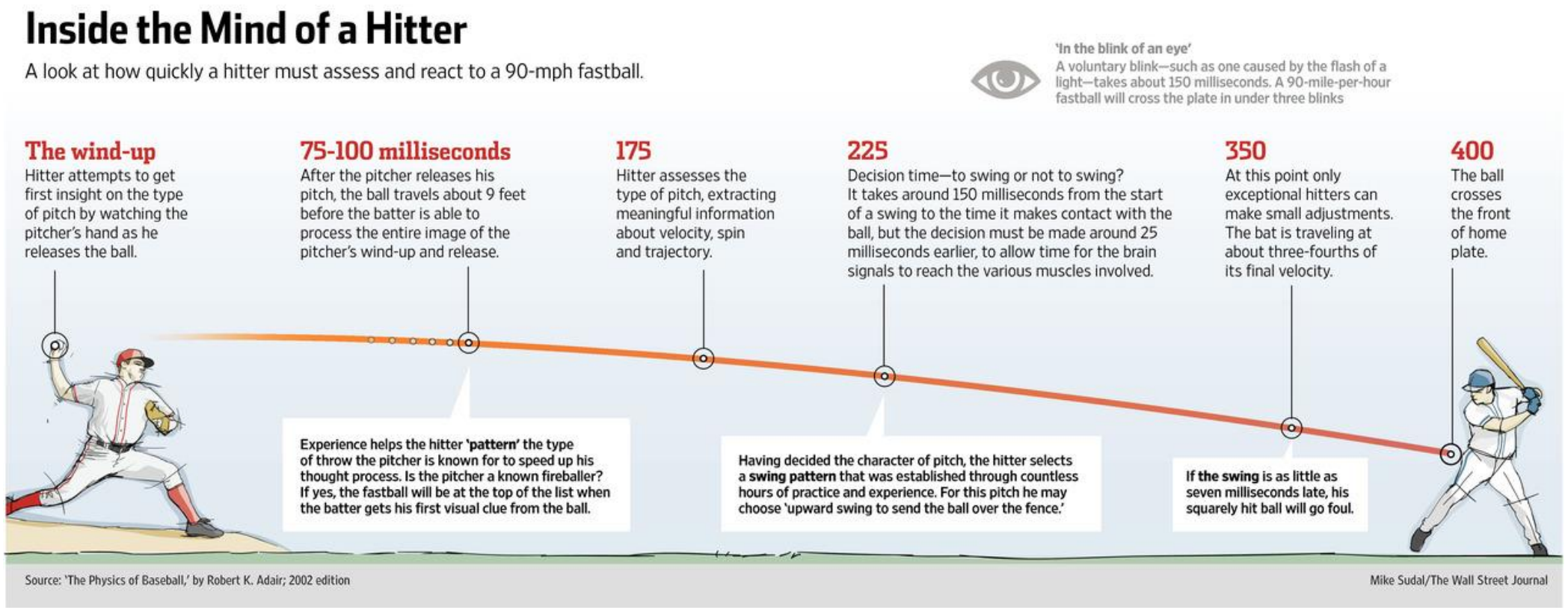
MATTHEW ROE, OD, FAAO

ASSISTANT PROFESSOR | SPORTS VISION, PEDIATRICS, VISION THERAPY

MIDWESTERN UNIVERSITY | ARIZONA COLLEGE OF OPTOMETRY

I have no financial disclosures to report

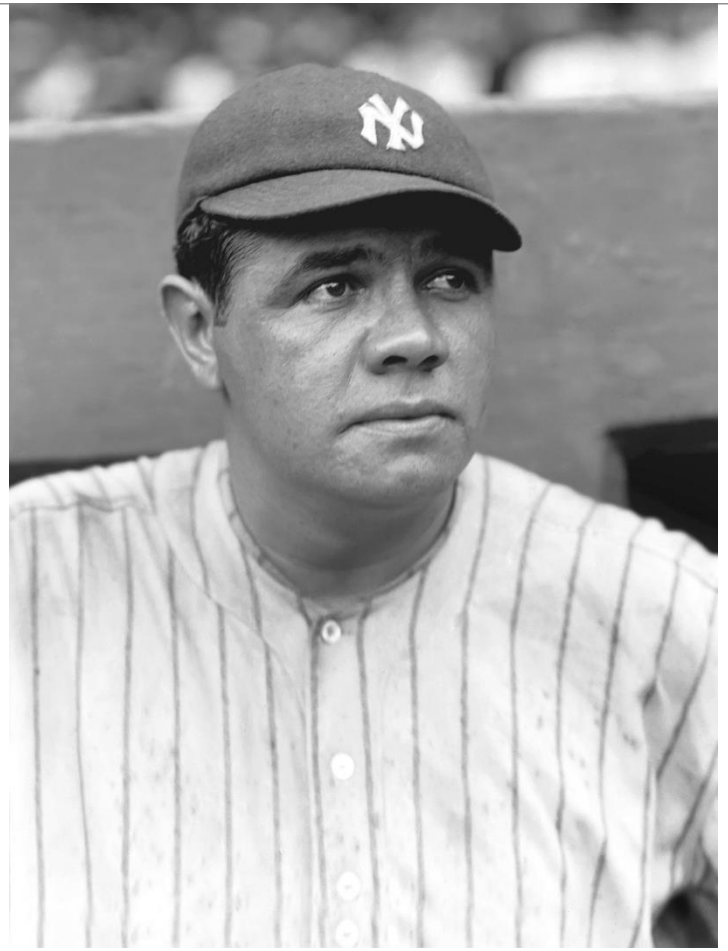
Baseball: 400 milliseconds

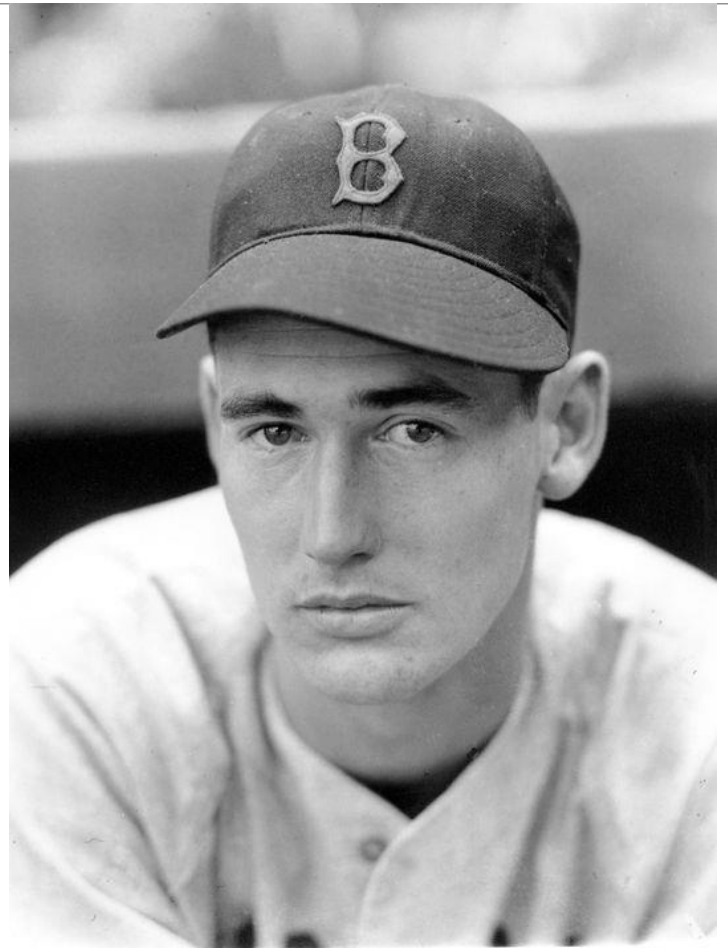


http://www.youthpitching.com/strategy.html

Where We Have Been

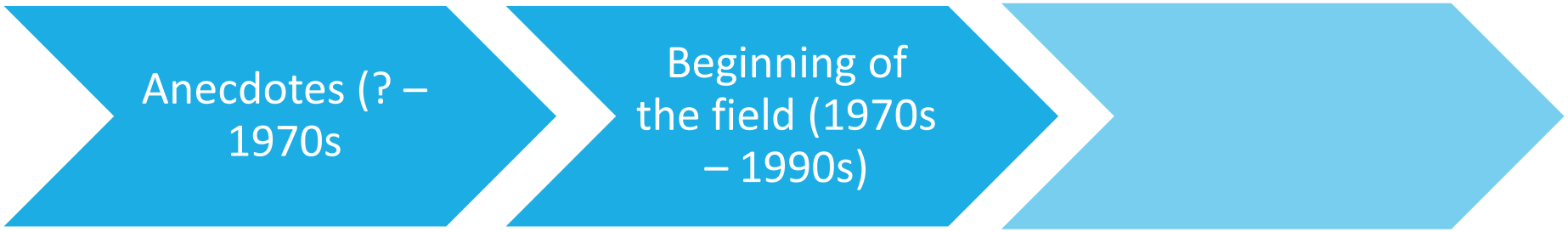
Anecdotal Evidence





“See the ball, hit the ball”

Where We Have Been

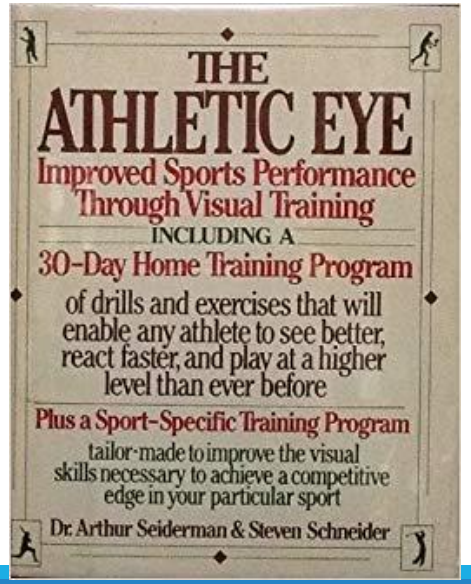


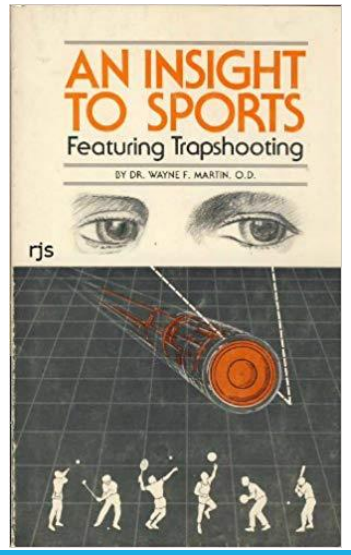
Beginning of the Field

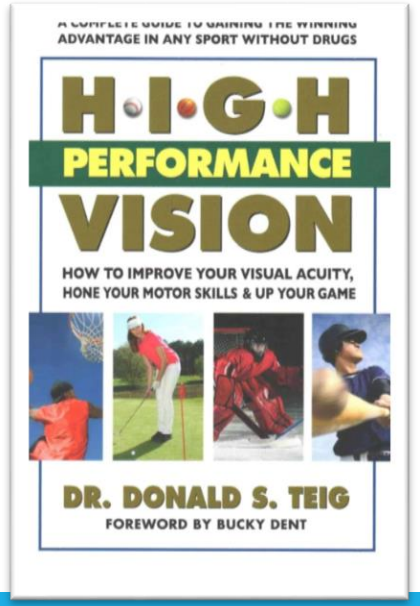
Practices begin to open

- Dr. Arthur Seiderman
- Dr. Donald Teig
- Dr. Harry Wayne

Books begin to be published



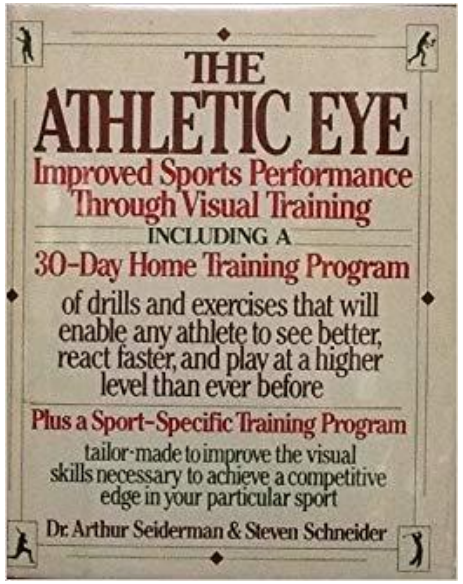




The Athletic Eye (1983)

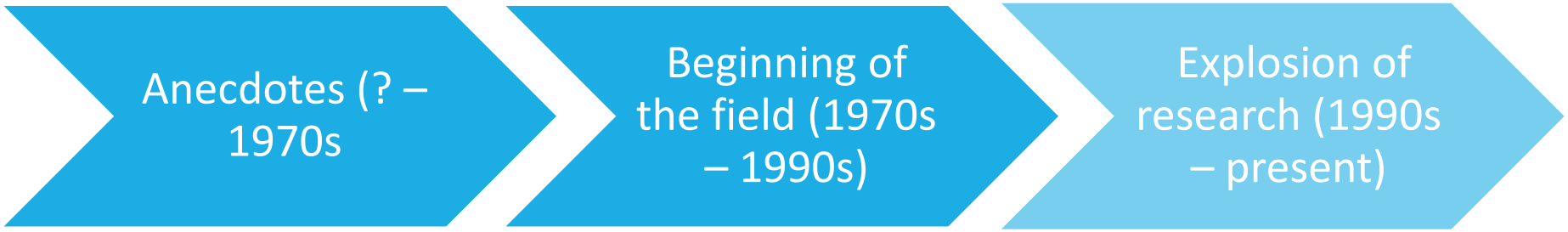
Discussed the following skills:

- Dynamic Visual Acuity
- Eye Tracking
- Eye Teaming
- Depth Perception
- Eye-Hand Coordination (not the other way around!)
- Central-Peripheral Field Awareness
- Visual Reaction Time
- Visualization
- Visual Concentration
- Accommodation, Balance, and Glare Recovery
- Sports Vision and the Young Athlete



Also includes chapters on Sports Psychology and an at home sports vision training program

Where We Have Been



Research

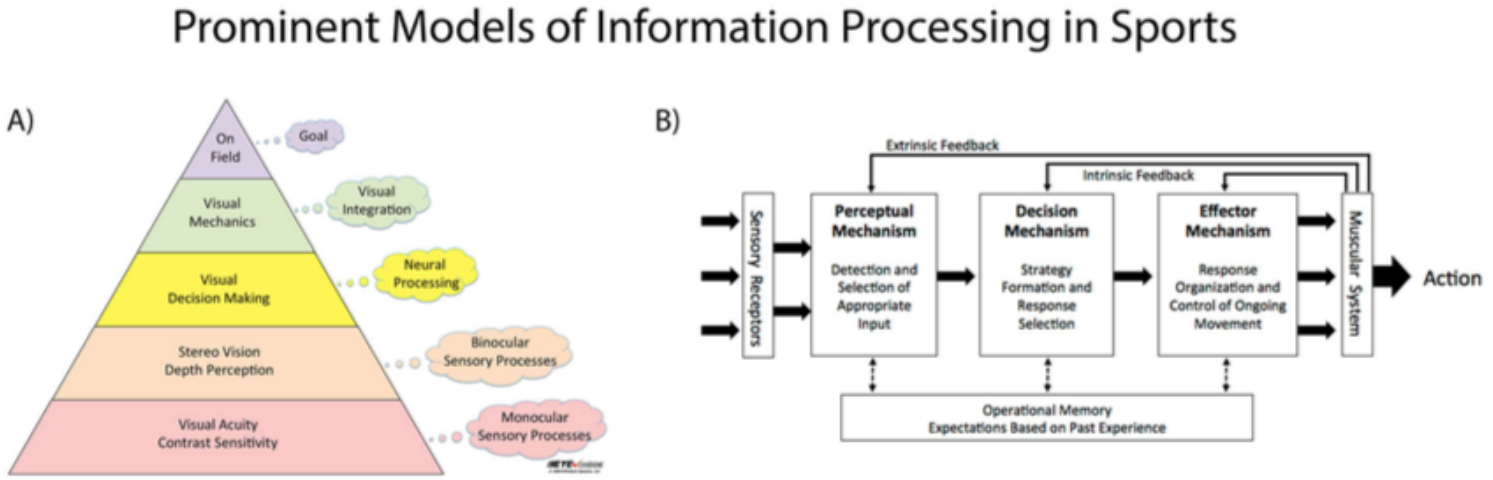


Figure 1. Two prominent models of sports vision and the processes that lead to successful on-field performance. (a) The Sports Vision Pyramid (©EYE Check Systems LLC. Reproduced with permission of Daniel Laby). (b) Modified depiction of the Welford information processing model. To view this figure in color, please visit the online version of this Journal.

Erickson G. Sports vision: vision care for the enhancement of sports performance. St. Louis: Butterworth-Heinemann; 2007.

Industry Involvement

New devices and concepts are rolled out at an incredible pace

Some don’t last very long

Two Philosophies

Common Belief

At the professional level, athletes have extremely similar physical abilities

To stand above the pack, must find unique training

Sports vision fits this missing segment

Maximize Approach

1	**Eye Movement Control**	*The ability to move both eyes together to point at an intended target or follow along a path, like a line of text*
2	**Simultaneous Focus at Far**	*Forming a clear image of something in the distance*
3	**Sustaining Focus at Far**	*Keeping an image of something in the distance clear*
4	**Simultaneous Focus at Near**	*Forming a clear image of something close to the eyes*
5	**Sustaining Focus at Near**	*Keeping a clear image of something close to the eyes*
6	**Simultaneous Alignment at Far**	*Lining up both eyes at the same point the distance*
7	**Sustaining Alignment at Far**	*Holding both eyes lined up at the same point in the distance*
8	**Simultaneous Alignment at Near**	*Lining up both eyes at the same point up close*
9	**Sustaining Alignment at Near**	*Holding both eyes lined up at the same point up close*
10	**Central Vision (Visual Acuity)**	*This is where "20/20" vision comes in!*
11	**Peripheral Vision**	*Being able to see what's on either side of you while your eyes are pointed forward*
12	**Depth Awareness**	*Being able to tell that things are further away or closer up than each other (also know as depth perception)*
13	**Color Perception**	*Being able to tell different colors apart (if you are not color-blind)*
14	**Gross Visual-Motor**	*Moving yourself through space without bumping into things by using information from your vision*
15	**Fine Visual-Motor**	*Writing, sewing, texting, and doing other small and close-up activities with accuracy by using information from your vision*
16	**Visual Perception**	*Being aware of your environment and what is going on around you in your visual field (the area you can see)*
17	**Visual Integration**	*Bringing together your vision and your other senses to accomplish complex tasks, like reading while walking a balance beam*

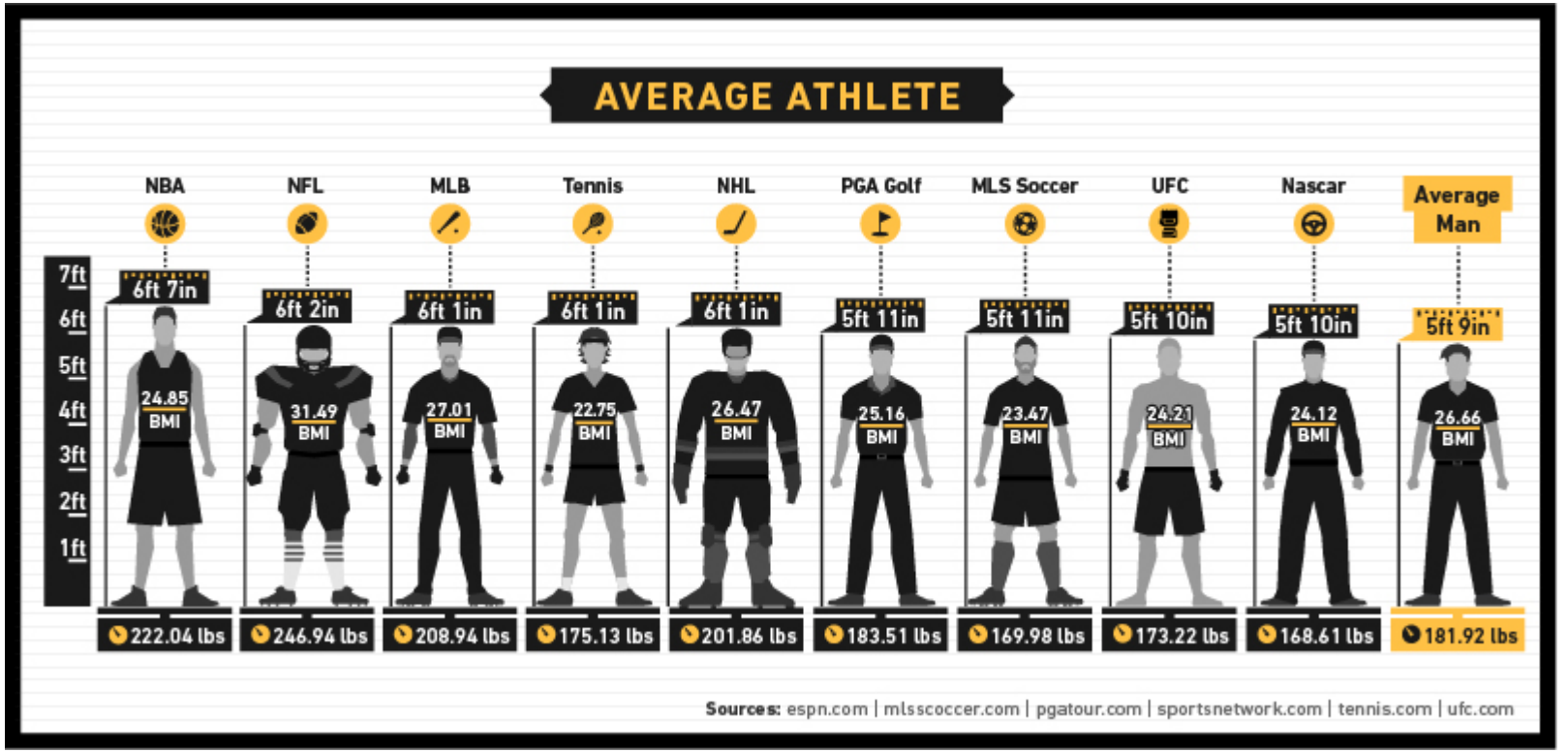
Maximize Approach

1	**Eye Movement Control**	*The ability to move both eyes together to point at an intended target or follow along a path, like a line of text*
2	**Simultaneous Focus at Far**	*Forming a clear image of something in the distance*
3	**Sustaining Focus at Far**	*Keeping an image of something in the distance clear*
4	**Simultaneous Focus at Near**	*Forming a clear image of something close to the eyes*
5	**Sustaining Focus at Near**	*Keeping a clear image of something close to the eyes*
6	**Simultaneous Alignment at Far**	*Lining up both eyes at the same point the distance*
7	**Sustaining Alignment at Far**	*Holding both eyes lined up at the same point in the distance*
8	**Simultaneous Alignment at Near**	*Lining up both eyes at the same point up close*
9	**Sustaining Alignment at Near**	*Holding both eyes lined up at the same point up close*
10	**Central Vision (Visual Acuity)**	*This is where "20/20" vision comes in!*
11	**Peripheral Vision**	*Being able to see what's on either side of you while your eyes are pointed forward*
12	**Depth Awareness**	*Being able to tell that things are further away or closer up than each other (also know as depth perception)*
13	**Color Perception**	*Being able to tell different colors apart (if you are not color-blind)*
14	**Gross Visual-Motor**	*Moving yourself through space without bumping into things by using information from your vision*
15	**Fine Visual-Motor**	*Writing, sewing, texting, and doing other small and close-up activities with accuracy by using information from your vision*
16	**Visual Perception**	*Being aware of your environment and what is going on around you in your visual field (the area you can see)*
17	**Visual Integration**	*Bringing together your vision and your other senses to accomplish complex tasks, like reading while walking a balance beam*

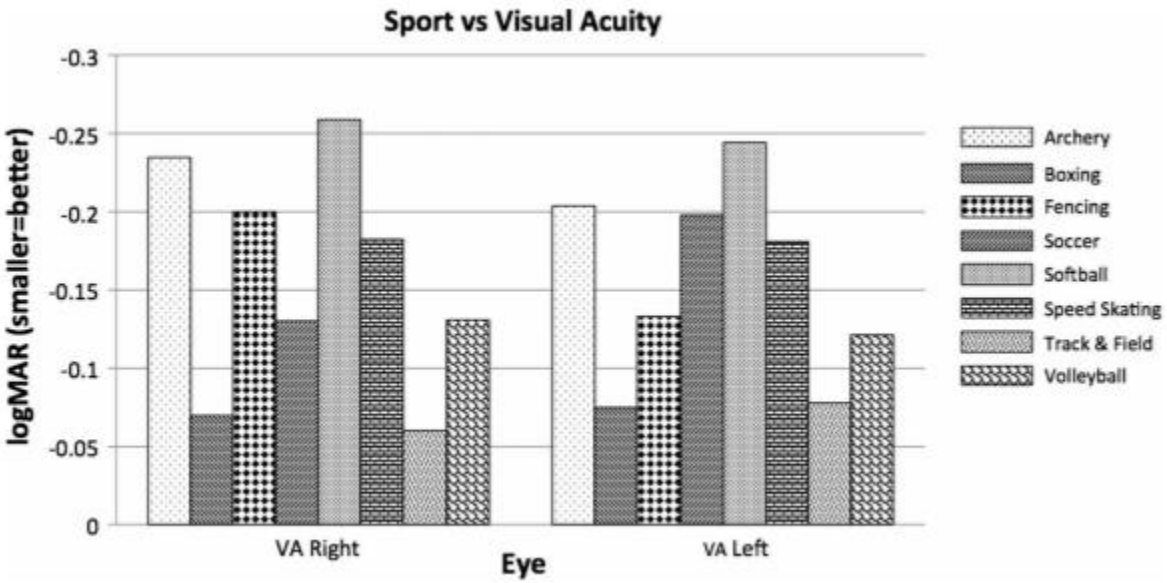
Maximizing each of these visual skills will improve athletic performance

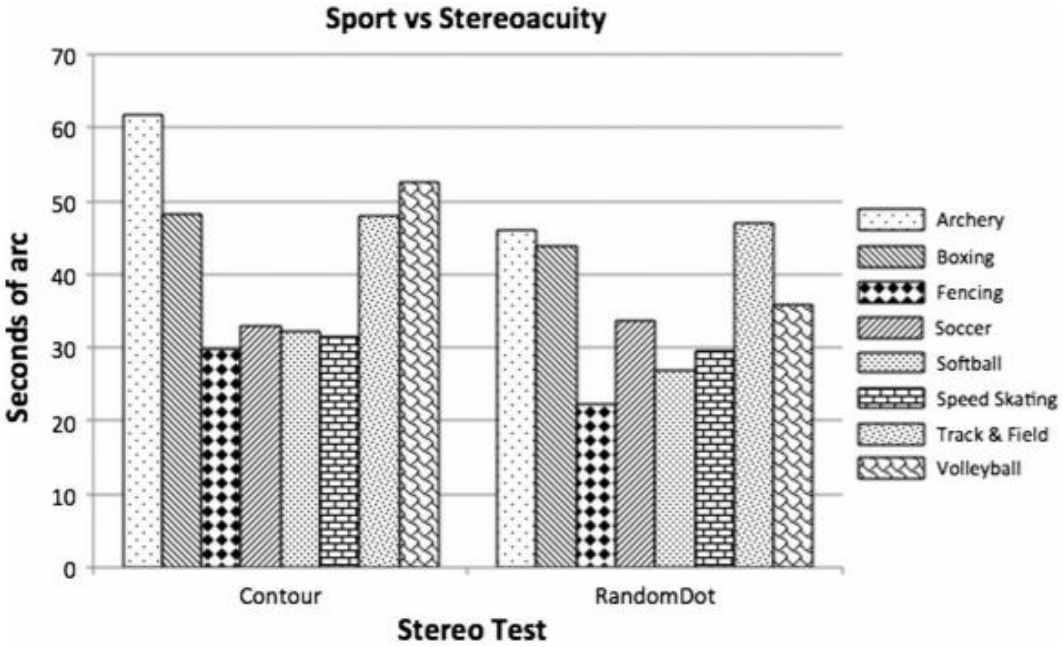
Also include perceptual abilities, such as processing speed

Every Sport Has a Specific Body Type



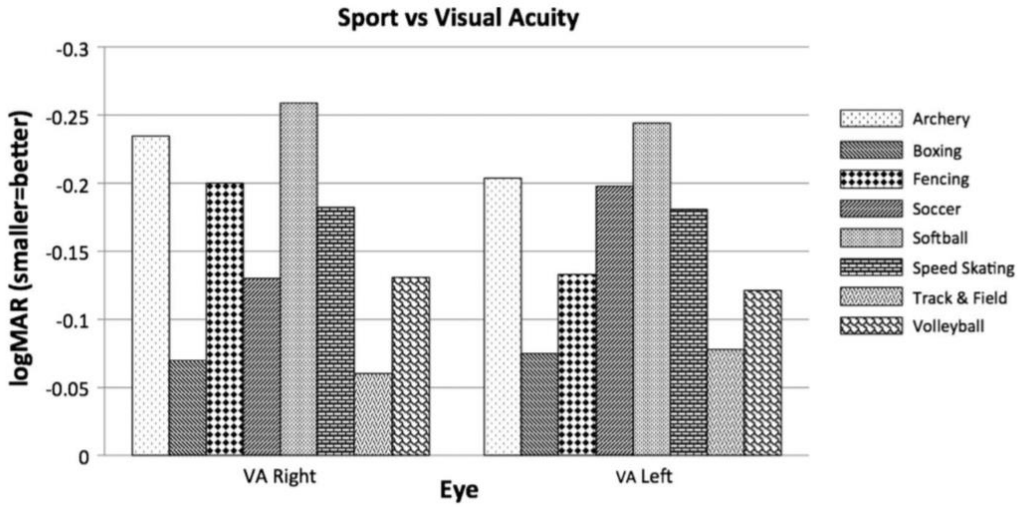
Every Sport Has a Visual Fingerprint





Laby DM, Kirschen DG, Pantall P. The visual function of olympic-level athletes—an initial report. Eye & contact lens. 2011 May 1;37(3):116-22.

Visual Fingerprint (“Optimize”) Approach



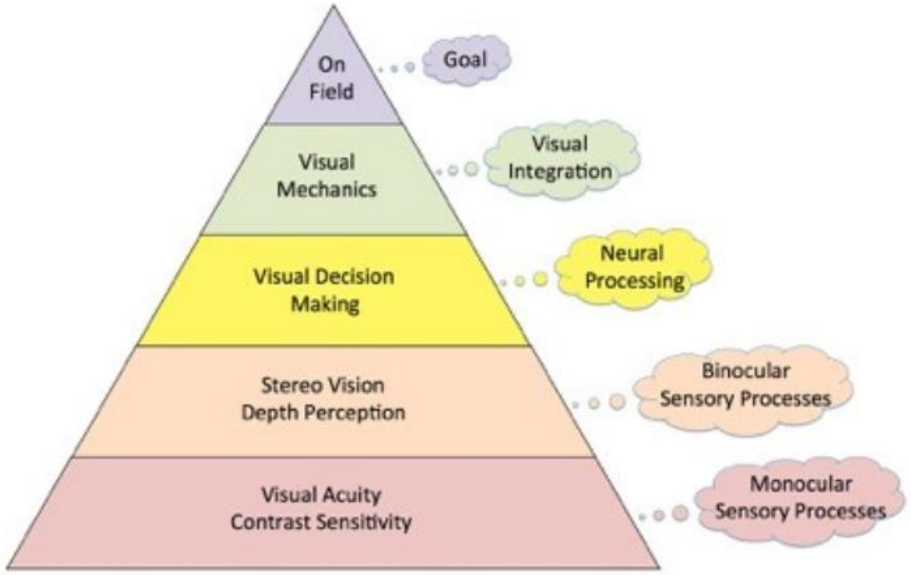
Every sport has a threshold/average level that will determine sports performance

Anything beyond this level may be considered “extraneous”

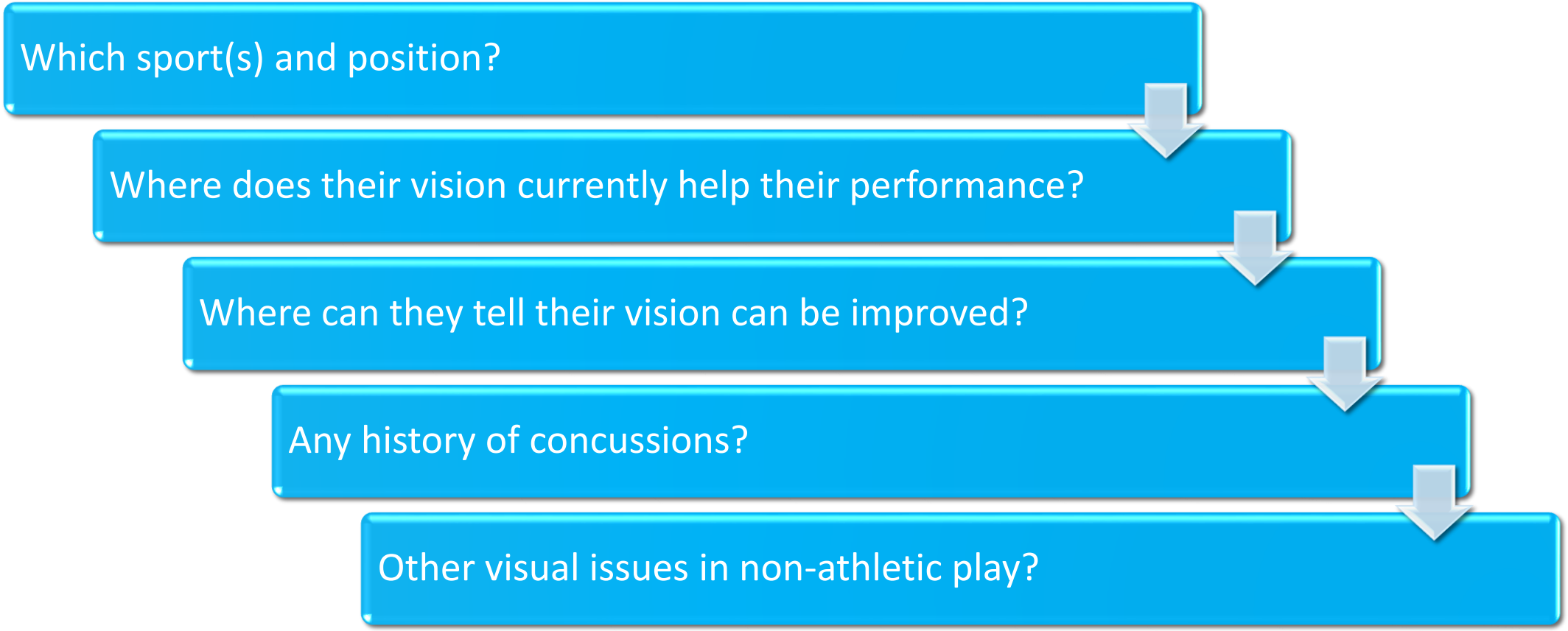
Example: Baseball visual acuity

Evaluating the Athlete

Pyramid of Vision



Athletic Case History – 5 Points



Monocular Sensory Processes - Acuity

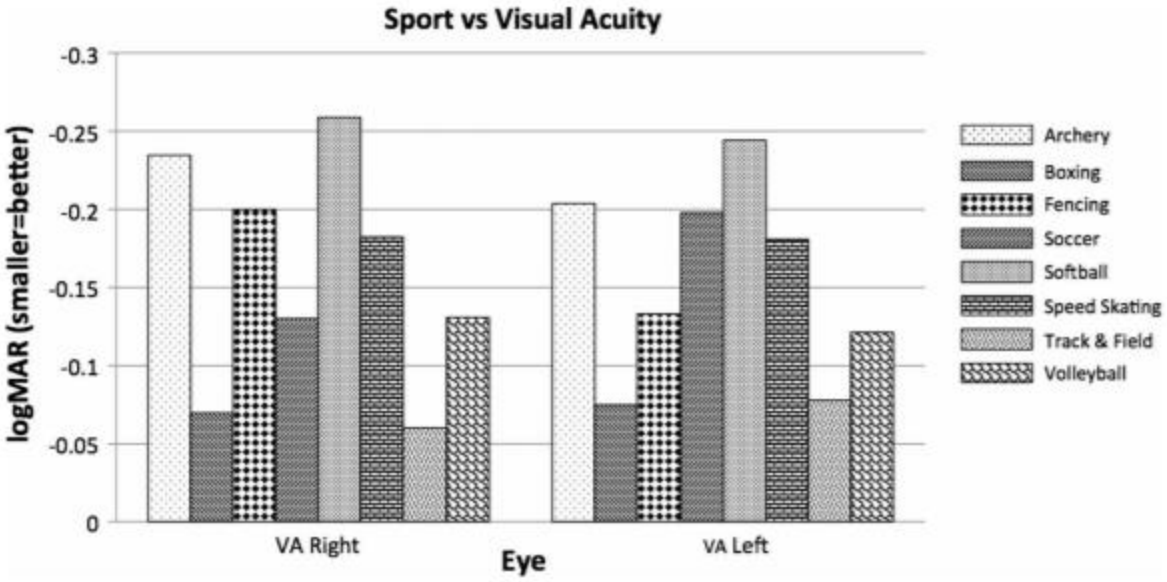
Perform with habitual sports correction

Not every sport requires

- Again, the offensive lineman vs the wide receiver
- The wide receiver vs the baseball batter
- The pitcher vs the batter
- Basketball – free throw shooting worsens from 20/20 → 20/40, remains stable[1]
- We need to think about everything in the context of the athlete and their sport

OD, OS, OU

- Not many sports involve using only one eye
- Maximize if possible



[1]Applegate RA. Set shot shooting performance and visual acuity in basketball. Optometry and vision science: official publication of the American Academy of Optometry. 1992 Oct;69(10):765-8.

Monocular Sensory Processes – Dynamic Acuity

Dynamic visual acuity is intrinsically tied to athletic performance

- Almost all athletes are in constant motion during gameplay
- Baseball – seeing the seams on a pitch
- Soccer – observing the ball rotation for curve

MLB East Coast Pro Showcase 2014

Evaluated the visual system of 150 prospects for MLB east of the Mississippi

Dynamic visual acuity was one of the categories

Evaluated at 20/50 and 20/30

- 20/50 – Ranged between ~55 – 85 rpm
- 20/30 – Ranged between ~25 – 55 rpm

Sherman A, Bovenzi MD, Byne R, Maxon T, Roe M, Tannen N. Sports Vision and Major League Baseball: East Coast Pro Showcase. Vis Dev Rehab. 2016 Oct;2(3):185-189.

Monocular Sensory Processes - Contrast


Budweiser
Twins
BEST BUY
FOX NORTH
usbank
TARGET FIELD
DELTA
usbank


Prudential Center
EXCLUSIVE DEVILS COVERAGE
MSG+
WATCH THE DEVILS ON MSG+
8:24
DEVILS HOCKEY ON MSG+
FOR EXCLUSIVE DEVILS COVERAGE VISIT MSG.COM/DEVILS
MSG.COM/DEVILS
Atlantic
PNC BANK
GEICO
Tim Hortons
WFAN

Refractive Error Solutions – Pros/Cons

Glasses

Contact lenses

LASIK

- Laby – "…professional baseball players should not expect a laser refractive surgical procedure to significantly improve their offensive baseball performance, despite the elimination of glasses or contact lens wear."
- "…a leading expert in contrast sensitivity reports a decrease in contrast sensitivity and visual function after the LASIK procedure"[1]
- Consider glare and halos at night

Ortho-K

[1]Laby DM, Kirschen DG, De Land P. The effect of laser refractive surgery on the on-field performance of professional baseball players. Optometry-Journal of the American Optometric Association. 2005 Nov 1;76(11):647-52.

Binocular Processing - Stereopsis

Stereo should be performed at near or distance depending on the sport

Studies have shown that athletes tend to have more acute depth perception

Near – any stereo book is fine

- East Coast MLB Pro Showcase – testing performed at 80cm in order to achieve 10”

Distance – Howard-Dolman device; Keystone Visual Skills

- Horopter in clinical setting

“There is a statistically significant reduction in 6m stereoacuity when measuring collegiate baseball players in batting stance compared to primary gaze position”[1]

1 - Reichow, G. Yoo, H. Erickson, A. (2010). A Comparison of Stereoacuity at 6m of Collegiate Baseball Players in Primary Gaze and Batting Stance [Abstract]. *Journal of Vision*, 10(7):374, 374a, http://www.journalofvision.org/content/10/7/374, doi:10.1167/10.7.374.

Binocular Processing - Binocularity

NOT included in the sports vision pyramid

Anecdotal, found in publications including “The Athletic Eye” and “Insights into Sports Vision”

Phoric posture of the athlete

- Eso – hypothesized to perceive targets as closer than they are
  - Baseball – swing too early, foul the ball down the same baseline as the hitter
  - Tennis – same as above, launch ball towards opposite side of the body
  - Basketball – hits the front rim on foul shots
- Exo – hypothesized to perceive targets as further than they are
  - Reverse all the above

Neural Processing – Visual Decision Making

The Go/No-Go system of the brain – Do I swing or do I let it go by?

Slower than Eye-Hand Reaction Time due to increased cognitive processing

Baseball players only have ~50-75ms to determine if they want to swing

- Need to analyze all information presented

Sport	Where It's Seen
Baseball/Softball	Swing or let it go by
Tennis	Swing or let it bounce out of bounds
Hockey	Pass or shot on goal
Soccer	Pass, shot on goal, or PK direction

Neural Processing – Visual Decision Making

How to evaluate

- Tachistoscope – measure the ability to take in information presented in a rapid manner
- Vision Coach – Red = right hand, green = left hand
- Sanet Vision Integrator – Go/NoGo
- FitLights – program your own program

The Quiet Eye

The final fixation or tracking gaze that is located on a specific location or object in the visuomotor workspace within 3° of visual angle (or less) for a minimum of 100 ms.

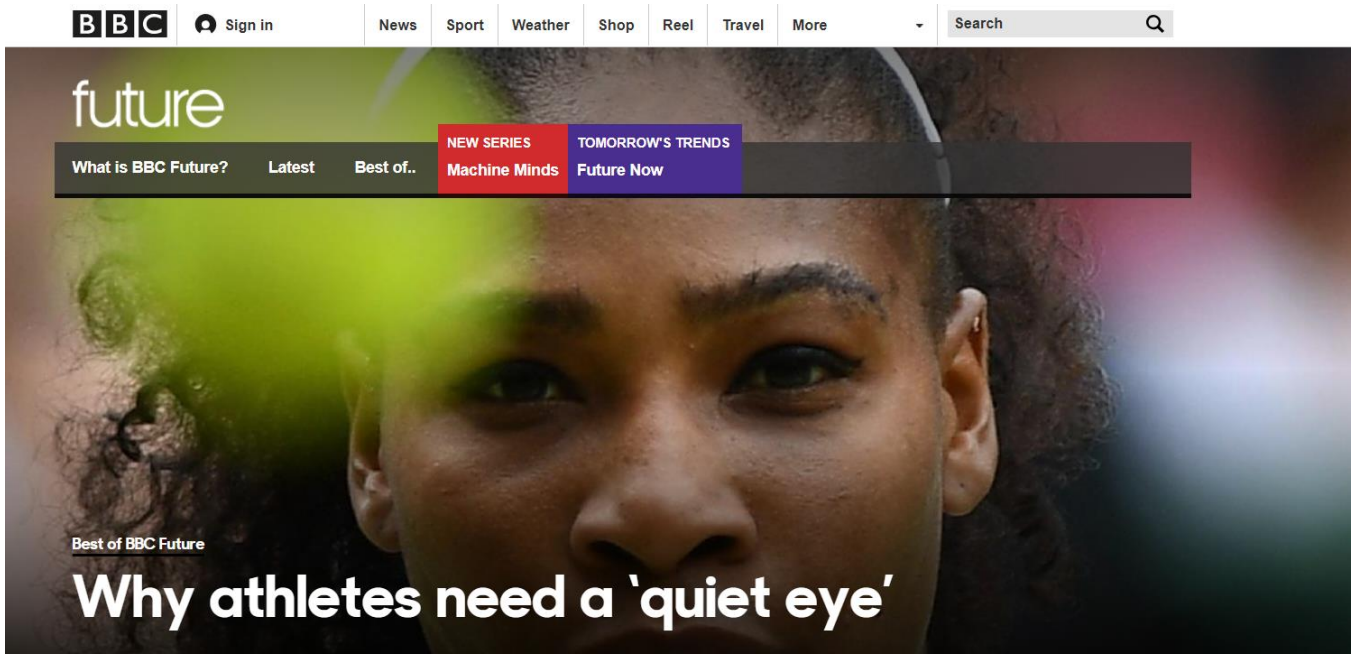
Prevalent in elite athletes

Discriminatory from near-elite athletes

- In practice, no difference
- In performance, significant difference

Fragile system

Vision is the last sense we train and the first sense that fails



The Quiet Eye

Purpose hypothesized by Dr. Harry Wayne

Mechanism first discovered in 1992 – "Gaze Control in Putting"[1]

- "…with the acquisition of the putting skill, there are changes in gaze control, characterized by economy in the number of gaze shifts, the development of priority to specific gaze locations, and economy in the allocation of time between preferred gaze locations."

First named in 1996 – "Visual Control When Aiming at a Far Target"[2]

- "*Quiet eye duration* (ms) was defined as that portion of the final fixation from onset to the first observable movement of the hands into the shooting action (preshot)."

Observed in almost every sport

[1] Vickers JN. Gaze control in putting. Perception. 1992 Feb;21(1):117-32.

[2] Vickers JN. Visual control when aiming at a far target. Journal of Experimental Psychology: Human Perception and Performance. 1996 Apr;22(2):342.

Eye-Body Coordination

The eye leads the body, not the other way around

The evaluation serves as the baseline measurement for which to compare

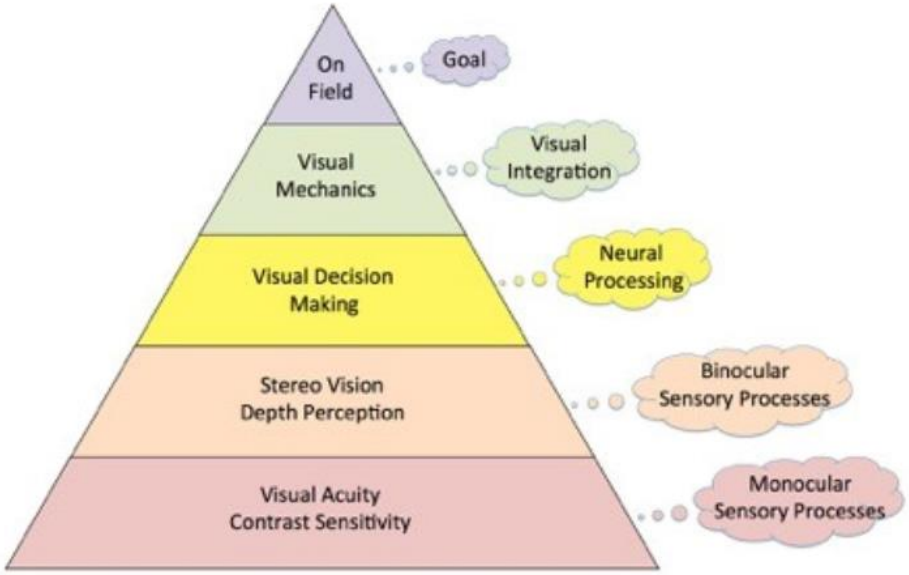
- Need to consider a possible learning curve to a device

Ways to measure:

- FitLights
- Senaptec Sensory Station
- Sports Vision Trainer
- Sanet Vision Integrator
- Binovi

Training the Athlete

Refer Back to the Pyramid of Vision



Maximizing each component should improve performance on the field

The evaluation alone takes care of the first two levels

Training occurs with levels 3 and 4

Understanding the Sport

Over 800 sports officially recognized throughout the world

Need to understand the sport in terms of:

- Success
- Mechanisms
- Rules
- Statistics

Open conversation with athlete

Questionnaire during case history

Determine the Skills to Evaluate/Train

Identify areas where research has shown thresholds are required

Identify areas that can be reasonably improved

- Comparison to metrics obtained through specific devices

Measuring success can be its own challenge

- Subjective vs. objective
- Improvement in certain statistics is dependent on opponent performance and therefore unreliable
- “Under promise, over deliver”

Training the Athlete

Research for sports vision isn't clear on its effect

"…there is limited and mixed support for the notion that traditional analog [Sports Vision Training] drills can improve sports-relevant vision" – Appelbaum and Erickson, 2016[1]

"…fully randomized and controlled experiments has been the exception rather than the rule."

But is it really the profession's fault?

- Professional athletes are an incredibly small percentage of the population
- Difficult to make a database of athletes as well as information is generally hidden among teams
- Difficult to assess the validity of such a database as every position of every sport will likely have different demands

[1] Appelbaum LG, Erickson G. Sports vision training: A review of the state-of-the-art in digital training techniques. International Review of Sport and Exercise Psychology. 2018 Jan 1;11(1):160-89.

Four Pillars

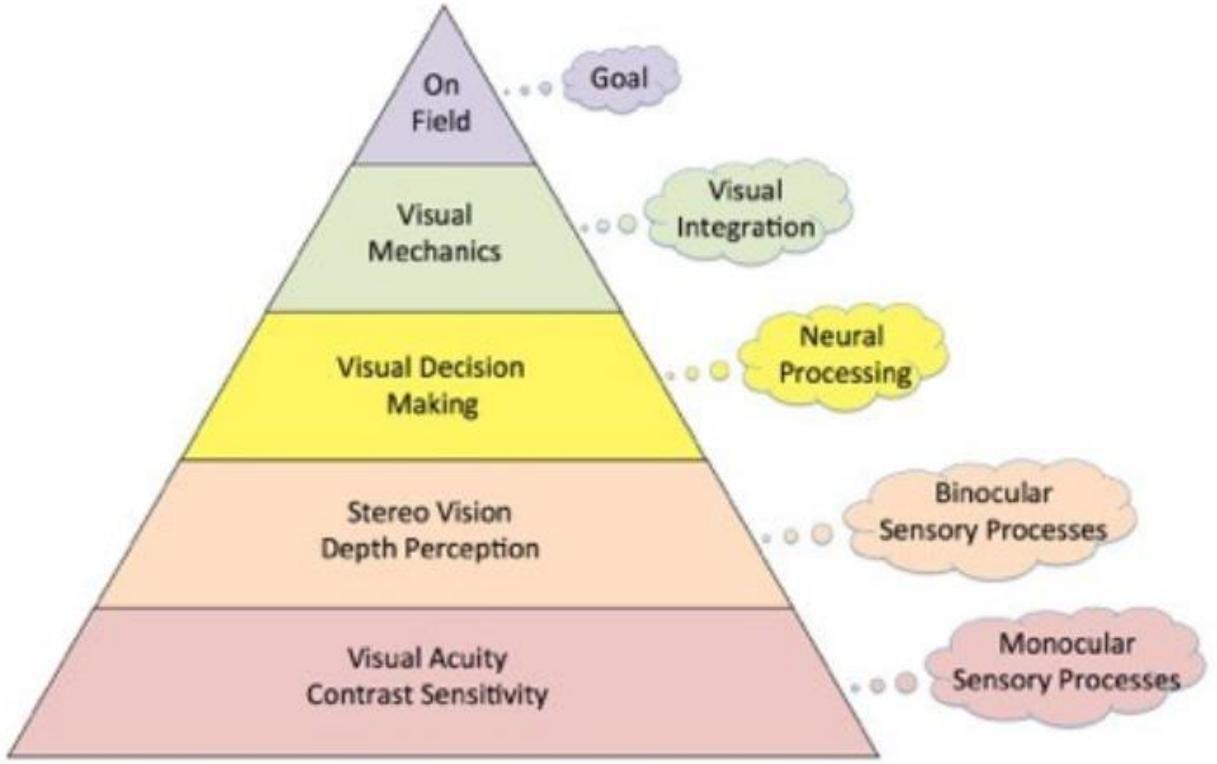
Is there a difference between the visual systems of elite athletes and near-elite or non-athletes?

Does that difference correlate to increased performance?

Can this skill be trained and improved?

Does improving this skill improve the athlete's performance?

Training Levels Three and Four



Processing Speed

Tachistoscope
- PowerPoint
- Sports-related pictures

Computer Perceptual Therapy (CPT)

Sanet Vision Integrator

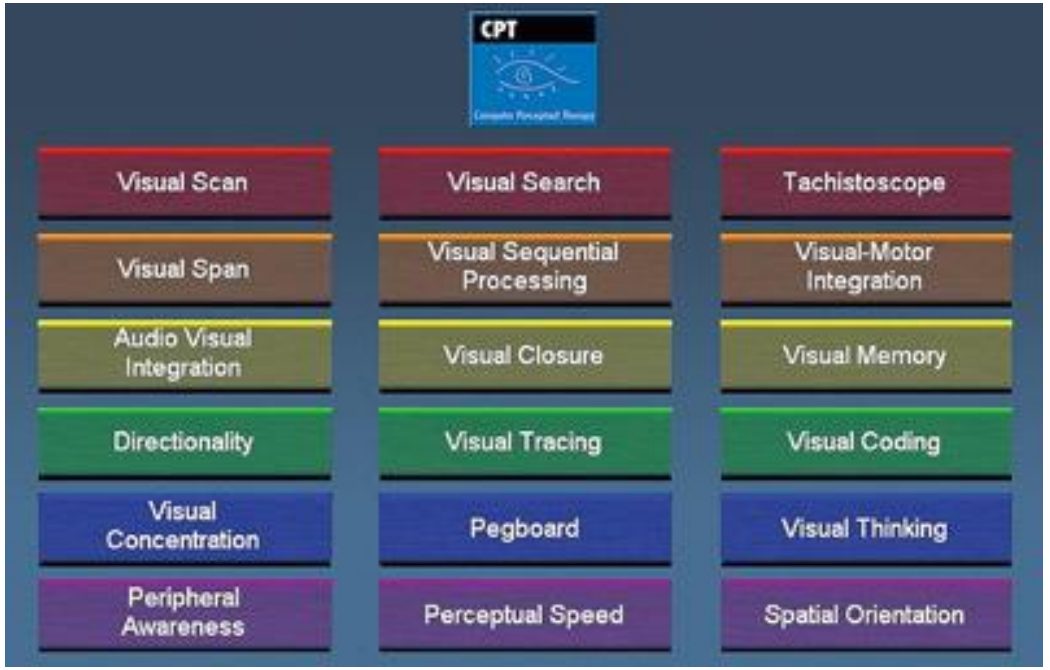
Senaptec Stroboscopic Glasses

Computer Perceptual Therapy (CPT)

Tachistoscope = processing speed

Items that can be changed:

- Number of stimuli
- Type of stimuli
  - Letters (lower/uppercase)
  - Symbols
  - Numbers
- Duration of presentation



Sanet Vision Integrator (SVI)

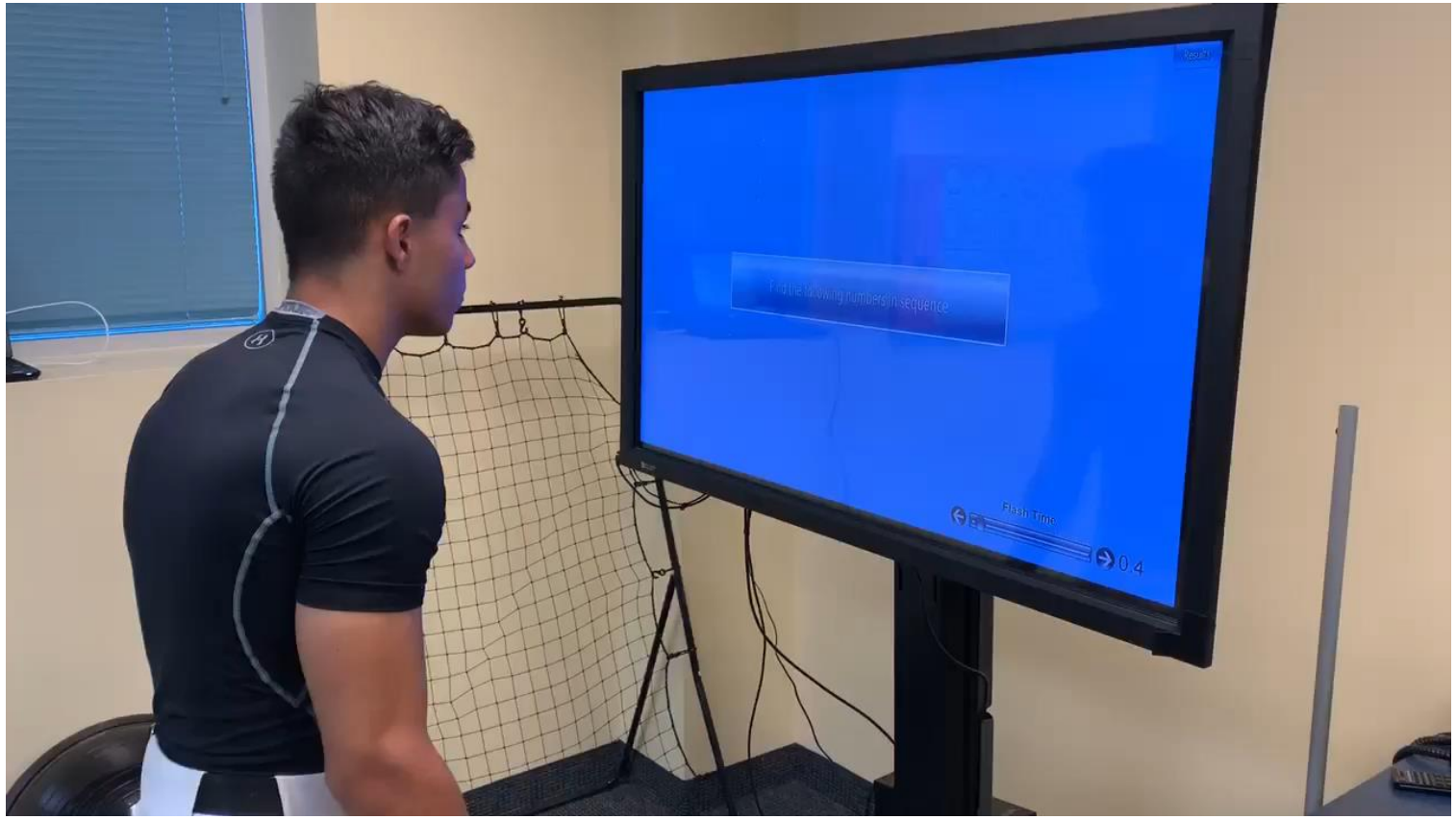
Touch-screen monitor to help train eye-hand, oculomotor, and perceptual activities

Does not require the use of glasses or extra controllers in order to work

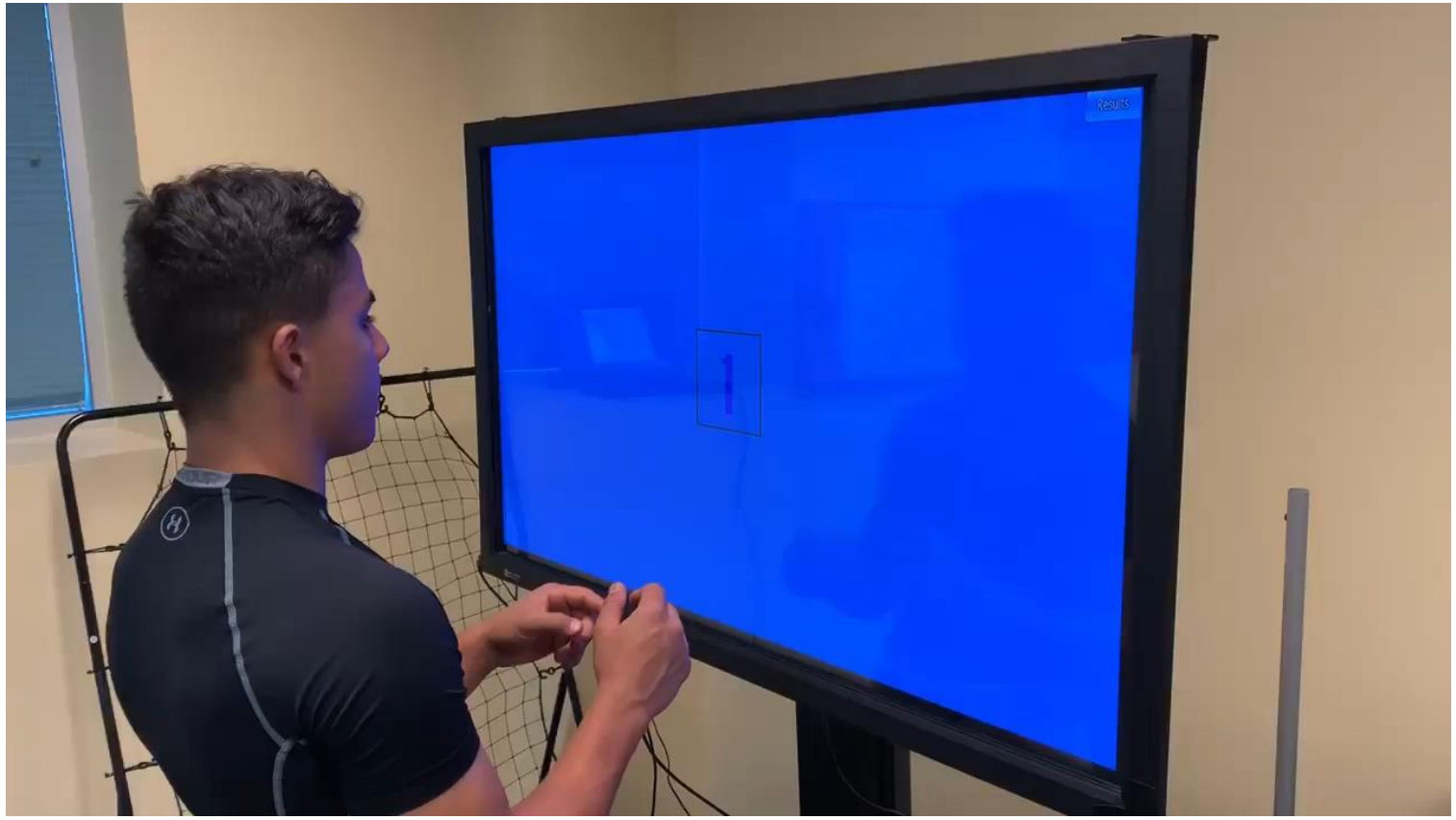
Eye-Hand functions also incorporated into:

- Tachistoscope
- Go/NoGo*

Sanet Vision Integrator - Tach



Sanet Vision Integrator – Go/NoGo



Senaptec Strobe Glasses

Liquid crystal stroboscopic effect that serves as a form of resistance training for an athlete

Multiple settings programmed plus Bluetooth app support to customize your own programs

Can be combined into any of the level 3 and level 4 activities to increase difficulty

Can be used as a visual warm-up for an athlete prior to competitive play

Wilkins L, Appelbaum LG. An early review of stroboscopic visual training: insights, challenges and accomplishments to guide future studies. International Review of Sport and Exercise Psychology. 2019 Mar 1:1-6.

Training the Quiet Eye - Goals

Identify fixation points

- Baseball/Softball – Pick up ball immediately from point of release
- Tennis – cease following the ball in the lob before the serve
- Soccer – improved accuracy by looking directly where the shot should go

Decreasing the time to react

Increasing the difficulty of the task (loading)

Feedback goals:

- Video screen review
- Distinguishing object
- Awareness of a task “Sight…Focus”

Use of sport-related tasks

- Stimuli placed on a ball
- Stimuli placed on a target

Examples taken from: Vickers JN. Perception, cognition, and decision training: The quiet eye in action. Human Kinetics; 2007.

Quiet Eye Tennis Ball Drill – Level 1

Quiet Eye Tennis Ball Drill – Level 2

Quiet Eye Tennis Ball Drill – Level 3

Go/NoGo and Strobes

Research in basketball players found that showing only 350ms of visual information improved performance[1]

Go/NoGo training is about speed of recognition

Stroboscopic glasses limits visual information to provide increased speed of recognition

Combination of activities may result in even quicker performance

[1] de Oliveira RF, Huys R, Oudejans RR, Van De Langenberg R, Beek PJ. Basketball jump shooting is controlled online by vision. Experimental Psychology. 2007 Jan;54(3):180-6.

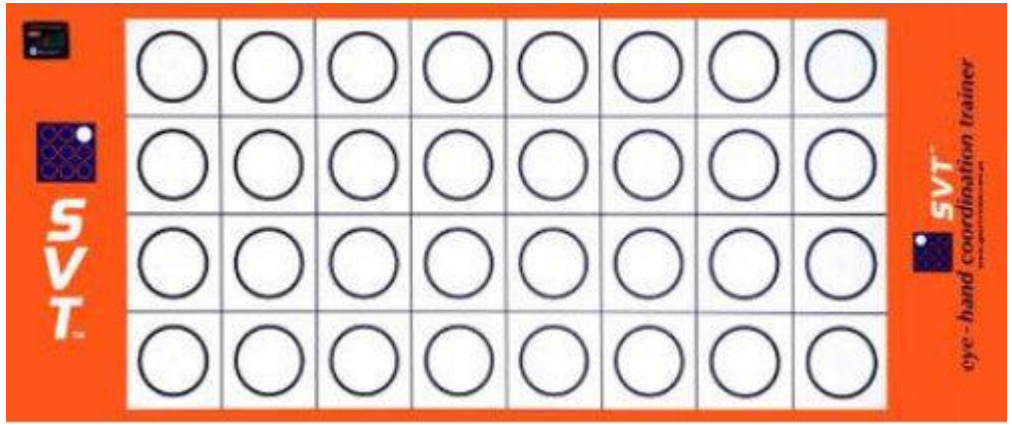
Sports Vision Trainer (SVT)

Power source is the laptop, powered through USB drive

Can create own programs, randomize between programs

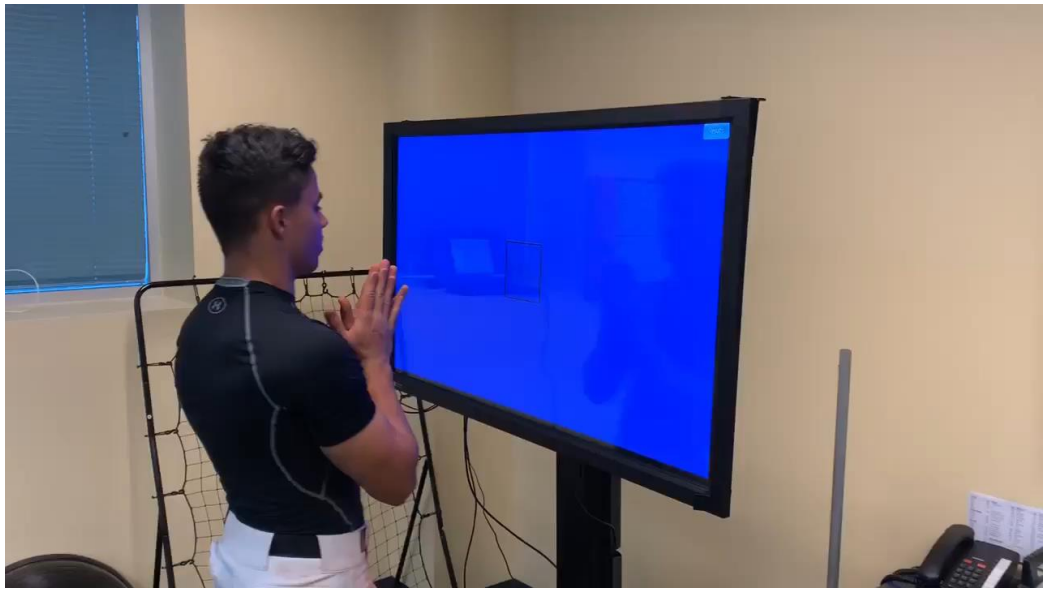
Has its own testing protocol (“Test Bench”) that determines threshold levels

Excellent Go/NoGo option



Comparison

SVI



SVT

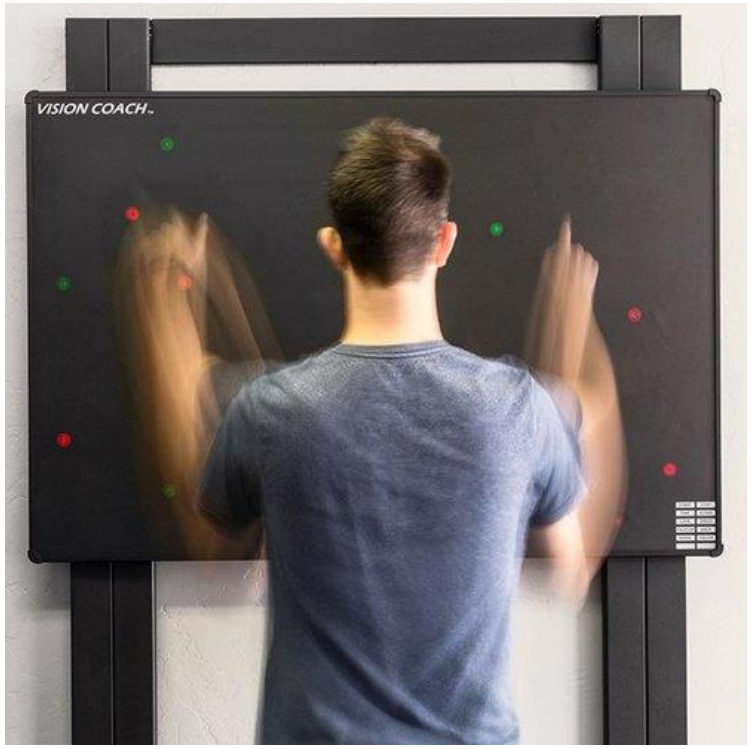
**post-lecture note: SVI can be mounted on the wall in order to limit the impact of the monitor moving

Comparison

PROACTIVE

GO/NOGO (SAME AVERAGE SPEED)

Binovi Touch + Vision Coach



Senaptec Sensory Station

Can be used for evaluation AND training

Athlete's results get automatically uploaded and compared to the norms for their sport, position, and skill level

Good option as a one-stop shop

Need to understand what and why you are training or evaluating a certain skill

FitLights

Extremely mobile and customizable

Can be adapted to almost any sport

Also beneficial for visual endurance exercises

- Including physical endurance

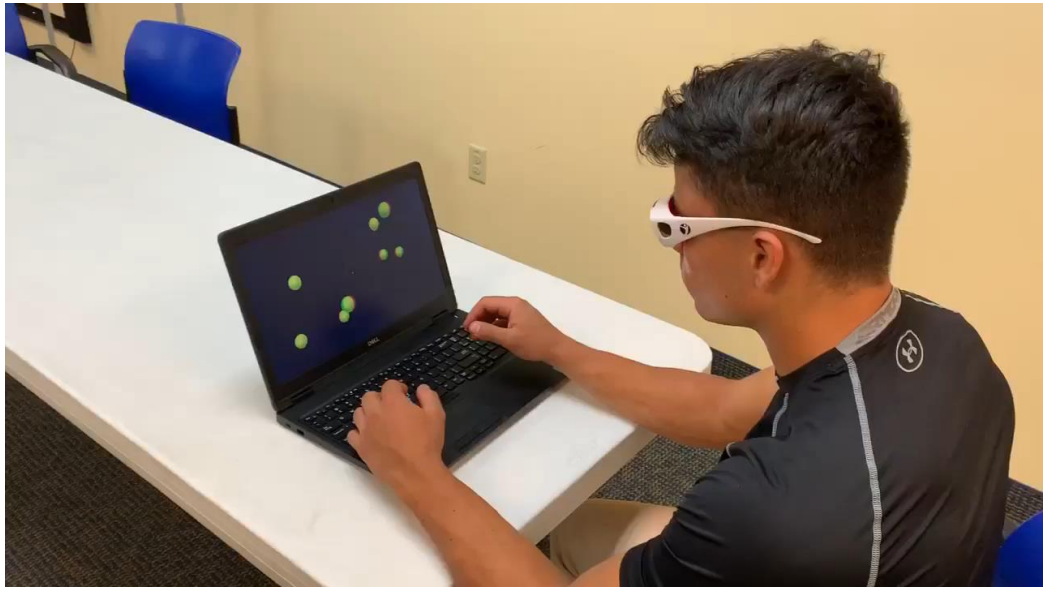
FitLights - Hockey

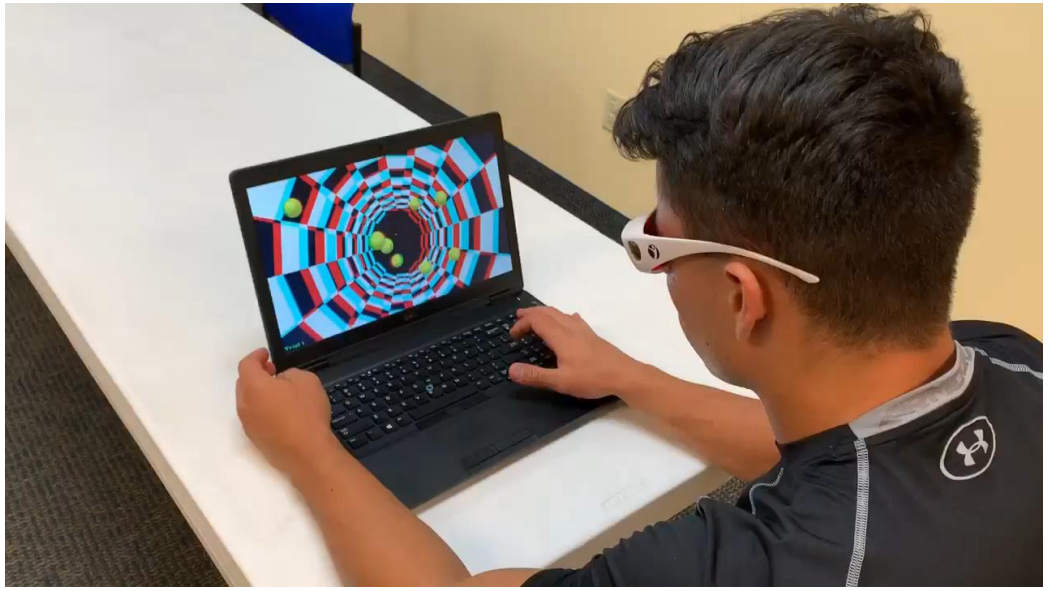
Sports Vision Rings

http://www.hrasportsvision.com/visiondisplay.htm

HecoStix

NeuroTracker





Home “Training” for the Athlete

Develop ways to practice these activities at home

Quiet Eye Drills

Fixation practice

HecoStix

Recommend no phone usage for one hour

Prominent Available Equipment

Levels 1 and 2 – normal examination equipment, plus rotating pegboards

- RightEye
- Senaptec Sensory Station or Sensory Tablet

Level 3 and 4

- CPT
- SVI
- SVT
- VisionCoach
- Wayne Saccadic Fixator/Binovi Touch
- FitLights
- Senaptec Strobe Lights
- Senaptec Sensory Station or Tablet
- Sports Vision Rings/HecoSticks
- NeuroTracker
- Additional equipment for Quiet Eye include: Tennis balls (or volleyballs, basketballs, etc), pitchback

Training the Hockey Player - Sample

12 yo M hockey goalie with difficulty tracking and reacting

Primary activities chosen:

- FitLights – Go/NoGo (training before sport-specific)
- Sports Vision Rings (eye-hand)
- Strobe glasses
- Tachistoscope

12 sessions

Review of Predictive Literature

The Visual Function of Professional Baseball Players

Measured DVA, stereopsis, and contrast sensitivity of MLB athletes between 1992-1995

Over 80% of athletes were able to achieve 20/15 or better

- Number likely higher as athletes were re-refracted after their initial measurements but was not included

Distance stereoacuity was noted as much better compared to the general population

Athletes have increased contrast sensitivity at high spatial frequencies

MLB athletes performed higher as a group as compared to MiLB athletes on almost every visual function conducted

- Limited statistical significance due to small sample size of MLB athletes

Laby DM, Davidson JL, Rosenbaum LI, Strasser C, Mellman MF, Rosenbaum AL, Kirschen DG. The visual function of professional baseball players. American journal of ophthalmology. 1996 Oct 1;122(4):476-85.

The Hand-Eye Coordination of Professional Baseball Players: the Relationship to Batting

450 professional baseball players were measured in their eye-hand coordination speed

The proactive ability was found to be statistically significant ($P<0.0001$) with five plate disciplines:

- Out-of-zone chase percentage
- Fastball chase percentage
- In-zone swing percentage
- In-zone fastball swing percentage
- Bats per base on ball

Players with faster eye-hand reaction time had longer major league careers with a higher level of play

Laby DM, Kirschen DG, Govindarajulu U, DeLand P. The hand-eye coordination of professional baseball players: the relationship to batting. Optometry and Vision Science. 2018 Jul 1;95(7):557-67.

Sensorimotor Abilities Predict On-Field Performance in Professional Baseball

Use of Senaptec Sensory Station to develop a prediction-based method of evaluating baseball performance

252 professional baseball players between 2012-2013

Perception Span (remembering visual patterns) exhibited the strongest relationships

- Associated with increased on-base percentage and reduced strikeout rates

Higher walk rates correlated with Depth Perception, Eye-Hand Coordination, Reaction Times

Increased ability to avoid strikeouts observed with Perception Span, Near-Far Quickness, Target Capture (peripheral recognition), and Contrast Sensitivity

Burris K, Vittetoe K, Ramger B, Suresh S, Tokdar ST, Reiter JP, Appelbaum LG. Sensorimotor abilities predict on-field performance in professional baseball. Scientific reports. 2018 Jan 8;8(1):116.

The role of visual perception measures used in sports vision programmes in predicting actual game performance in Division I collegiate hockey players

Study from University of North Dakota's Men's and Women's hockey teams

Using Nike SPARQ (precursor to Synaptec Sensory Station) on 38 athletes, no control, for one season

Skills on Nike's sensory station with significant correlation with goal percentage:

- Near-far quickness
- Go/NoGo
- Perception span (peripheral awareness/memory)
- Average reaction time

69% of variance in the goals made by forwards in a 2-year period could be predicted by these four skills

Skills unimportant (noted with surprise by author) included DVA and eye-hand coordination

- Found hypothesis from previous research to conclude that higher puck speeds negates the need for DVA to make reliable decision making

Poltavski D, Biberdorf D. The role of visual perception measures used in sports vision programmes in predicting actual game performance in Division I collegiate hockey players. Journal of sports sciences. 2015 Apr 3;33(6):597-608.

Quiet Eye Studies

Sport	Article	Finding
Golf	Vickers JN. Gaze control in putting. Perception. 1992 Feb;21(1):117-32.	Elite golfers spending more time looking at the ball pre- and post-putt
Basketball	Harle SK, Vickers JN. Training quiet eye improves accuracy in the basketball free throw. The Sport Psychologist. 2001 Sep 1;15(3):289-305.	University basketball players who received QE training improved free throw accuracy more than control teams with no QE training
Biathlon	Vickers JN, Williams AM. Performing under pressure: The effects of physiological arousal, cognitive anxiety, and gaze control in biathlon. Journal of motor behavior. 2007 Sep 1;39(5):381-94.	Near-elite and elite athletes showed no difference in QE in practice, but significant differences when under pressure with similar levels of anxiety.
Hockey	Panchuk D, Vickers JN, Hopkins WG. Quiet eye predicts goaltender success in deflected ice hockey shots. European journal of sport science. 2017 Jan 2;17(1):93-9.	University goaltenders with earlier QE onset, longer QE duration, and later QE offset were more likely to save a deflected (aka low-predictability) shot

An Exploratory Study of the Potential Effects of Vision Training on Concussion Incidence in Football

Study explored the use of a sports vision training program initiated in 2010 in the prevention of concussions in football

2006-2009 (pre-study) found 9.2 concussions per 100 player seasons

2010-2013 (study) found 1.4 concussions per 100 player seasons

Similar protocol as used in the University's baseball study

Clark JF, Graman P, Ellis JK, Mangine RE, Rauch JT, Bixenmann B, Hasselfeld KA, Divine JG, Colosimo AJ, Myer GD. An exploratory study of the potential effects of vision training on concussion incidence in football. Optometry and Visual Performance. 2015 Apr;3(1).

An Exploratory Study of the Potential Effects of Vision Training on Concussion Incidence in Football

2.5 weeks prior to start of season, performed ~40 minute sessions 6-7 days per week

- 20 minutes on Dynavision
- 7 minutes tachistoscope
- 7 minutes pitch and catch

Maintenance – In Season

- Dynavision only
- 10 minutes 1x/week at minimum
- Available on free-time if so desired

Besides decreased concussions, additionally found:

- Peripheral reaction times were faster


SENAPTEC

Concussion Statistics

Concussion Statistics

Estimated 1.1-1.9 million recreational concussions and sports related concussions (SRCs) in the US are in athletes 18 and younger

True number is unknown as not everyone seeks out medical providers

- Warrior mentality

Incidence is dependent on sport and sex:

- Men's football
- Girl's soccer
- Men's lacrosse
- Men's ice hockey
- Men's wrestling
- Girl's lacrosse

Concussion Statistics

Men's/Women's	Sport	Concussions per 1000 Aes
Men's	Football	0.54-0.94
	Lacrosse	0.30-0.67
	Ice Hockey	0.54-0.62
	Wrestling	0.17-0.58
Women's	Soccer	0.30-0.73
	Lacrosse	0.20-0.55
	Field Hockey	0.10-0.44
	Basketball	0.16-0.44

Table from: Halstead ME, Walter DK, Moffatt K. Sports-Related Concussion in Children and Adolescents. *Pediatrics*. 2018;142:e20183074.

International Conference on Concussion in Sport

Continued to adapt the Return-to-Play and Return-to-School strategies

Emphasized that sideline assessments are designed for screening, not for diagnosis

All athletes who are considered to have been at-risk for SRC should be removed

- Somatic, cognitive, and/or emotional symptoms
- Physical signs
- Balance impairment
- Behavioural changes
- Cognitive impairment
- Sleep/wake disturbance

No discussions on the role of neuro-optometric rehabilitation

Current Return-to-Play Protocol

Taken from the CDC's Heads Up management for concussions

Only allowed to continue to the next step if no symptoms occur at the current step

If symptoms return, the new activity must be stopped and medical providers contacted once again

1. Back to regular activities (such as school)
2. Light aerobic activity – increase athlete's heart rate, 5-10 minutes of activity
3. Moderate activity – longer/more intense aerobic, beginning weightlifting
4. Heavy, non-contact activity
5. Practice and full contact – no competitive play yet
6. Competition

Current Expected RTP Duration

Different durations based on level of expertise

- Professional: 5-7 days
- Collegiate: 7-10 days
- High school: 30 days

Difference in part due to a decrease in frequency and availability of physician for assessment in non-elite athletes

Reconsidering Return-to-Play Times: A Broader Perspective on Concussion Recovery

Investigation performed at the USAF Academy

Retrospective analysis of all cadets suffering a concussion between 9/2012-11/2015 (n=512)

414 cadet records contained completed return-to-play protocol

Complete recovery took an average of 29.4 days

- Male athletes took 20.47 days, longer than 7-10 day average
- Female athletes suffered greater severity concussions and/or slower recovery trajectories
- Non-elite athletes took on average 34.7 days vs. 25.4 for elite athletes

Challenges current return-to-play protocol lengths to reach full completion

D'Lauro C, Johnson BR, McGinty G, Allred CD, Campbell DE, Jackson JC. Reconsidering return-to-play times: a broader perspective on concussion recovery. Orthopaedic journal of sports medicine. 2018 Mar 9;6(3):2325967118760854.

References

Appelbaum LG, Erickson G. Sports vision training: A review of the state-of-the-art in digital training techniques. International Review of Sport and Exercise Psychology. 2018 Jan 1;11(1):160-89.

Applegate RA. Set shot shooting performance and visual acuity in basketball. Optometry and vision science: official publication of the American Academy of Optometry. 1992 Oct;69(10):765-8.

Burris K, Vittetoe K, Ramger B, Suresh S, Tokdar ST, Reiter JP, Appelbaum LG. Sensorimotor abilities predict on-field performance in professional baseball. Scientific reports. 2018 Jan 8;8(1):116.

Clark JF, Graman P, Ellis JK, Mangine RE, Rauch JT, Bixenmann B, Hasselfeld KA, Divine JG, Colosimo AJ, Myer GD. An exploratory study of the potential effects of vision training on concussion incidence in football. Optometry and Visual Performance. 2015 Apr;3(1).

D'Lauro C, Johnson BR, McGinty G, Allred CD, Campbell DE, Jackson JC. Reconsidering return-to-play times: a broader perspective on concussion recovery. Orthopaedic journal of sports medicine. 2018 Mar 9;6(3):2325967118760854.

Harle SK, Vickers JN. Training quiet eye improves accuracy in the basketball free throw. The Sport Psychologist. 2001 Sep 1;15(3):289-305.

Halstead ME, Walter DK, Moffatt K. Sports-Related Concussion in Children and Adolescents. *Pediatrics*. 2018;142:e20183074.

Laby DM, Davidson JL, Rosenbaum LI, Strasser C, Mellman MF, Rosenbaum AL, Kirschen DG. The visual function of professional baseball players. American journal of ophthalmology. 1996 Oct 1;122(4):476-85.

Laby DM, Kirschen DG, De Land P. The effect of laser refractive surgery on the on-field performance of professional baseball players. Optometry-Journal of the American Optometric Association. 2005 Nov 1;76(11):647-52.

Laby DM, Kirschen DG, Govindarajulu U, DeLand P. The hand-eye coordination of professional baseball players: the relationship to batting. Optometry and Vision Science. 2018 Jul 1;95(7):557-67.

References

Laby DM, Kirschen DG, Pantall P. The visual function of olympic-level athletes—an initial report. Eye & contact lens. 2011 May 1;37(3):116-22.

de Oliveira RF, Huys R, Oudejans RR, Van De Langenberg R, Beek PJ. Basketball jump shooting is controlled online by vision. Experimental Psychology. 2007 Jan;54(3):180-6.

Panchuk D, Vickers JN, Hopkins WG. Quiet eye predicts goaltender success in deflected ice hockey shots. European journal of sport science. 2017 Jan 2;17(1):93-9.

Poltavski D, Biberdorf D. The role of visual perception measures used in sports vision programmes in predicting actual game performance in Division I collegiate hockey players. Journal of sports sciences. 2015 Apr 3;33(6):597-608.

Sherman A, Bovenzi MD, Byne R, Maxon T, Roe M, Tannen N. Sports Vision and Major League Baseball: East Coast Pro Showcase. Vis Dev Rehab. 2016 Oct;2(3):185-189.

Vickers JN. Gaze control in putting. Perception. 1992 Feb;21(1):117-32.

Vickers JN. Visual control when aiming at a far target. Journal of Experimental Psychology: Human Perception and Performance. 1996 Apr;22(2):342.

Vickers JN. Perception, cognition, and decision training: The quiet eye in action. Human Kinetics; 2007.

Vickers JN. Gaze control in putting. Perception. 1992 Feb;21(1):117-32.

Vickers JN, Williams AM. Performing under pressure: The effects of physiological arousal, cognitive anxiety, and gaze control in biathlon. Journal of motor behavior. 2007 Sep 1;39(5):381-94.

Wilkins L, Appelbaum LG. An early review of stroboscopic visual training: insights, challenges and accomplishments to guide future studies. International Review of Sport and Exercise Psychology. 2019 Mar 1:1-6.