Optimal Vision Performance
Enhancing Visual Function from Development to Rehabilitation to High Level Athletic Skill

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Practice Emphasis – Optometric Vision Therapy
Vision Related Learning Disorders, Autism, Stroke/Brain Injury, ADHD, Dyslexia, Athletic Vision Training and Concussion

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Member of the College of Optometrists in Vision Development
D1 University of Iowa Athlete
Lead Athletic Vision Therapist for VisioSport
Some of us just need a little extra help with all the wiring up there!
As a Developmental Optometry Clinic we are trained to assess more than sight, all our doctors screen both Visual Function and Visual Perception in General Eye Examinations.

Visual Efficiency Skills/Functional Vision

*How we gather visual information?*

Visual Perceptual Skills

*How we interpret the visual information that was gathered?*
Vision Therapy Breakdown - Neuroplasticity – Brain re-organization

The three changes to the brain that can help support learning – Lara Boyd (British Colombia)

1. Chemical – Neurons firing, promotes short-term memory

2. Structural – Changes the connections between neurons, takes longer to produce and can lead to integrated networks of brain regions, promotes long-term memory. Can change the structure or enlarge some brain regions. (Example - dominant hand region is larger in the brain.)

3. Functional – Brain regions are activated and more easily excited the more you use it. (Sounds like it promotes something we call automaticity.)
Dyslexia - It’s Personal
We acknowledge the Language Based Nature of the Disorder
Why is Vision not universally accepted as a piece of the puzzle

Major achievement in the scientific study of reading has been to demonstrate the central role of phonemic awareness, or the ability to attend to and manipulate speech sounds (phonemes), in the development of skilled reading (Bradley & Bryant, 1983; Wagner & Torgesen, 1987).
We acknowledge the Language Based Nature of the Disorder
Why is Vision not universally accepted as a piece of the puzzle

Impaired phonemic awareness is the most common precursor to dyslexia, and interventions that target phonemic awareness skills have been shown to be the most effective treatment for the average child with dyslexia. Thus due to the success of these interventions, many scientists have minimized the role of the visual system in reading and the role of visual impairments in dyslexia.

Coupled with the policy statements from the American Medical Association and Organizations in Pediatrics and Pediatric Ophthalmology. Vision gets overlooked and squashed!
Introduce your Patients to Vision, Reading and Learning

The Dyslexic Advantage, The Mislabeled Child
Brock and Fernette Eides
Educates the Reader about the link between vision and reading –

There are so many types and degrees of dyslexia. Family of dyslexia... dysgraphia, dysnomia, dyscalcula.... Huge % of associated deficits in attention, auditory processing, anxiety and behavioral disorders.
Supply the Research


• This paper concludes that the atypical eye movement patterns observed in dyslexic children suggest a deficiency in the visual attentional processing as well as an impairment of the ocular motor saccade and vergence systems interaction.
Research


• These authors concluded that besides documented phoneme processing disorders, visual/ocular motor imperfections may exist in dyslexics that lead to fixation instability and thus, to instability of the letters or words during reading. Such instabilities may perturb fusional processes and might – in part – complicate letter/word identification.
Connect the Science - The Harvard Research

• Margaret Livingstone, et al, from the Department of Neurobiology, Harvard Medical School and the Dyslexia Research Laboratory, Beth Israel Hospital in Boston defined dyslexia as follows:

  • "Developmental dyslexia is the selective impairment of reading skills despite normal intelligence, sensory acuity, and instruction. Several perceptual studies have suggested that dyslexic subjects process visual information more slowly than normal subjects. Visual abnormalities (in functional and associated pathways) were reported to be found in more than 75 percent of the reading - disabled children tested."
More from Harvard....Dyslexia is not only a Language Only Disorder?

- Although dyslexia is a reading disorder, it is **not limited to language**. Recent research has demonstrated the significance of visual information processing in dyslexia. The visual factors associated with dyslexia include spatial perception, timing, and rhythm. These **problems may also be maintained** when catching a ball, maintaining orientation for balance, tying shoelaces, and in tendencies to be accident prone, distractible or absent minded.

Not for all of course........
The teams of researchers at Harvard University and Beth Israel Hospital also reported that information in the two major processing pathways (transient and sustained systems) arrive at the visual brain centers out of sequence. As a result, for most dyslexics, words on a printed page seem to move chaotically and appear as reversals. In essence, this is a visual problem of timing and coordination. Research has shown that transient visual system deficits impact upon reading skills.
Light travels through the eye where it is focused on the retina, and there is converted into analog electrical signals. These signals travel through the brain and arrive at the primary visual cortex in about 100 milliseconds. Although our dyslexia patients have normal vision, they have positive neurological signs and abnormal signals traveling through their brain, which can slow the arrival of the signals from the eye. In a person with dyslexia, signals often take 115 to 140 milliseconds to arrive at the primary visual cortex. This represents a significant delay of fifteen to forty percent, which causes the processing difficulties that people with dyslexia experience.
How we use Visual Evoked Potential - VEP

• Much more than typical neurological investigations........

• Dyslexia – measuring the primary visual pathway in Dyslexics

• Amblyopia- tool for monitoring the need for continued tx

• Autism – evidence for yoked prism
Explaining this to patients
The teams of researchers at Harvard University and Beth Israel Hospital also reported that information in the two major processing pathways (transient and sustained systems) arrive at the visual brain centers out of sequence. As a result, for most dyslexics, words on a printed page seem to move chaotically and appear as reversals. In essence, this is a visual problem of timing and coordination. Research has shown that transient visual system deficits impact upon reading skills.
High Contrast Vs Low Contrast Latency Ms
Objective Measurement of the Primary Visual Pathway in Dyslexia: Visual Evoked Potential

Subtle asymmetries in latency (speed) can be measured with the V.E.P.
MP1, 2, 3 Tints

Pech Optical

Contact Lenses

Yoked Prism

Other common tints used in TBI
Objective Measurement of the Primary Visual Pathway in Dyslexia: Visual Evoke Potential

Subtle asymmetries can sometimes be corrected with tinted lenses.
PRACTICE MANAGEMENT PEARL:
Dyslexia Cases – Abby and Ava
19 year old female -- Dyslexic

“The MP1 tints calm everything on the page down for me. It makes it easier for me to concentrate during tests and helps me to stay focused while studying. The MP1 lenses actually make me want to study now because it allows me do so in a more focused and relaxed way.”

Abby (age 19)
Vision Therapy Exercise Examples

A. Dyslexia
   a. Laterality/directionality

   In a research study involving school-aged children, the ones that had ambiguous handedness and could not define left from right showed inferior outcomes in literacy and numeracy tests when compared with children of defined hand preference. According to Siviero and Capellini and Souza, children with dyslexia often present cross-dominance. *The settlement and self-awareness of laterality are paramount for the development of spatial orientation and relation, interfering directly on school learning.*

Hart Chart Variations: Reading Eye Patterns
Visualization

Creating visual memory and thinking by storytelling

Spelling in multi-sensory/visual way
Can you make a movie in your head? Stop during the story and have child close eyes. Ask them to describe details about what they “see” in their mind. Then ask them to draw the image they “see” in their mind.
Visualization

Spelling in multi-sensory/visual way

1. Use simple spelling words.
2. Each letter gets a different color.
3. Turn your eyes into a camera and take a picture of the word with your eyes and brain.
4. Close your eyes and describe the letters—what color is the 1st letter, second etc.?
5. Trace the word in the air and tell me what color the letter is that you are tracing.
6. Write the word back out on a blank piece of paper. Does it match?
7. Spell the word out loud now. If it is hard, close your eyes and “see” the colors of the letters.
8. Re-enforce at home with shaving cream, salt or by tracing the word on your leg.
Deficits in visual function are far more prevalent in school-aged children with DD....

- July 19, 2018

**Frequency of Visual Deficits in Children With Developmental Dyslexia**

- Aparna Raghuram, OD, PhD\(^1,2\); Sowjanya Gowrisankaran, PhD\(^1\); Emily Swanson, BS\(^1\); et al; David Zurakowski, MS, PhD\(^3,4,5\); David G. Hunter, MD, PhD\(^1,2\); Deborah P. Waber, PhD\(^6,7\)


**Key Points**

- **Question** Are deficits in visual function more frequent in children with developmental dyslexia than in typically developing readers?

- **Findings** In this cohort study, school-aged children with developmental dyslexia exhibited more deficits in visual function—vergence, accommodation, and/or ocular motor tracking—than did a nonrandomized control group of typically developing children.

- **Meaning** These findings suggest that visual function deficits contribute to reading acquisition in children with developmental dyslexia.

**Abstract**

**Importance** Developmental dyslexia (DD) is a specific learning disability of neurobiological origin whose core cognitive deficit is widely believed to involve language (phonological) processing. Although reading is also a visual task, the potential role of vision in DD has been controversial, and little is known about the integrity of visual function in individuals with DD.

**Objective** To assess the frequency of visual deficits (specifically vergence, accommodation, and ocular motor tracking) in children with DD compared with a control group of typically developing readers.

**Design, Setting, and Participants** A prospective, uncontrolled observational study was conducted from May 28 to October 17, 2016, in an outpatient ophthalmology ambulatory clinic among 29 children with DD and 33 typically developing (TD) children.

**Main Outcomes and Measures** Primary outcomes were frequencies of deficits in vergence (amplitude, fusional ranges, and facility), accommodation (amplitude, facility, and accuracy), and ocular motor tracking (Developmental Eye Movement test and Visagraph eye tracker).

**Results** Among the children with DD (10 girls and 19 boys; mean [SD] age, 10.3 [1.2] years) and the TD group (21 girls and 12 boys; mean [SD] age, 9.4 [1.4] years), accommodation deficits were more frequent in the DD group than the TD group (16 [55%] vs 3 [9%]; difference = 46%; 95% CI, 25%-67%; *P* < .001). For ocular motor tracking, 18 children in the DD group (62%) had scores in the impaired range (in the Developmental Eye Movement test, Visagraph, or both) vs 5 children in the TD group (15%) (difference, 47%; 95% CI, 25%-69%; *P* < .001). Vergence deficits occurred in 10 children in the DD group (34%) and 5 children in the TD group (15%) (difference, 19%; 95% CI, –2.2% to 41%; *P* = .08). In all, 23 children in the DD group (79%) and 11 children in the TD group (33%) had deficits in 1 or more domain of visual function (difference, 46%; 95% CI, 23%-69%; *P* < .001).

**Conclusions and Relevance** These findings suggest that deficits in visual function are far more prevalent in school-aged children with DD than in TD readers, but the possible cause and clinical relevance of these deficits are uncertain. Further study is needed to determine the extent to which treating these deficits can improve visual symptoms and/or reading parameters.
High Functioning Autism - Yoked Prism

Subtle Asymmetries can also be balanced by using yoked prism
Two Main Higher Level Visual Pathways: *Ambient and Focal*

- These pathways carry visual information through the brain, and are parallel processing pathways.
- They process different types of visual information, but must work together for optimal visual performance.
Binocularity (Eye Teaming)

• Children with autism exhibit a lack of organization at a higher visual cortical level between their ambient and focal visual processing, therefore inhibiting eye teaming developments.

• These systems must coordinate for one to have the perception of “normal depth perception.”
Observations are helpful in coming up with the best plan.

- Where and on what does the autistic individual look and fixate and for what length of time?
- How flexible and accurate is the individual’s fixation ability in moving from one target to another, and accommodation ability in focusing on different objects at different distances?
- What is the quality of binocular vision and depth perception?
- How does this seeing contribute to his or her autistic functions and behaviors?
Yoked Prism Case – 2 Base Down
Bilateral Integration--Early education
The Three Basic Bilateral Movements

Symmetrical Movements
Symmetrical movements have each leg or hand doing the same action at the same time, for example, rolling out pastry with a rolling pin, pushing a toy stroller cart, or clapping hands.

It is important that both sides of the body do the same movement at the same time, with an equal amount of force.

Watch out for: child using one hand to do something that needs two hands, or having one hand doing more of the work, resulting in a lopsided movement. In gross motor activities, watch out for one leg doing a better job or jumping/leaping etc. than the other.

Alternating Movements
Alternating movements are actions where first one hand or leg and then the other carries out the same movement in a rhythmic way. Examples would be pulling a rope hand-over-hand or pedaling a bike.

Watch out for: movements which are jerky and don’t flow well, or when one hand or leg does more work than the other, resulting in lopsided action.

Leading and Supporting
We often use one hand to play a supporting role while the other hand does more skilled work, such as cutting with scissors, threading beads or drawing a line with a ruler.

Both hands are equally important, but one is specializing in tool use, and the other is specializing in assisting. Both hands need to work together smoothly in a coordinated way to ensure the task is completed well.

Watch out for: awkward positioning, where the supporting hand does not help the leading hand properly. During scissor cutting activities, check that the supporting hand is holding and moving the paper in such a way that the cutting hand can easily keep the scissors on the line. In some cases, the child may avoid using the supporting hand altogether.
Tracking
Simplify when necessary

ADHD/AD/Spectrum

Peripheral Awareness Games
Vestibular stimulation, fixation, and eye Tracking activities
Floor maze for laterality and directionality
Ambient pathway stimulation tools
Strabismic Amblyopia Case

• Significance of VEP
• Early home intervention activities
  • I-pad applications
• Use of lenses
• Dedication of the Family – Regular follow up
• Use of lenses
  • Monocular Bifocal
• How Amazing the Outcomes can become
I Pad Activities
More with Vision and Learning

We are always making connections to vision, as it is often assumed.
More Typical Visual Dysfunction Patterns
With the therapist/test administrator

- Greeting
- Explanation of Day/Tests
- Why parents don’t sit in the room
  - Need to make parents feel comfortable with process
- Staff and Practice
PRACTICE MANAGEMENT PEARL:
Pre-Education prior to testing

Setting up the atmosphere from the beginning

PAVE VIDEO
HANDOUTS
SME, VEP, FVF, VEP testing
Video of Maria setting up the testing
We have to demonstrate the evidence...although it is unfair, we have to do it better than other professions. Try to align the science when able.
Speak the Language of Research


This paper demonstrated that improving vergence and accommodation even the absence of ocular motility therapy results in improved reading speed and eye movements as seen on objective computerized tools for monitoring eye movement changes.
Testing Smooth Pursuits: NSUCO Oculomotor Test

• Shows you the norms for different ages/genders.
  • Pursuits: 2 full rotations in each direction
  • Saccades: 10 horizontal saccades/fixations
  • <20cm diameter total, centered on midline

• There is a PDF available online, just search for “NSUCO Oculomotor Test.”
DEM

Age 11-- 5th Grade

Test taken on same day

Patient went from the 10-15 %
to 70-75% after using MP2 tints
during testing.

Test with no tints
Vertical 43 sec  Horizontal 52 sec

Re-tested while wearing MP2 tints
Vertical 36 sec  Horizontal 38 sec
(14 seconds faster)
Camryn’s Case - Complex

- ADHD (inattentive type)
- Auditory Processing Disorder
- Dyslexia
- Failed VEP without the tints
Early Intervention Vision Therapy

How do we approach working with infants and young children in vision therapy?
Early Intervention – Early Inspiration

Rethy – “Vision moves from motor to sensory”

Sutton – “Movement is learning”

Streff – “Vision is Motor”
Early Intervention – Fixation and Pursuit Eye Movements Examples

• Flashlight games (tag, racetrack, drawing on wall, tracing objects)
• Hanging/Swinging ball (side to side, around the world)
• Rotating pegboard
• Marble Roll (or with balls, cars, trains, etc)
• Cup Shuffle (toy hidden under one of two or more cups, keep their eye on the one with the toy)
Early Intervention – Bilateral Integration, Midline Crossing, VMI, Primitive Reflexes, & Gross Motor

• Any age-appropriate bilateral integration, midline, gross motor activity is beneficial and supportive to development of the visual and binocular system.
  • Ask about how long patient crawled before walking.
• Tummy time is particularly important for cases of esotropia, even for those walking well.
• Activities of daily life often allow for the presentation of objects encouraging reach and grab across midline (food, toys, paci, etc).
Bilateral Integration--Early education
The Three Basic Bilateral Movements

Symmetrical Movements
Symmetrical movements have each leg or hand doing the same action at the same time, for example rolling out pastry with a rolling pin, pushing a toy shopping cart, or clapping hands.

It is important that both sides of the body do the same movement at the same time, with an equal amount of force.

Watch out for: child using one hand to do something that needs two hands, or having one hand doing more of the work, resulting in a lop-sided movement. In gross motor activities, watch out for one leg doing a better job or jumping/skipping etc than the other.

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Watch out for: awkward positioning, where the supporting hand does not help the leading hand properly. During scissor cutting activities, check that the supporting hand is holding and moving the paper in such a way that the cutting hand can easily keep the scissors on the line. In some cases, the child may avoid using the supporting hand altogether!
Bilateral Integration
Early education activities

- Cross Crawl
- Body Lifts and Angels in the snow
- Chalkboard Circles / Figure 8’s
- Ball Bouncing with both hands
- Bean Bag Toss / Basketball
- Jumping Jacks
- Skipping
- Cross body march

- Arm Circles
- Exploring Balance
- Balance board on hands and knees
- Infinity Walk
- Perler beads
- Swimming Lessons
- Marble Roll
- Catching Bubbles
- Simon Says
Early Intervention – Vestibular

- Any vestibular stimulation is good for binocular development, however ROTATIONAL is best for ESOTROPIA and LINEAR is best for EXOTROPIA.
  - More intense response with chin tilted down about 30 degrees
  - Most cases of early strabismus will be ESOTropia (rotational).
  - Maximize effectiveness by following with a basic tracking activity.
Early Intervention – Vestibular

• Rotational activities we suggest:
  • Log rolling
  • Spinning (Astro board, office chair/stool, sit-n-spin)
  • Twisting (Twisting tree activity)
  • Merry-go-rounds, carousels
  • Dance ribbons and spinning
  • Blanket burrito roll up
Early Intervention – Vestibular

• Linear movement activities we encourage:
  • Rocking (chair, horse)
  • Swinging (swing, hammock, blanket)
  • Bouncing (jumpers, trampoline, swiss/thera-ball)
  • Skipping

• Other vestibular ideas:
  • Bosu, balance board, baby wearing, swimming, hanging upside down, dancing, bilibo toy, wagon rides, walking rail, infinity walk, etc.
Early Intervention – Vestibular

• Which way to spin?
  • Eyes open: (Dominant eye patched)
    • Right Esotrope – spin counter-clockwise
    • Left Esotrope – spin clockwise
    • Follow with a tracking activity
  • Both eyes closed:
    • Right Esotrope – spin clockwise
    • Left Esotrope – spin counterclockwise
    • Follow with a tracking activity.
• Or just complete the entire Astronaut Training Sequence. There’s *almost* no such thing as bad vestibular stimulation for strabismus.
Early Intervention – Ambient

• Remind Parent’s - What is the Ambient System?
  • Ambient is the sub-system that integrates visual information with all of our other senses and systems. It is learned, and is also responsible for our peripheral vision and our normal perception of 3D vision.

• Activities:
  • Peripheral awareness (scarves, finger puppets from behind)
  • Proprioceptive (pulling, pushing, climbing, squeezing, pinching, sucking/blowing, heavy work)
PRACTICE MANAGEMENT PEARL:
SPORTS VISION AWARENESS CREATES GENERAL VISION THERAPY AWARENESS

In-Office Sports Vision
Screening
Packages vs Global Fee
Athletic Vision Training

Remember we are not there to coach the athlete about their sport.

Our job is to improve their visual potential for that sport.

Coach Testimonial

“Sports vision is an untapped area for improvement and I believe this is the start of something big. The Strobe glasses drove me to Dr. Heying but I believe the other drills are probably more important than the glasses. The most critical factor in improved sports vision is working with an expert and getting, then using empirical data to outline a plan for vision strengthening.”

Desi Druschel
Pitching Coach, University of Iowa Baseball
Improved visual cognition through stroboscopic training

L. Gregory Appelbaum,1,2 Julia E. Schroeder,1,2 Matthew S. Cain,1,2 and Stephen R. Mitroff1,2

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The Effect of Visual and Sensory Performance on Head Impact Biomechanics in College Football Players

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(Received 30 April 2013, accepted 24 July 2013)
A Portable and Motivating Program for Athletes, Integrated with Experts and Analytics, and Efficiently designed to maximize the Time spent training. Measure Outcomes and Minimize Cost!
Visual Skills Important in Sports that can be assessed, analyzed, corrected and trained! Let us help your Athlete reach their visual potential!

- Eye-Hand Coordination
- Peripheral Awareness
- Speed of Focus
- Visual Clarity
- Depth Perception
- Spatial Localization
- Eye Movement Tracking
- Contrast Sensitivity
SENSORY PERFORMANCE REPORT

SPORT & POSITION
SOFTBALL (FAST PITCH) PITCHER

CURRENT LEVEL
0

COMPARED TO
SOFTBALL (FAST PITCH) PITCHER

STRENGTHS
NEAR FAR QUICKNESS
MULTI-OBJECT TRACK
REACTION TIME

OPPORTUNITIES
CONTRAST SENSITIVITY
DEPTH PERCEPTION
PERCEPTION SPAN

IMPROVEMENT PLAN
FOCUS & TRAINING
LIGHTBOARD
STROBE TRAINING

FIRST EVALUATION
09/28/2016 • 08:43 PM

SECOND EVALUATION
09/12/2017 • 01:13 PM

AREA OF INCREASE

PERCENTILE

SCORE
48
Athletic Vision Training

Off the field benefits

Regardless of the sport or position played, the benefits of AVT training do not stop at the locker room. Many of the techniques, methodologies and modalities become portable to other aspects of life, notably in the classroom. Student-athletes are, first and foremost, students.
Setting up stations

**Station: Tracking**

- Marsden ball
- Eye Movement Control
- Baseball Saccades
- Hart Chart with a Twist
Station: Periphery

- Peripheral Awareness Chart
- Hart Chart with a Twist – with Strobes
- Baseball Saccades
- Marsden ball for Periphery
- Strobes - Balance
Station : Focus

- Binocular Lens Flippers
- Near Far Quickness
- Monocular Minus Lens Dip
- Baseball Saccades with Flippers
Station: Binocularity

Divergence
- Brock String for Divergence
- Large Eccentric Circles
- Lifesaver Card – Divergence
- Small Eccentric Circles for Divergence

Convergence
- Brock String One Bead Basic
- Brock String – 3 bead jump
- Small Eccentric Circles for Convergence
- Lifesaver Card – Convergence

Vergence Flexibility
- Eccentric Circles – Alternate Large to Small, at Small alternate
- Converge/Diverge
- Brock String – 3 bead jump, then add flipper and alternate for each jump
- Lifesaver Card – Front to Behind
Station : Senaptec Sensory Station

On Eye Hand Coordination and Near Far Quickness, they will increase the level of demand based on the preset settings.
Station: Strobes

- Any Strobe activity that is position necessary and challenging for the players.
Football Vision Training

**Quarterbacks:**
- More efficient scanning of the field
- Quicker defensive reads
- Improved pass timing and accuracy
- Cleaner hand-offs
- Improved consistency in the passing game
- Increased field of view and awareness

**Kicker/Punter:**
- Improved handling of snaps
- More accurate judgment of goal posts
- Improved kicking accuracy
- Improved kicking distance through more consistent contact (eye-foot coordination)

**Linemen:**
- React to snap quicker
- Read plays quickly and more accurately

**Receivers:**
- More consistent catching
- Improved perception of location of ball in space
- Improved awareness of defensive players in relation to self

**Running Backs:**
- Quicker recognition of gaps in the line
- Quicker determination of cutbacks and angles on sweeps
Working with Helmets on

Can the player cross midline easily with helmets on?

Does it impact their peripheral awareness?
Fit Lights Before and After Prism Work
Visual skills influence overall court awareness and specifically depth perception, eye tracking, focusing flexibility, eye alignment, and visual memory are all used for free throw shooting, jump shots, set shots, passing, and judgment of distances between yourself, the basket, and other players.

- Improved consistency in performance
- Improved hand-eye coordination
- Improved performance under pressure
- Improved coordination and balance
- Quicker reaction time and timing for block shots, steal passes, and rebounds
- Enhanced court awareness of teammates and opponents
- Increased overall court and situational awareness with a widened field of view
- Improved concentration
- Improved overall decision-making
- Improved shooting accuracy through better judgement of basket depth and angle of approach
Create your own drills

- Red = in and out + behind the back.
- Yellow = in and out + between the legs.
- Green = in and out + crossover.
Tennis player that needs improvement in tracking during movement.

Working fixation, tracking, and saccades customized to athlete

Arrow chart saccades with sport specific movement
Tennis player that needs improvement in fixation and tracking during movement.

Laser pointer by ear must stay on a specific target

Dynamic Movement

Loads:

Periphery
Complex Questions
Changing Targets
The Effect of Visual and Sensory Performance on Head Impact Bio mechanics in College Football Players

Jared A. Hespander, Jason F. Michael, Andy C. Loane, Robert J. Frank, and Kevin M. Guskiewicz

Abstract—The development of prevention strategies is crucial to the ongoing reduction of sports-related concussions. Visual and sensory performance may influence an individual's risk to suffer concussive or subthreshold impacts. The purpose of this study was to determine the relationships among measures of visual, spatial, and auditory acuity; the association between visual and sensory performance and head impact exposure; and whether these factors are related to any other factors that may contribute to head injury. The study included 34 college football players from one university, divided into three groups based on head impact exposure. A battery of vision and auditory tests was administered to all players. The results showed that players who experienced higher head impact exposure had lower visual and auditory acuity scores. This finding suggests a potential relationship between visual and auditory acuity and head impact exposure.

INTRODUCTION

Concussion has been defined as a complex physiologic event characterized by conditions affecting the brain, induced by traumatic biomechanical forces that typically result in an impairment of cognitive function and behavioral symptoms. Concussion-related issues have become a major public health concern, with approximately 1.7 million sports-related traumatic brain injuries occurring in the United States each year. The majority of these injuries occur in moderate to high-impact contact sports such as football, which is one of the most growing sports among high school and college-related activities.

Several mechanisms of action for concussions include both direct and indirect factors. A review of the literature on the prevention of concussions revealed that visual and auditory acuity can influence the risk of head impact exposure. This finding is supported by the study of athletes who showed a significant correlation between visual and auditory acuity and head impact exposure.

Keywords—Concussion, Football, Injury prevention, Neuroscience, Visual, Auditory, Vision.

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Published online: 6 August 2013

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Practice Management Pearl:  
The Significance of Convergence Insufficiency

Conclusion: In-office Vision Therapy is by far the most effective treatment for this condition.


Scheiman, et al. (CITT2) “Randomized Clinical Trial of Treatments for Symptomatic Convergence Insufficiency in Children.” Archives of Ophthalmology 2008; 126(10):1336-1349
Does it affect Learning?
PRACTICE MANAGEMENT PEARL:
Supply referrals Convergence screening tools:
Convergence Screening Procedures -- PLRG

5-Step Screening for Convergence Insufficiency

1. Place red/green glasses on patient
2. Instruct patient to watch light and state when they see a green light and a red light (x3)
3. On the third trial, record the distance where the patient reports two lights
4. If the patient reports two lights closer in than 4 inches (10 cm), the patient passes the screening.
5. If the patient reports two lights further out than 4 inches (10 cm), have the patient complete the Convergence Insufficiency Symptom Checklist (other side).
6. The doctor will review the data with the patient.

www.aoa.org/documents/PLRG-CICard.pdf
Convergence Screening Procedures – CISS (symptoms checklist)
Convergence Screening Procedures -- PLRG

Penlight Red/Green (PLRG) Procedure
For Screening of Convergence Insufficiency

Convergence Insufficiency is a condition in which a patient finds it difficult to maintain alignment of the eyes on a near object, inability to sustain convergence may cause a person to focus with just one eye at a time, or to see double.

The PLRG procedure is a near point of convergence test with good sensitivity that is relatively easy to perform in a short period of time. With the room illumination dimmed, the patient is asked to put on the red/green glasses. If the patient typically wears glasses for near, the red/green glasses are placed over the patient’s eyewear.

The penlight is presented directly in front of the patient at a distance of 24 inches. The penlight is held along the midline and slightly below eye level. Ask the patient “How Many Lights Do You See?” If the patient has normal convergence to their distance, the expected response is “2.” Tell the patient that you are going to slowly move the penlight toward their nose and ask them to report if they ever see two lights instead of one. At some point, while you are slowly moving the penlight toward, the patient should report seeing two colored lights, one red and one green. This is the convergence break point. The penlight is then moved slowly away from the nose until the patient reports seeing one light again. Repeat this procedure three times and record the convergence break point for the first measurement only. The reason why you repeat the procedure three times is because the Near Point of Convergence tends to recede (move outward) over time due to fatigue, particularly when the patient has convergence insufficiency.

5-Step Screening for Convergence Insufficiency

Place red/green glasses on patient

1. Instruct patient to watch light and state when they see a green light and a red light (e.g.)

2. On the third trial, record the distance where the patient reports two lights

3. Patient reports two lights closer in than 4 inches (10 cm)

4. Patient passes screening


TBI/ABI – Vision Rehabilitation
Does it affect Recovery?

Chapter on Spatial
Sanet & Press
Filters

• Tinted lenses for Concussed or Brain Injury patients.
  • Enhance beneficial wavelengths while blocking bothersome wavelengths
  • Reduce glare.

• Mono-Nasal or Bi-Nasal filters for adjunctive treatment of Esotropia with or without Amblyopia. Applications for brain injury as well.
THE SITE OF THE INJURY OR INFARCT may help decide where to begin the assessment and treatment.

- **Frontal Lobe**
  - Voluntary eye movement deficits (smooth pursuits, saccades, Optokinetic nystagmus, vestibular reflex, convergence)
  - Apraxia (can affect eyes)
  - Visual inattention deficits
  - Cognitive deficits in visual problem solving and judgment
  - Slowed responses to visual stimulus in periphery
  - Reduced speed in visual motor tasks
• **Parietal Lobe**
  • Difficulty with perception of motion & distance – “Where is it from me?”
  • Visual processing difficulties in figure ground, visual-tactile integration, and understanding 3-dimensional space
  • Neglect (Unilateral Spatial Inattention) – particularly posterior parietal cortex
  • Difficulty integrating information from the kinesthetic, proprioceptive, vestibular, and tactile systems for the purpose of orientation
• **Temporal Lobe**
  • Difficulty with form awareness & identification – “What is it?”
  • Global visual processing difficulties, especially visual closure
  • Visual Agnosia
  • Speech & Language (Visual recognition critical for speech & language)
Right Brain vs. Left Brain

• **Right Brain**
  • What is the big picture?
  • Simultaneous processing; spatial, visual
  • I see the forest, not the trees.

• **Left brain**
  • Only a small picture
  • Sequential processing; temporal, language
  • I see the trees, not the forest
Ventral Stream vs. Dorsal Stream

• **Parvocellular Pathway** (aka: Ventral Stream, Focal Visual Pathway, Central Pathway)
  • Transforms visual information into a form that can be identified through language.
  • **“What is it?”**
  • Occipital & temporal lobes

• **Magnocellular Pathway** (aka: Dorsal Stream, Ambient Visual Pathway, Peripheral Pathway)
  • Matches information with other systems for the purpose of letting you know where you are and where you are looking, before you process what you are looking at.
Ventral Stream vs. Dorsal Stream
Parvo/Focal vs. Magno/Ambient

- Focal/Parvo – purple
- Magno/Ambient – green
- Occipital Cortex - blue
Effect of oculomotor rehabilitation on accommodative responsivity in mild traumatic brain injury

Preethi Thiagarajan, BS Optom, MS, PhD;* Kenneth J. Ciuffreda, OD, PhD

Department of Biological and Vision Sciences, State University of New York College of Optometry, New York
Vision and Reading Deficits in Post-Concussion Patients: A Retrospective Analysis

<table>
<thead>
<tr>
<th>Visual System Diagnosis</th>
<th>Percent Occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convergence Insufficiency</td>
<td>56%</td>
</tr>
<tr>
<td>Convergence Excess</td>
<td>8%</td>
</tr>
<tr>
<td>Accommodative Insufficiency</td>
<td>76%</td>
</tr>
<tr>
<td>Reduced Reading Rate</td>
<td>82%</td>
</tr>
<tr>
<td>Reduced Reading Efficiency</td>
<td>68%</td>
</tr>
<tr>
<td>More than one diagnosis</td>
<td>92%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other Findings</th>
<th>Percent Occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache (*25% were related to reading)</td>
<td>84%</td>
</tr>
<tr>
<td>Reading at least 2 grade levels below current school grade level</td>
<td>68%</td>
</tr>
</tbody>
</table>
Screening for lifetime concussion in athletes: Importance of oculomotor measure

Dmitri V. Polt, PhD
Department of

Abstract
Hypothesis/objectives: Oculomotor-based measures have been hypothesized to have diagnostic utility for persistent oculomotor dysfunction following concussion. Our objective was to determine if an objective oculomotor screen could predict the likelihood of future concussion.

Methods: Forty-two Division I collegiate male and female hockey players were evaluated using the guidelines of an overall oculomotor-based diagnostic clinical test protocol for the mTBI population. The sensitivity of the collected measures to lifetime concussion was then compared to the corresponding sensitivity of measures of neuropsychological functioning (i.e., PACT) often used with athletes for acute concussion diagnosis.

Results: This model showed that a hockey player with a Near Point of Fixation Disparity (NPFD) equal to or greater than 15 cm, Visagraph comprehension rate less than 85% and the total score on part A of the ADHD questionnaire equal to or greater than 11 was on average 10.72 times more likely to have previously suffered a concussion than an athlete with lower values on the NPFD and ADHD questionnaire and a higher comprehension rate on the Visagraph. None of the IMPACT baseline assessment measures were significantly predictive of the individual's concussion history.

Conclusion: The study provides a relatively sensitive screening tool to assess the probability of previous concussion(s) in an athlete. This model may allow athletic personnel to address in a timely manner the risks associated with repeat concussions and to develop individualized concussion management protocols.

Effect of oculomotor rehabilitation on accommodative responsivity in mild traumatic brain injury

Prateek Thakrar, BS Optom, MS, PhD; Kenneth J. Canfield, OD, PhD
Department of Biological and Health Sciences, State University of New York College of Optometry, New York, NY

Abstract—Accommodative dysfunction is a common oculomotor sequelae of mild traumatic brain injury (mTBI). This study evaluated a range of dynamic (subjective) and static (objective) measures of accommodation in 17 non-neurologically impaired with mTBI and nine non-concussed controls before and after accommodative training (OMT) and phoropter (P) training 65 vs. two sessions per week, 3 h of training each. Following OMT, the dynamic of accommodation improved similarly. Clinically, there was a significant increase in the maximum accommodative amplitude both nasally and temporally. In addition, the same vision symptoms reduced along with improved visual attention. None of the measures were found to change significantly following P training. These results provide evidence for a significant positive effect of the accommodative training on accommodative responsivity. Such improvement is suggestive of oculomotor learning, demonstrating modifiable visual system plasticity in the adult compromised brain.
Post-Concussion Football Player

- Referred by Sports Medicine Department
- HEADACHES
- Seen neurology, PT, sports medicine, internist, sports pychologist, athletic trainer, etc
- Tried medicine, therapies, counseling, accommodations, etc

- Traditional Functional Vision Deficits- severe and never looked at!
- Need for corrective lenses
- Cervical Referral
- Light Therapy
Light Therapy – Syntonics + AO Pupil/HA’s Post Concussed
Jim’s Case

- Right Occipital Lobe, small clot 2 days post open large heart surgery
- Left temporal scotoma
- Loss of spatial organization, with decreased depth perception and localization.
- Change in clarity of sight
- Mayo recommendation post-defect
WHEN SHOULD VISION REHABILITATION BEGIN?

• Depends on the injury! (Once the patient is stable and able.)
• Typically the Developmental Optometrist becomes involved during the general rehab stage, sometimes during the sub-acute care stage, in concussions “Return to Learn” stage.
• If a patient has reached a plateau in their rehab, then their visual skills need to be evaluated!
PRACTICE MANAGEMENT PEARL:

• Offering Pre-Concussion Vision Screenings
King-Devick Screening Test for Concussions:

• Test of rapid number naming & eye movements
• Best of 2 trials to determine Baseline Time (learning effect)
• Retest after suspected head injury: \textit{INCREASED} time or \textit{ERRORS} = Assumed Concussion

http://www.youtube.com/watch?v=URjMCuRJrrE&feature=youtu.be&noredirect=1 (Today Show)

• Can be administered by coaches/parents (non-medical professional)
• May help coaches/trainers with game time decisions

www.kingdevicktest.com
Impaired eye movements in post-concussion syndrome indicate suboptimal function beyond the influence of depression, malingering, or intellectual ability.

Heitger MH, Jones RD, Macleod AD; Brain. 2010 133:2850-70

Brought to you by: COFOE

Stages of recovery should be coordinated with the patient’s treating physician

Injury Occurs

**Stage One**
- Read schoolwork to child for short periods

**Stage Two**
- Enlarge text

**Stage Three**
- Increase visual activities if symptoms do not worsen

**Stage Four**
- Return to school with accommodations
  - Reduced or No:
    - Homework
    - Test taking
    - Note taking
    - Reading
  - Breaks every 20 minutes

If symptoms continue for >2 weeks:

- Double or blurry vision
- Loss of place when reading
- Headaches after reading

Find an optometrist who provides neuro-optometric rehabilitation at coved.org
Thank You

• Questions
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• 319-366-4455
• drkara@creyecare.com