

The Role of Neuro-Optometric Rehabilitation in the Care of the Concussed Athlete Evaluation and Management

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What is a Concussion?

Definition- a form of mild traumatic brain injury (mTBI), is defined as “any transient neurologic dysfunction resulting from a biomechanical force”

Concussions are due to either direct impact, such as a blow to the head, or extreme acceleration forces, like whiplash.

The Concussion Crisis

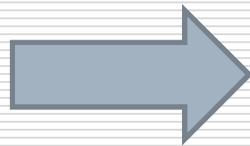


- CDC estimates reveal that up to 3.8 million concussions occur each year
 - Fewer than 10% of sport related concussions involve a loss of consciousness (e.g., blacking out, seeing stars, etc.)
 - Estimated 47% of athletes do not report feeling any immediate symptoms after a concussive blow
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Typical Symptoms of Concussion

- Confusion
- Headache
- Disorientation
- Vomiting and/or Nausea
- Unsteadiness
- Light sensitivity**
- Blurred Vision**
- Double vision**
- Loss of place when reading**
- Post-traumatic amnesia
- Dizziness

These are visual symptoms



Post Concussion Syndrome

- ❑ Post-concussion syndrome is a complex disorder in which a variable combination of post-concussion symptoms — such as headaches and dizziness — last for weeks and sometimes months after the injury that caused the concussion.
- ❑ Post-concussion syndrome is considered when symptoms last for more than three months.
- ❑ Post-concussion syndrome treatments are aimed at easing specific symptoms.

Concussion to Post Concussion Syndrome

Concussion
Day 1-10



Post Concussion
3 months



What is Neuro-Optometric Rehabilitation?

- Neuro-Optometric Rehabilitation represents a specialized area of optometry, which addresses the oculomotor, accommodative, binocular, visual-vestibular, perceptual/, visual information processing, and specific ocular/neurological sequelae of the acquired brain injury population. This includes patients with concussion, traumatic brain injury, cerebrovascular accident/stroke, post-surgical brain complications, encephalopathy, vestibular dysfunction, and neurological conditions adversely affecting the visual system.
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Who are Neuro-Optometric Rehabilitative Optometrists?

Typically these optometrists will be Fellows (board certified) by either:

The College of Optometrists in Vision Development
FCOVD (www.COVD.org)

or

The Neuro-Optometric Rehabilitation Association
FNORA (www.Nora.cc)

Role of Neuro-Optometric Rehabilitation in Concussion Care

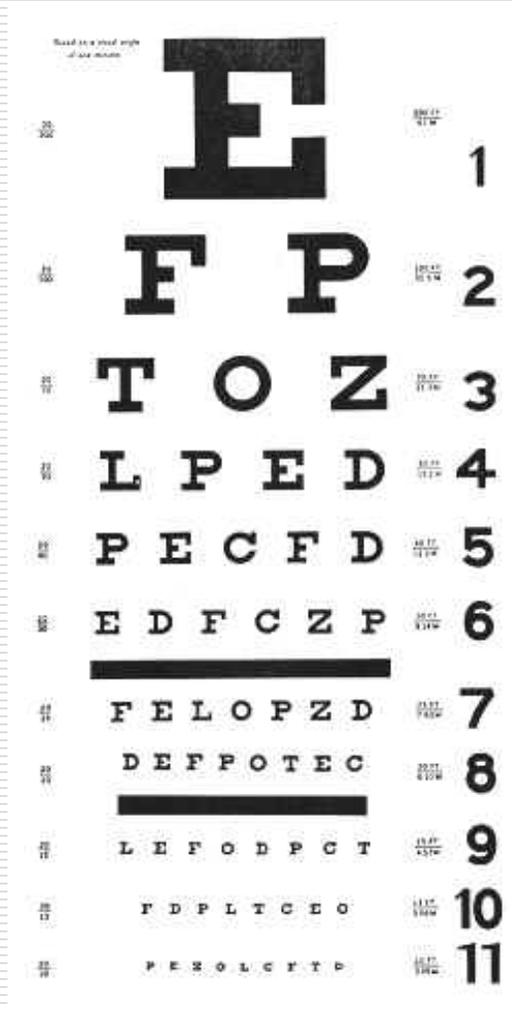
As a member of, or consultant to, the patient's rehabilitation team, the optometrist is able to relate specific visual dysfunctions to patient's symptoms and performance in order to provide remediation and guidance. This will increase the effectiveness of the overall rehabilitation program, which is often highly dependent upon vision.

Role of Neuro-Optometric Rehabilitation in Concussion Care

The evaluation and treatment of the patient with brain injury may include the following:

- Comprehensive eye and vision examination
 - Extended sensorimotor evaluation
 - Higher cerebral function assessment of visual information processing
 - Extended visual field evaluation
 - Electrodiagnostic testing
 - Spectacle prescriptions (including lenses, prisms, and therapeutic tints)
 - **Neuro-optometric rehabilitation (vision therapy)**
-

What is 20/20 Visual Acuity?



Numerator equals test distance

20/20

Denominator equals letter size (a "20" letter is 8.7mm at 20 feet)

Vision & Concussion

Studies show visual dysfunction is prevalent in patients after concussion:

- About 40% have some type of accommodative dysfunction
 - Insufficiency, infacility and excess
 - About 60% have some type of vergence dysfunction
 - 42%- Convergence Insufficiency
 - Anywhere from 30-70% have saccadic/oculomotor dysfunction
-

Common Vision Symptoms After Concussion

- Headaches and asthenopia after short periods of near work
 - Diplopia and blurred vision associated with near work
 - Decreased reading speed and reading comprehension
 - Visual memory deficits
 - Visual discomfort in busy visual environments
 - Persistent light sensitivity
-

Neuro-optometric rehabilitation

- **Evaluation**
- **Treatment**

Extended Case History

- Document
 1. Detailed account of accident or injury
 2. How much does pt. recall before or after?
 3. Was pt. unconscious & for how long
 4. Medications Esp. Antidepressants & Anti-anxiety Medications
 5. Current & Past Rehabilitation and progress
 6. Patient's expectations

Exam Considerations

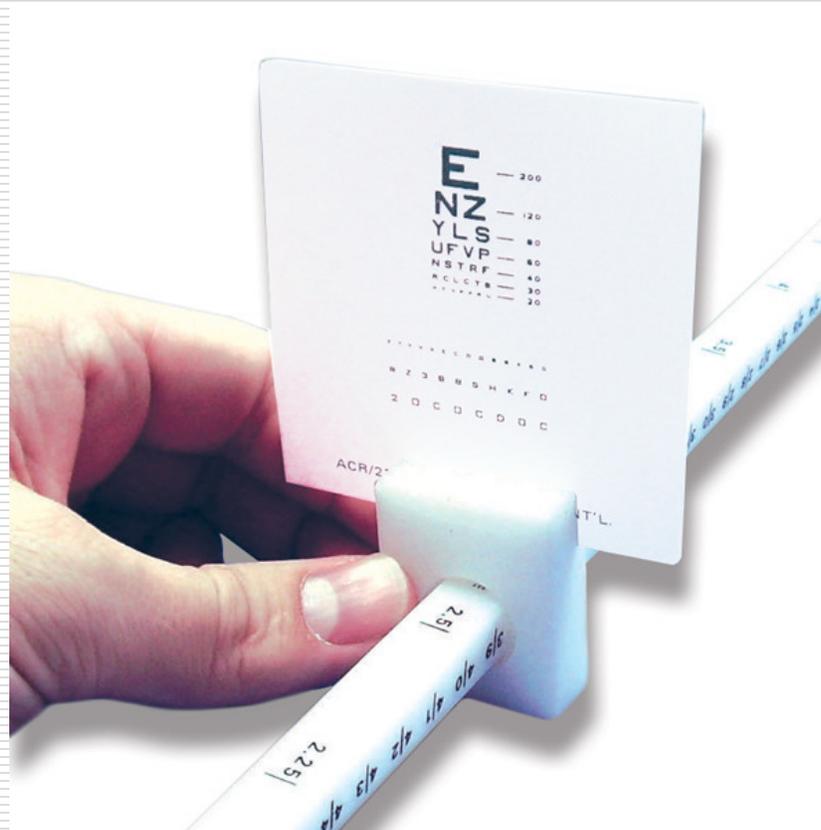
- ❑ Minimize movements that surround the patient
 - ❑ Keep the room illumination relatively dim (use incandescent, rather than fluorescent, lighting when possible)
 - ❑ Have the patient close their eyes in between tests
 - ❑ Work slowly to allow for the patient to answer accurately
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Neuro-Optometric Exam

- ❑ Refractive Analysis
 - ❑ Single-letter acuity
 - ❑ Small corrections in this population can make a big difference
 - ❑ Binocular Vision (eye teaming) Assessment
 - ❑ Nearpoint of convergence, other binocular vision tests
 - ❑ Ocular Motor (eye movement) Assessment
 - ❑ Saccades
 - ❑ Pursuits
 - ❑ Accommodation (focusing) Assessment
 - ❑ Nearpoint of accommodation, other accommodative tests
 - ❑ Visual Vestibular Interaction (motion sensitivity)
 - ❑ VOR testing
 - ❑ OKN Drum Testing
 - ❑ VOR cancellation
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Bernell Accommodation Convergence Rule

(<http://www.bernell.com/product/3146/1250>)



Nearpoint of convergence test

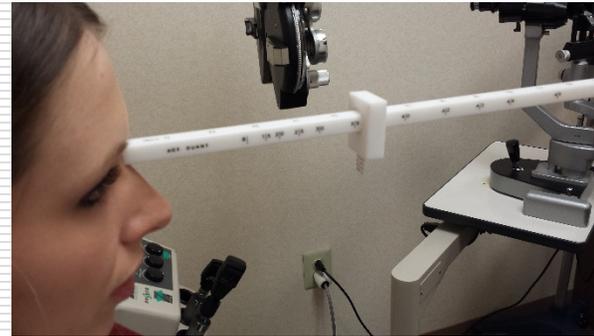
The near point of convergence (NPC) test is a measure of how well the eyes are able to converge when viewing a target that is brought progressively closer to the bridge of the nose.

Required Equipment

- Bernell Accommodation Convergence Rule

Norm:

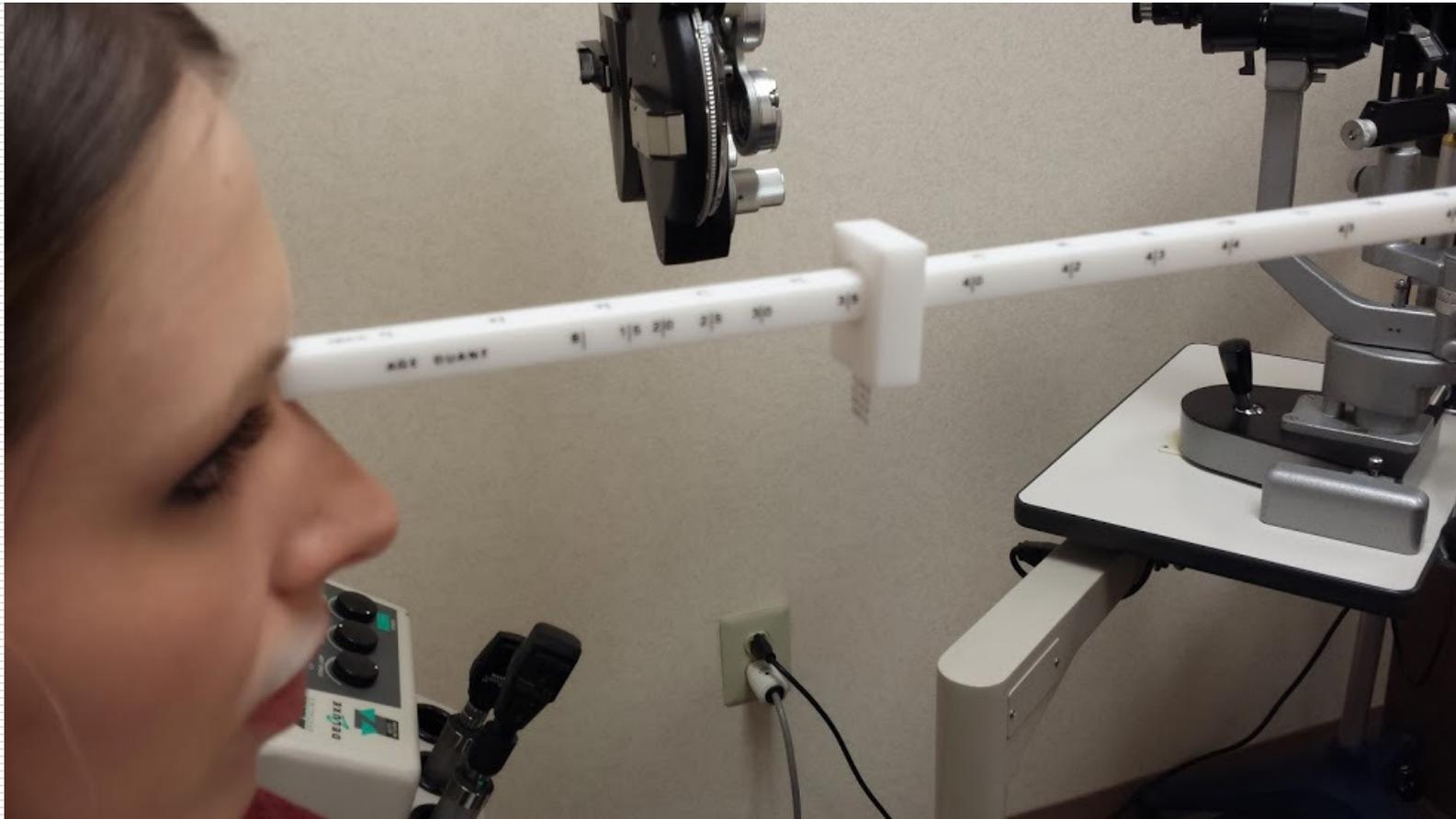
Break <10cm Recovery <15cm



Procedure

1. Testing should be done with the patient wearing his/her refractive correction.
 2. Position the Near Point Rule so that it is set at the brow right above the eyes.
 3. Hold the target at 40 cm from the patient and move the target toward the patient at approximately 1 to 2 cm/s.
 4. Instruct the patient to "keep the target single as long as possible".
 5. Move the target towards the patient until the patient reports double vision or until a loss of fusion is observed. When the patient can no longer keep the target single, record this value as the NPC break. Move the target away from the patient until the patient reports single vision or until a recovery of fusion is observed. This will be considered the NPC recovery.
-

Nearpoint of convergence



Nearpoint of convergence



How would you feel if the words looked like this when you tried to read?

The consumption of soft drinks by American youth is increasing. National dietary surveys show that carbonated soft drink consumption more than doubled in youths aged 6 to 17 from about 5 ounces per day in 1977-78 to 12 ounces in 1994-98, the most recent years for which national data is available. Adolescent boys' soft drink consumption more than tripled during those years.

There are at least two negative results to this soft drink explosion. First, the use of soft drinks is likely related to the rise in childhood obesity. A variety of studies suggest that we don't eat fewer calories from other sources when we increase calories from beverages. If a child drinks 9 to 10 ounces of a soft drink, that's equivalent to almost 120 calories.

Convergence
insufficiency
simulation

Convergence Insufficiency

Prevalence is 5-7% in children



Randomized Clinical Trial of Treatments for Symptomatic Convergence Insufficiency in Children

*Convergence Insufficiency Treatment Trial Study Group**

Objective: To compare home-based pencil push-ups (HBPP), home-based computer vergence/accommodative therapy and pencil push-ups (HBCVAT+), office-based vergence/accommodative therapy with home reinforcement (OBVAT), and office-based placebo therapy with home reinforcement (OBPT) as treatments for symptomatic convergence insufficiency.

Methods: In a randomized clinical trial, 221 children aged 9 to 17 years with symptomatic convergence insufficiency were assigned to 1 of 4 treatments.

Main Outcome Measures: Convergence Insufficiency Symptom Survey score after 12 weeks of treatment. Secondary outcomes were near point of convergence and positive fusional vergence at near.

Results: After 12 weeks of treatment, the OBVAT group's mean Convergence Insufficiency Symptom Survey score (15.1) was statistically significantly lower than those of 21.3, 24.7, and 21.9 in the HBCVAT+, HBPP, and OBPT groups, respectively ($P < .001$). The OBVAT group also

demonstrated a significantly improved near point of convergence and positive fusional vergence at near compared with the other groups ($P \leq .005$ for all comparisons). A successful or improved outcome was found in 73%, 43%, 33%, and 35% of patients in the OBVAT, HBPP, HBCVAT+, and OBPT groups, respectively.

Conclusions: Twelve weeks of OBVAT results in a significantly greater improvement in symptoms and clinical measures of near point of convergence and positive fusional vergence and a greater percentage of patients reaching the predetermined criteria of success compared with HBPP, HBCVAT+, and OBPT.

Application to Clinical Practice: Office-based vergence accommodative therapy is an effective treatment for children with symptomatic convergence insufficiency.

Trial Registration: clinicaltrials.gov Identifier: NCT00338611

Arch Ophthalmol. 2008;126(10):1336-1349

Long-Term Effectiveness of Treatments for Symptomatic Convergence Insufficiency in Children

Convergence Insufficiency Treatment Trial Study Group^a

Abstract

Purpose—To assess the long-term stability of improvements in symptoms and signs in 9- to 17-year-old children enrolled in the Convergence Insufficiency Treatment Trial who were asymptomatic after treatment for convergence insufficiency (CI).

Methods—Seventy-nine patients who were asymptomatic after a 12-week therapy program for CI were followed for 1 year [33/60 in office-based vergence/accommodative therapy (OBVAT), 18/54 in home-based pencil push-ups (HBPP), 12/57 in home-based computer vergence/accommodative therapy and pencil push-ups (HBCVAT+), and 16/54 in office-based placebo therapy (OBPT)]. Symptoms and clinical signs were measured 6 months and 1 year after completion of the 12-week therapy program. The primary outcome measure was the mean change on the CI Symptom Survey (CISS). Secondary outcome measures were near point of convergence (NPC), positive fusional vergence at near (PFV), and proportions of patients who remained asymptomatic or who were classified as successful or improved based on a composite measure of CISS, NPC, and PFV.

Results—One-year follow-up visit completion rate was 89% with no significant differences between groups ($p=0.26$). There were no significant changes in the CISS in any treatment group during the 1-year follow-up. The percentage who remained asymptomatic in each group was 84.4% (27/32) for OBVAT, 66.7% (10/15) for HBPP, 80% (8/10) for HBCVAT+, and 76.9% (10/13) for OBPT. The percentage who remained either successful or improved 1-year post-treatment was 87.5% (28/32) for OBVAT, 66.6% (10/15) for HBPP, 80% (8/10) for HBCVAT+, and 69.3% (9/13) for OBPT.

Conclusions—Most children aged 9 to 17 years who were asymptomatic after a 12-week treatment program of OBVAT for CI maintained their improvements in symptoms and signs for at least 1 year after discontinuing treatment. Although the sample sizes for the home based and placebo groups were small, our data suggest that a similar outcome can be expected for children who were asymptomatic after treatment with HBPP and HBCVAT+.

Near Point of Accommodation

The near point of accommodation is a measure of the participant's maximum accommodative ability.

Required Equipment

Bernell Accommodation Convergence Rule

Opaque occluder

Norm: 18 diopters- $1/3$ age

Or <12cm

Procedure

Testing should be done with the participant wearing his/her refractive correction.

Ensure good illumination using ambient and overhead lighting.

Occlude the participant's left eye.

Hold the Near Point Rule (with single column of 20/30 letters as the target placed at 40 cm on the rule) with edge of rule gently above participant's right eye at the level of his/her brow.

Slowly move the target toward the participant at approximately 1 to 2 cm/sec beginning at 40 cm from the participant.

Instruct the participant to: "Try and keep the letters clear for as long as possible, but tell me when it becomes blurry and you cannot get it clear again."

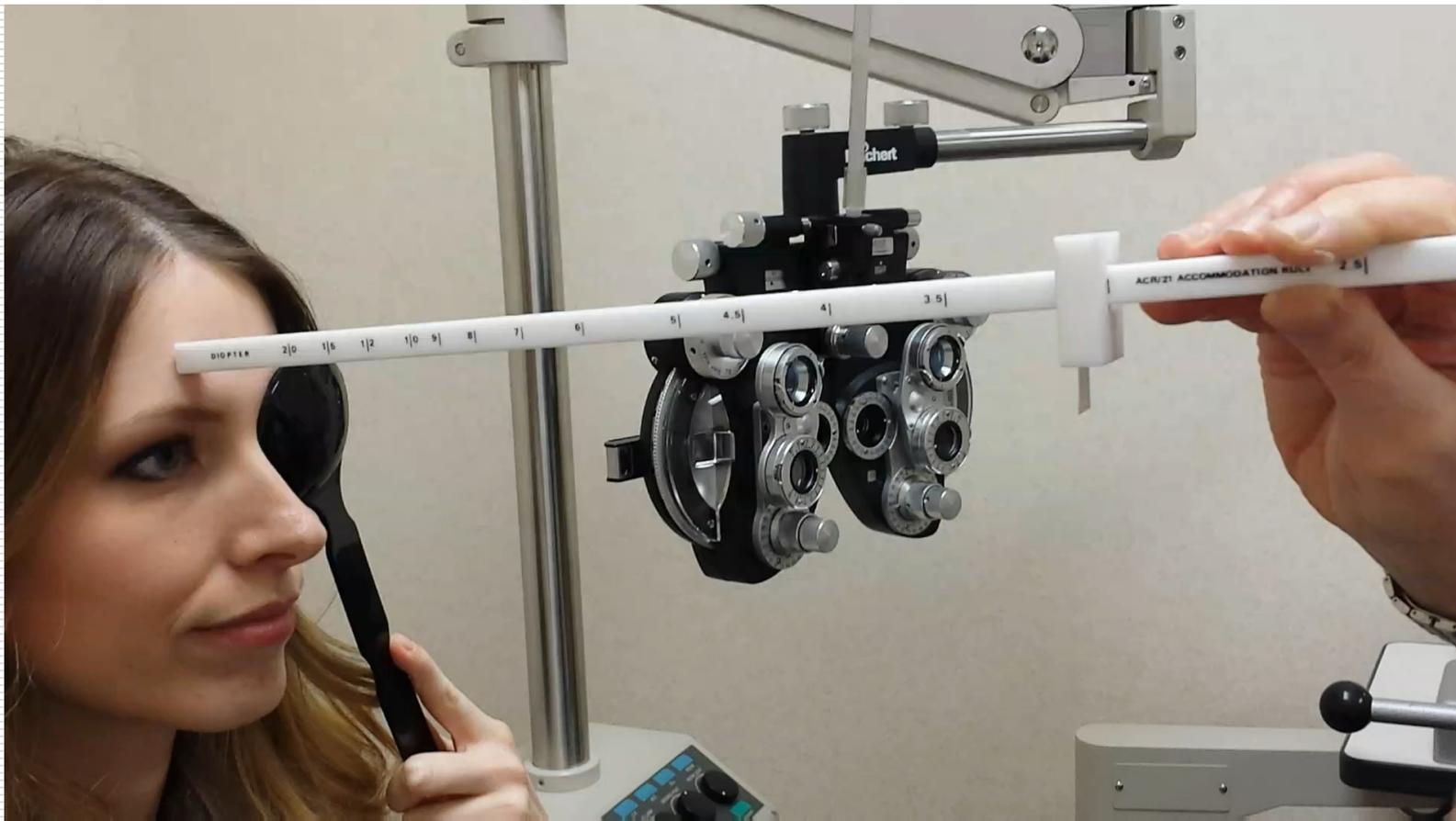
Move the target towards the participant's eye until the participant reports that the letter is blurred and he/she cannot regain clarity even when prompted to make the letter clear. This will be considered the endpoint. Measure and record to the nearest centimeter.



Nearpoint of Accommodation



Nearpoint of Accommodation



How would you feel if the words looked like this when you tried to read?

Failing to clean off your desk before lunch not only raises the risk of salad dressing spilling onto your work, but it could also increase your chances of getting sick. A new report shows that close to half of Americans don't clean their desks before eating at them, and a third don't wash their hands, which may foster the spread of infectious diseases like colds and flu.

Due to a shortage of the flu vaccine this year, health officials have urged the public to take measures to reduce their risk, and researchers say improving at-work hygiene and hand washing habits could have a major impact in reducing sick days. "Desks, phones, door knobs, conference tables, fax machines and other common workplace areas can be breeding grounds for bacteria-spreading germs," says Brian Sansoni, spokesman for the Soap and Detergent Association, in a news release.

Accommodative
insufficiency
simulation

Saccadic Eye Movements

GOAL: To assess the ability and accuracy of saccadic function

MATERIALS:

Two targets (pen, fixation stick, etc..)

Metronome

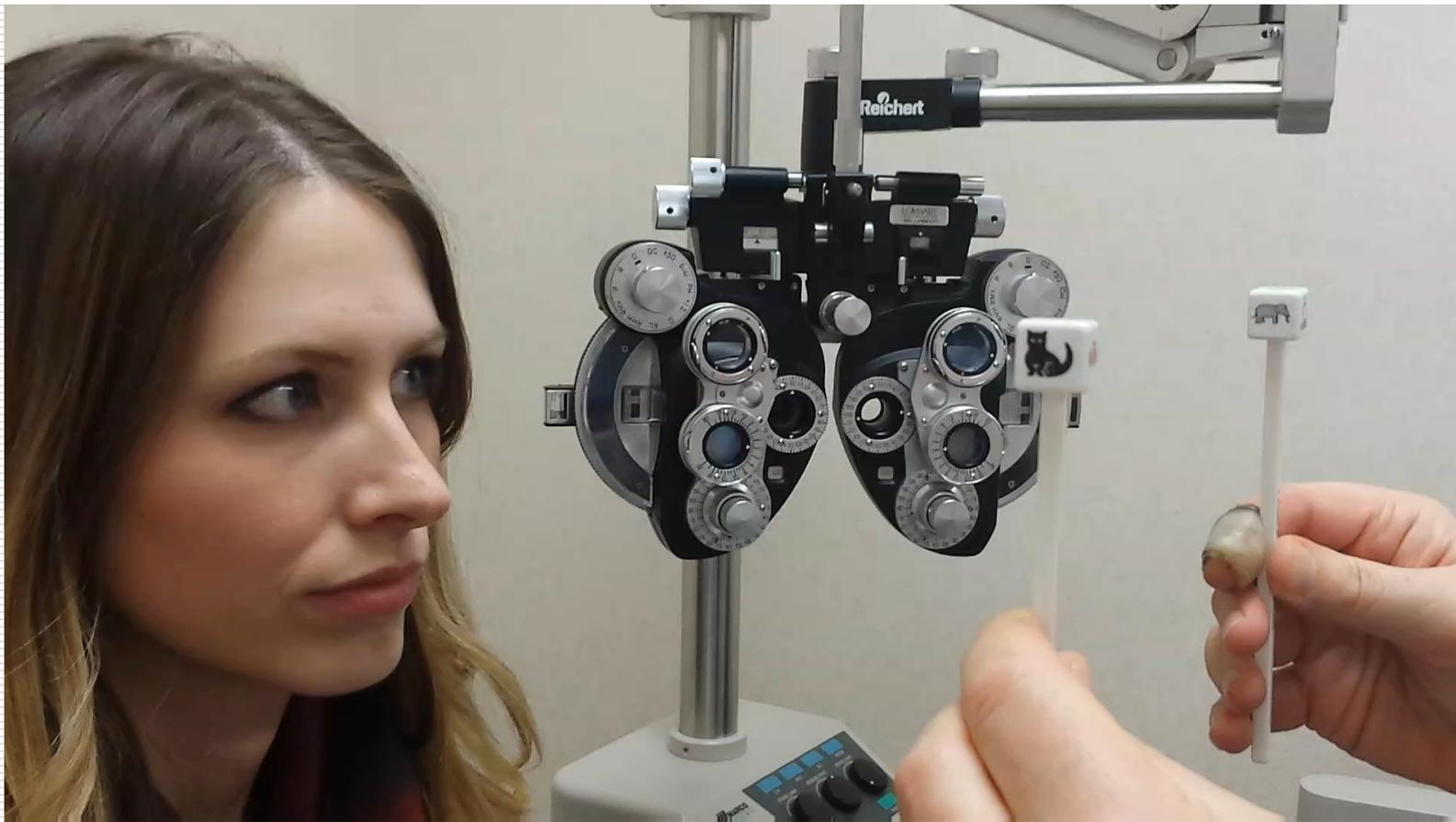
SET UP:

Have patient sit comfortably in a chair that is eye-level with the examiner

PROCEDURE:

- Hold the two target at 40 cm away from the patient and about 10 cm on each side of the patient's midline
 - Ask the patient to look from one target to the other
 - Have the patient make 10 saccadic movements between targets
 - If the patient is capable of making saccadic eye movements, then ask them to continue to do so to the beat of the metronome (60 beats/sec) for 30 sec.
 - Observe saccadic ability
 - Ask about increase of symptoms
-

Saccadic Eye Movements



Pursuit Eye Movements

To determine a person's ability to make smooth pursuit movements

MATERIALS:

Accommodative target (pen, fixation stick, etc..)

SET UP:

Have patient sit comfortably in a chair that is eye-level with the examiner

PROCEDURE:

Hold the target at 40 cm away from the patient at their midline

Begin to move the target slowly in a circle (~ 20 cm or less) and ask the patient to follow the target as best they can

Five rotations are made clockwise followed by five rotations counter-clockwise. The examiner may also be interested in make a figure-8 motion.

Ability

Are they able to complete the rotations?

Accuracy

Is the patient able to accurately and consistently fix and follow the target?

Does the patient lose their place and need to re-fixate?

Ask about increase of symptoms

Pursuit Eye Movements



A Brief Vestibular/Ocular Motor Screening (VOMS) Assessment to Evaluate Concussions

Preliminary Findings

[Anne Mucha](#), DPT,* [Michael W. Collins](#), PhD,† [R.J. Elbin](#), PhD,‡ [Joseph M. Furman](#), MD, PhD,§ [Cara Troutman-Enseki](#), DPT,* [Ryan M. DeWolf](#), MS, ATC,† [Greg Marchetti](#), PhD,|| and [Anthony P. Kontos](#), PhD†¶

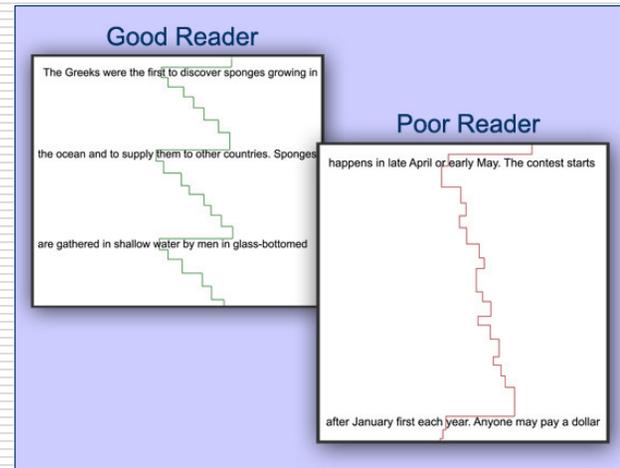
Online version: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4209316/#SD1>

Vestibular/Ocular-Motor Screening (VOMS) for Concussion

Vestibular/Ocular Motor Test:	Not Tested	Headache 0-10	Dizziness 0-10	Nausea 0-10	Fogginess 0-10	Comments
BASELINE SYMPTOMS:	N/A					
Smooth Pursuits						
Saccades – Horizontal						
Saccades – Vertical						
Convergence (Near Point)						(Near Point in cm): Measure 1: _____ Measure 2: _____ Measure 3: _____
VOR – Horizontal						
VOR – Vertical						
Visual Motion Sensitivity Test						

Visagraph/ReadAlyzer

- Great tool for looking at a patient's efficiency to read



Vestibular Visual Interaction

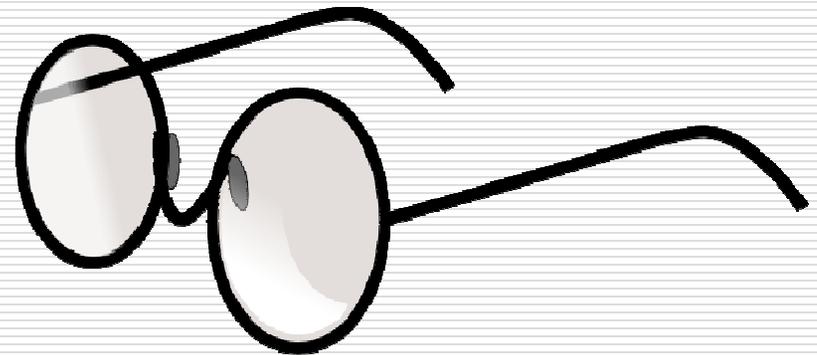
- ❑ The Visual and vestibular systems are **closely intertwined**, working together to keep a person's visual world stable and comfortable.
 - ❑ A concussion or any other form of traumatic brain injury will often have difficulty in the integration of these two systems.
 - ❑ This may result in symptoms such as dizziness, vertigo, headaches, disorientation, and light sensitivity, being provoked or aggravated by specific visual contexts (e.g. supermarkets, shopping malls, driving, or movement of objects).
 - ❑ It should be noted that with this condition certain types of computer monitors and digital televisions may also be bothersome.
-

Peripheral OKN Technique



Spectacle Considerations

- Small prescriptions are significant
 - Astigmatic correction
 - Near vision
- Prism
 - Consider small amounts for:
 - Vertical Deviations
 - Convergence Insufficiency/Excess
- Tints/Coatings
 - Sunglasses
 - AR-Coating
 - Therapeutic Tints



Tints

- **80% of all TBI patients will pick the blueish/purple hue known as “Omega”**
 - **This tint is designed to help the peripheral visual system gather and process information more efficiently.**
-



Case Report 1: JP

- ❑ JP sustained a severe concussion on May 21, 2012 when he swam full speed into a wall, breaking his nose. On the ride to the hospital he lost consciousness and experienced amnesia.
 - ❑ Subsequent concussions were likely sustained due to falls. One such fall occurred June 2012 when JP lost his balance and hit the side of his head.
 - ❑ JP's main symptoms include: severe eyestrain, headache, nausea, and fatigue, all of which are worsened by being in crowds. He experiences visual disturbances almost constantly but more so with fatigue. He is also light and motion sensitive, and tends to skip and lose his place when reading.
 - ❑ JP has undergone vestibular, exertional, physical, occupational, and cognitive therapies.
-

Test	Exam Result	Normal Range	Interpretation
Best corrected visual acuity	RE: 20/20 LE: 20/20	20/20	Normal
Refractive Status	RE: -2.75 LE: -2.75	N/A	Mild Hyperopia
Distance Phoria	2 <u>expophoria</u>	0-2 exophoria	Normal
Near Phoria	6 exophoria	0-6 exophoria	Normal
Nearpoint of convergence	8 inches	3 inches	Convergence Insufficiency
Near Convergence range	16 pd	18-24 pd	Convergence Insufficiency
Near Convergence recovery	8 pd	7-15pd	Normal
Near Divergence range	6 pd	18-24pd	Fusional Instability
Near Divergence recovery	16 pd	10-16pd	Normal
Distance Convergence range	4 pd	14-24pd	Fusional Instability
Distance convergence recovery	0pd	6-12pd	Fusional Instability
Distance divergence range	4 pd	5-10pd	Fusional Instability
Distance divergence recovery	2 pd	2-6pd	Normal
Vergence Facility	17 cpm	>15 cpm	Normal
Accommodative Facility	RE: 11 cpm LE: 17 cpm	12 cpm	Borderline Accommodative Infacility
Accommodative Amplitude	RE: 4.75 D LE: 4.25 D	11.00 D	Accommodative Insufficiency
Test of Silent Word Reading Fluency	27 th %ile	38 th %ile or better	Reading Fluency Deficit
Visagraph Reading Eye Movement Test 7 th grade text	7.9 grade level	9.0 or greater grade level	Oculomotor Dysfunction

Pd= prism diopters cpm cycles per minute OD=right eye OS=left eye OI=both eyes

Recommendations

□ **Full Time Spectacle Correction**

- It is strongly recommended that JP wear his newly prescribed spectacle correction for near based activities such as school -work and reading, over his current contact lens correction. This spectacle correction has a small, but significant prescription and a therapeutic tint to make JP more visually comfortable.

□ **Vision Therapy**

- A program of vision therapy is recommended to remediate the visual conditions discovered during the evaluation. I anticipate an active vision therapy program of about four months, 24 sessions, to remediate the vision conditions documented in the report. JP will be re-evaluated periodically to assure that he is making progress in his vision therapy program.

□ The goals and hoped for benefits of the vision therapy are summarized below:

- a. **Improve convergence and eye teaming abilities**, which would have the effect of improving visual comfort as well as making reading and studying more efficient.
 - b. **Improve visual tracking skills**, which would reduce loss of place and skipping or words while reading and the secondary benefit of improved selective and sustained visual attention.
 - c. **Improve accommodative (focusing) ability**, which should serve to make it easier to focus quickly and accurately to the blackboard and the paper and reduce blurred distance vision after reading.
 - d. **Improve fusional stability**, which will help JP feel more comfortable and improve his visual stamina.
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Pre & Post Vision Therapy Evaluation

Test	Initial Evaluation	Re-Evaluation	Interpretation
Best corrected visual acuity	RE: 20/20 LE: 20/20	RE: 20/20 LE: 20/20	Normal
Refractive Status	RE: -2.50 sph LE: -2.50 sph	N/A	Simple Myopia
Distance Phoria	2 exophoria	2 exophoria	Normal
Near Phoria	8 exophoria	8 exophoria	Normal
Nearpoint of convergence	8 inches	1 inches	Normalized
Near Convergence range	16 pd	36 pd	Normalized
Near Convergence recovery	8 pd	24 pd	Normalized
Near Divergence range	24 pd	28 pd	Normalized
Near Divergence recovery	16 pd	20 pd	Normalized
Distance Convergence range	4 pd	10 pd	Normalized
Distance Convergence recovery	0 pd	6 pd	Normalized
Distance Divergence range	4 pd	22 pd	Normalized
Distance Divergence recovery	2 pd	16 pd	Normalized
Visagraph, 7 th grade text	7.9 grade level equivalency	13.4 grade level equivalency	Normalized

Pd= prism diopters cpm cycles per minute OD=right eye OS=left eye OU=both eyes

Testimonial From JP

- ***"I feel that I have improved tremendously. My headaches have subsided completely from the combination of vision therapy and propranolol therapy. The near vision glasses that were prescribed have decreased my ocular pain and have made reading easier. I feel that vision therapy has helped my visual stamina as my eyes no longer tire. Supermarkets and crowded areas do not bother me as they once did. "***

"I feel 100% back to myself, back to being 'visually normal' "

Helpful Websites

- www.covd.org
 - www.visionhelp.com
 - www.nora.cc
-

Summary of Key Points

- ❑ Visual dysfunction is extremely common in concussion and post concussion syndrome
 - ❑ It is possible to screen for visual and vestibular/ocular motor function expeditiously.
 - ❑ It is important to grade symptoms pre and post testing.
 - ❑ Neuro-optometric rehabilitation can often help relieve symptoms in concussion and post concussion patients.
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Thank you!
