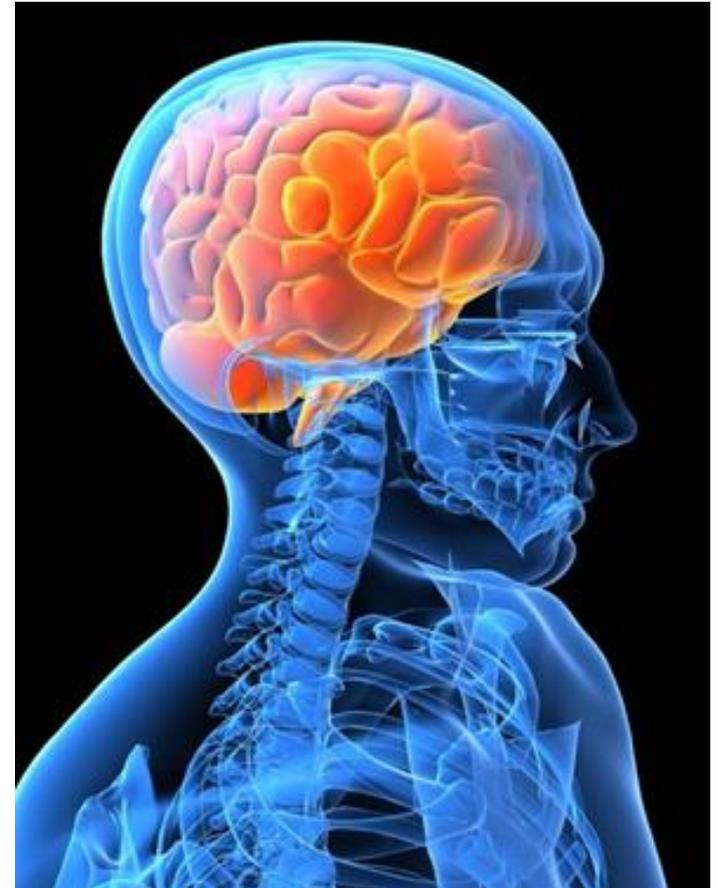


USE OF OCULOMOTOR TESTING AND THE KING DEVICK TEST IN CONCUSSION ASSESSMENT

2017 CATA Symposium

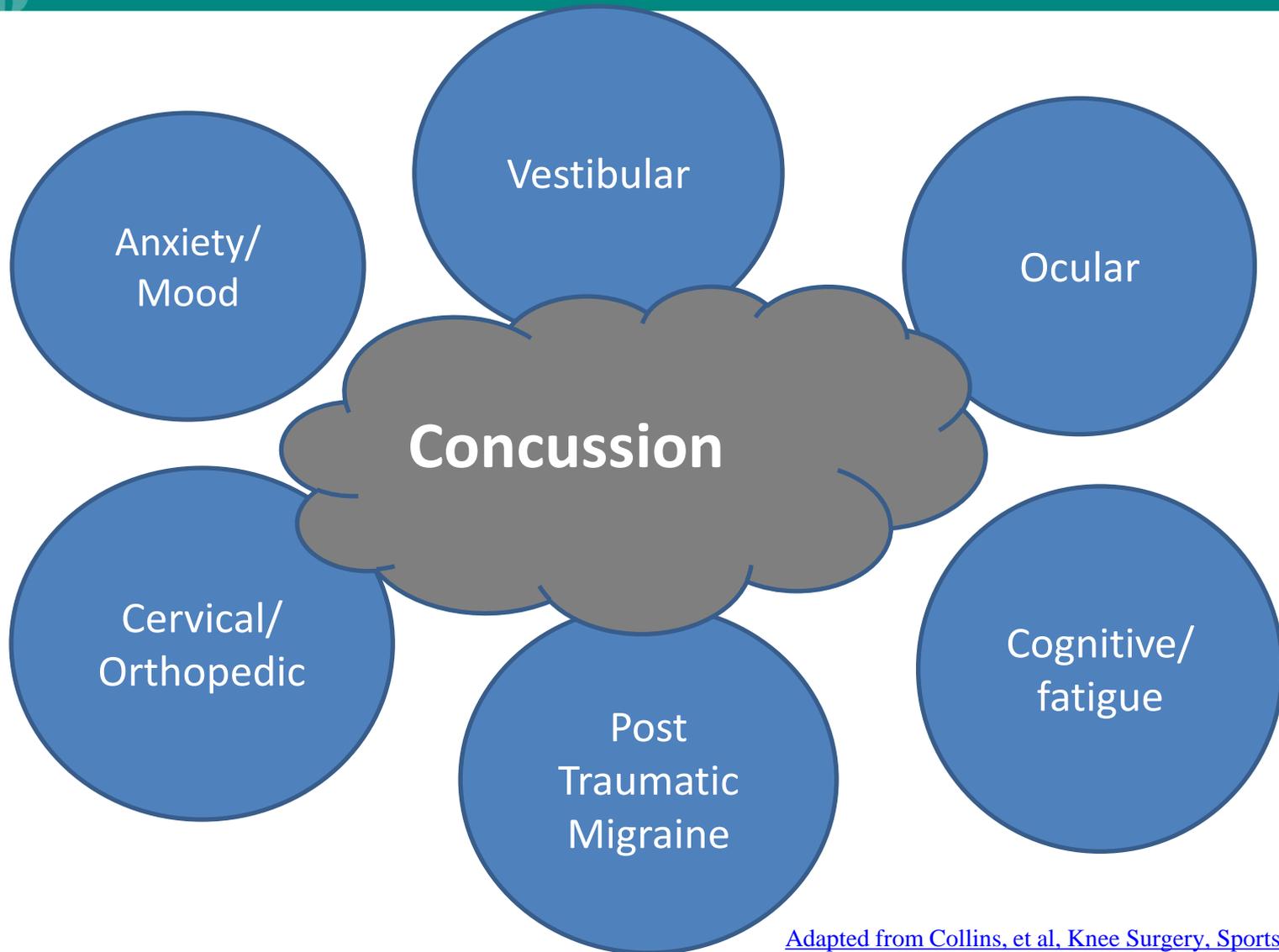
May 18, 2017

Anne Pacileo, PT



I have no financial interest/arrangement or affiliation with any organization that could be perceived as real or apparent conflicts of interest related to this presentation.

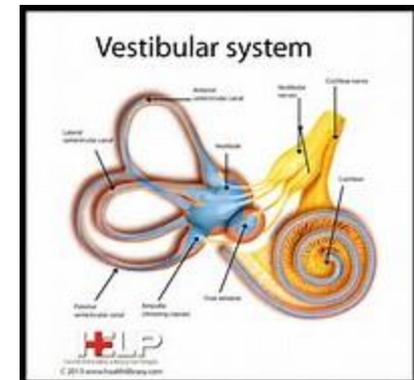
Clinical Presentations in Concussion



[Adapted from Collins, et al, Knee Surgery, Sports Traumatology, Arthroscopy Issue 2](#)

Why Assess the Vestibular-Ocular

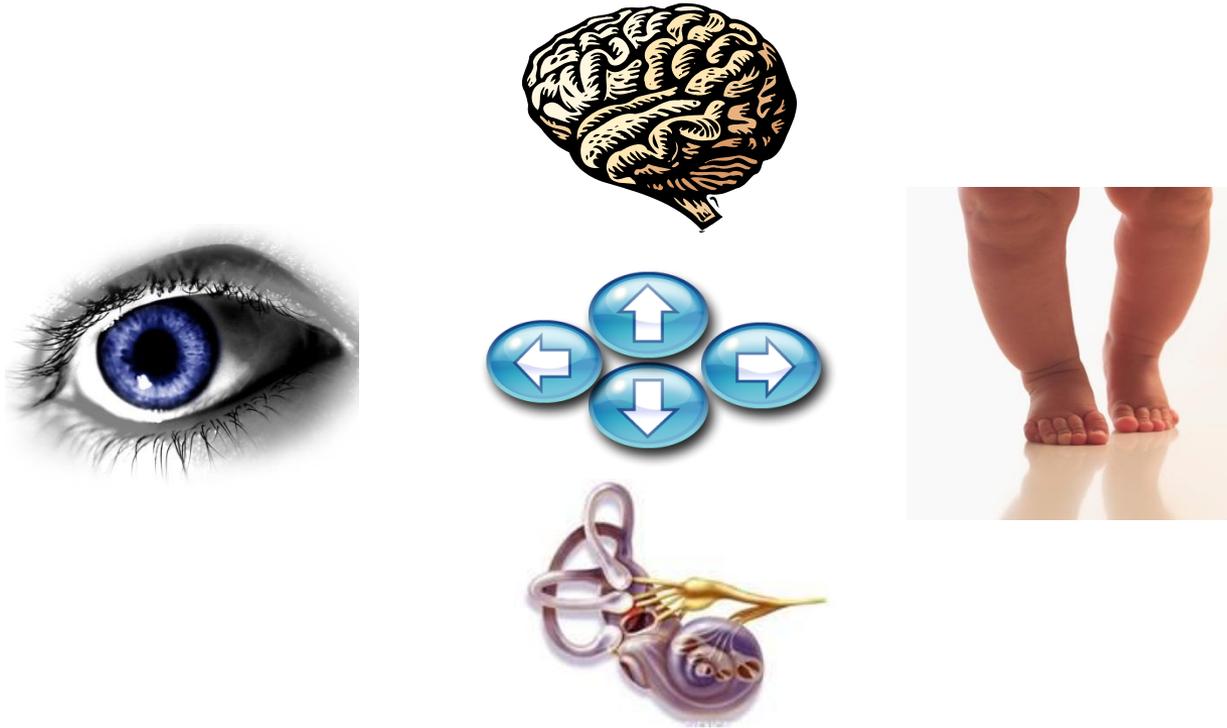
- **Concussion can involve damage to**
 - Central (brain related) structures involved in balance and vision
 - Vestibular apparatus in the inner ear that can involve eye movements
 - Vestibular and/or vision issues can cause problems with balance
- **Vision accounts for 55% of the brain's pathways.**



Subjective Complaints with concussion impacted by Vestibular-Ocular

- **Dizziness, Fogginess, Feeling detached, Fatigue**
- **Motion discomfort, Nausea**
- **Intolerance to busy places**
- **Anxiety/Irritability**
- **Difficulty focusing, Blurred vision, Difficulty with Math/Reading**
- **Impaired balance**

How do we balance?



Balance is controlled through signals to the brain from your eyes, the inner ear, and the sensory systems of the body (such as the skin, muscles, and joints). Changes in input from any of these sources can cause significant issues with balance, postural control and processing



Purpose of the Vestibular System

- **Sensory**

- Perception of motion and orientation

- Angular acceleration

- Linear acceleration

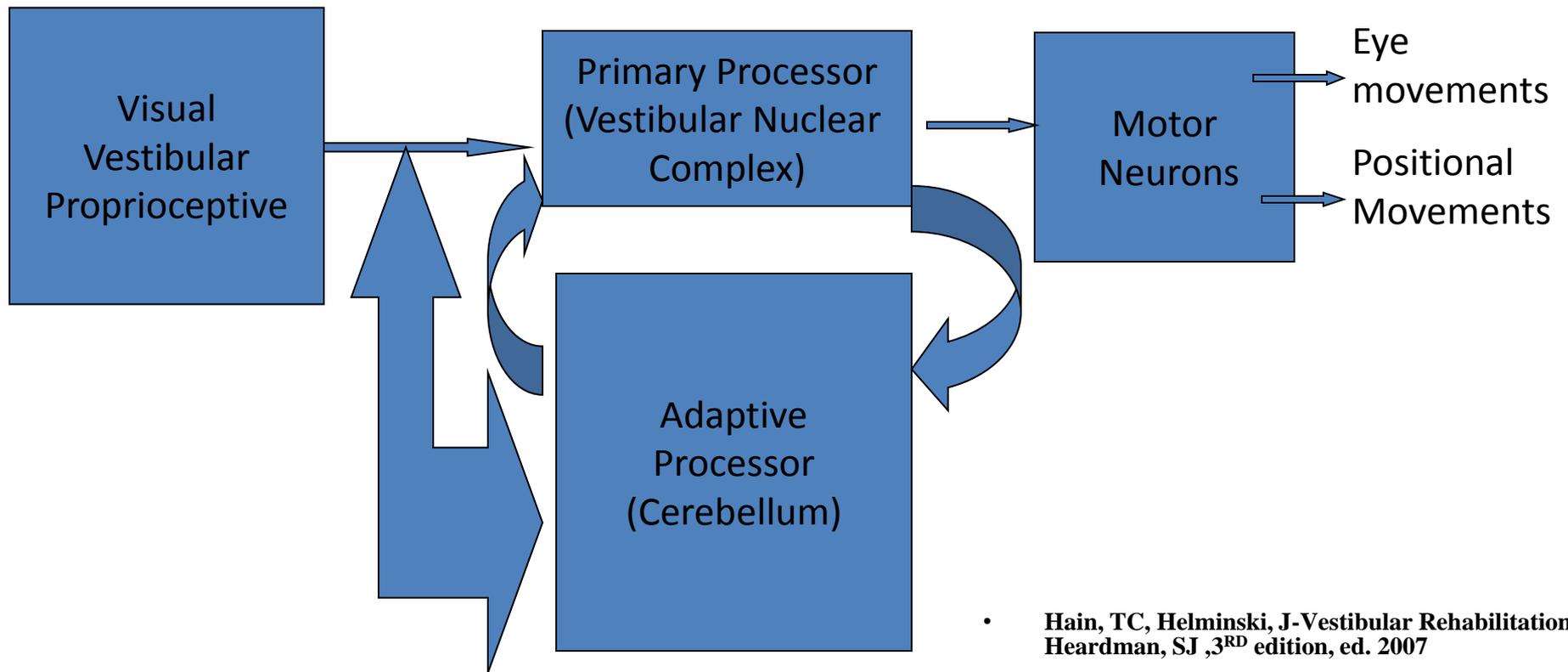
- Position in relation to gravity

- **Motor**

- Control eye movement in order for images in surrounding environment remain clear

- Maintenance of equilibrium and desired posture

Organization of Vestibular System



- Hain, TC, Helminski, J-Vestibular Rehabilitation, Heardman, SJ, 3RD edition, ed. 2007

Vestibular Ocular Reflex

VOR –Vestibulo-ocular reflex generates eye movements to stabilize gaze during head motion.

- Gain is the ratio of “output”(eye velocity) to input (head velocity) Ideally this number is 1.



Vestibular Ocular Reflex

VOR –

If the gain of the VOR is not 1 then head movement results in image motion on the retina, resulting in blurred vision



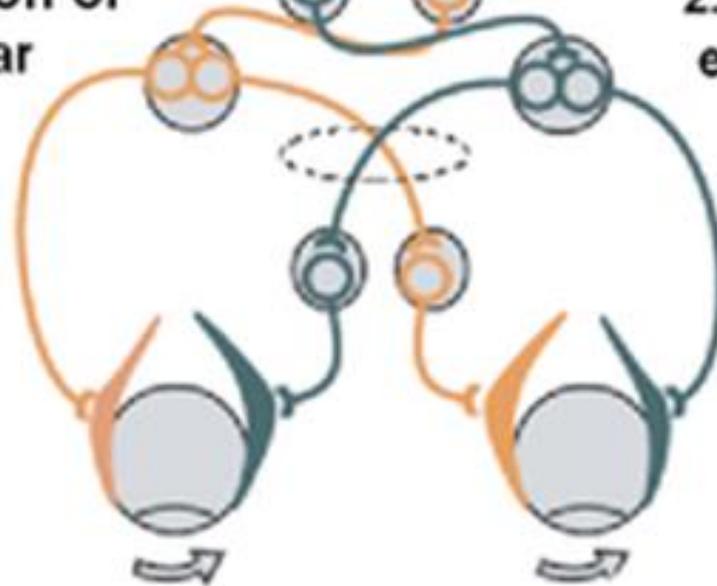
Vestibular Ocular Reflex

1. Detection of rotation



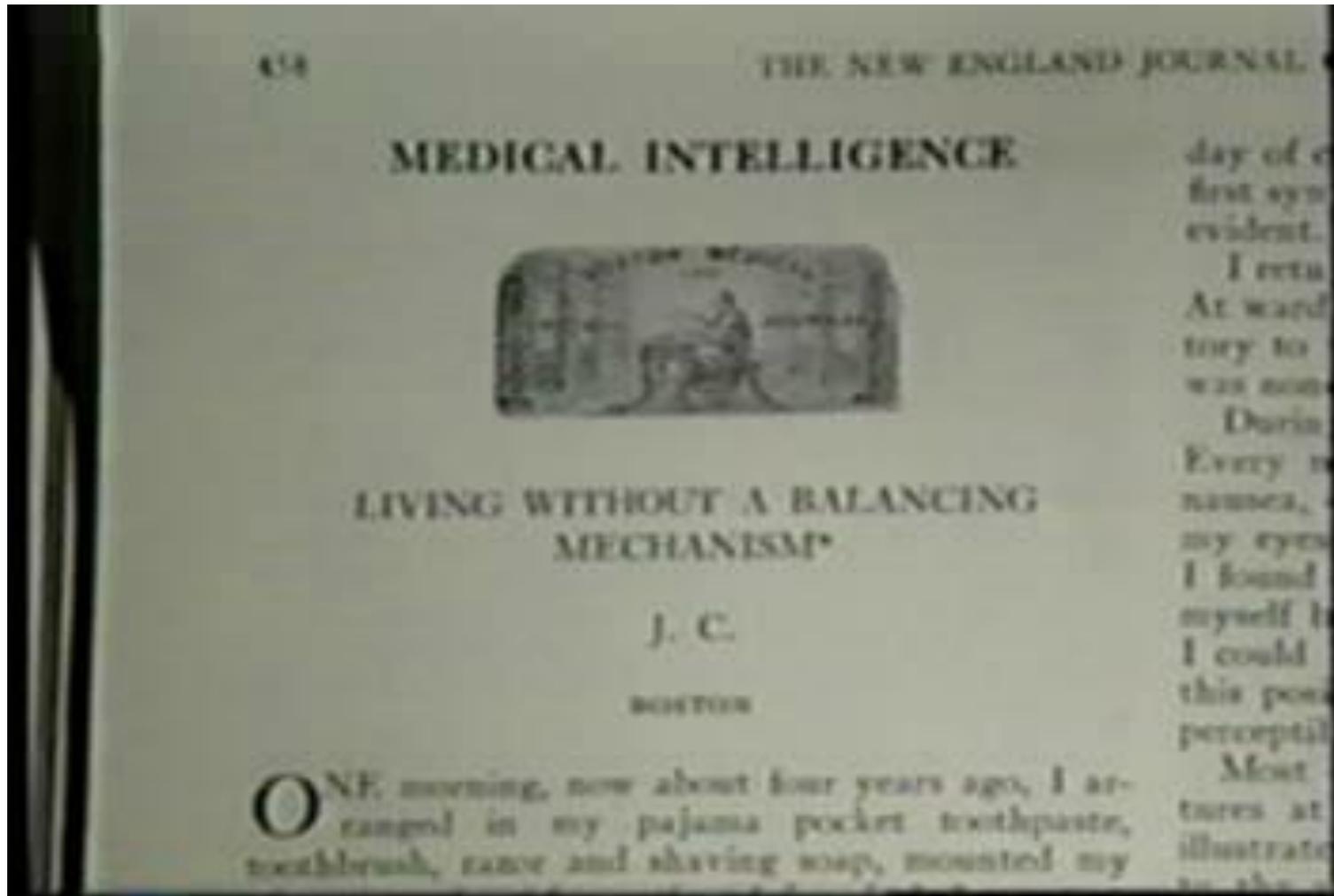
2. Inhibition of extraocular muscles on one side.

2. Excitation of extraocular muscles on the other side



3. Compensating eye movement

Oscillopsia



Classic Oculomotor Examination

- **Ocular Motility/Alignment**
- **VOR testing**
- **Oculomotor tests**

Tests central oculomotor pathway

- Smooth pursuit
- VOR cancellation
- Saccade Testing
- Vergence



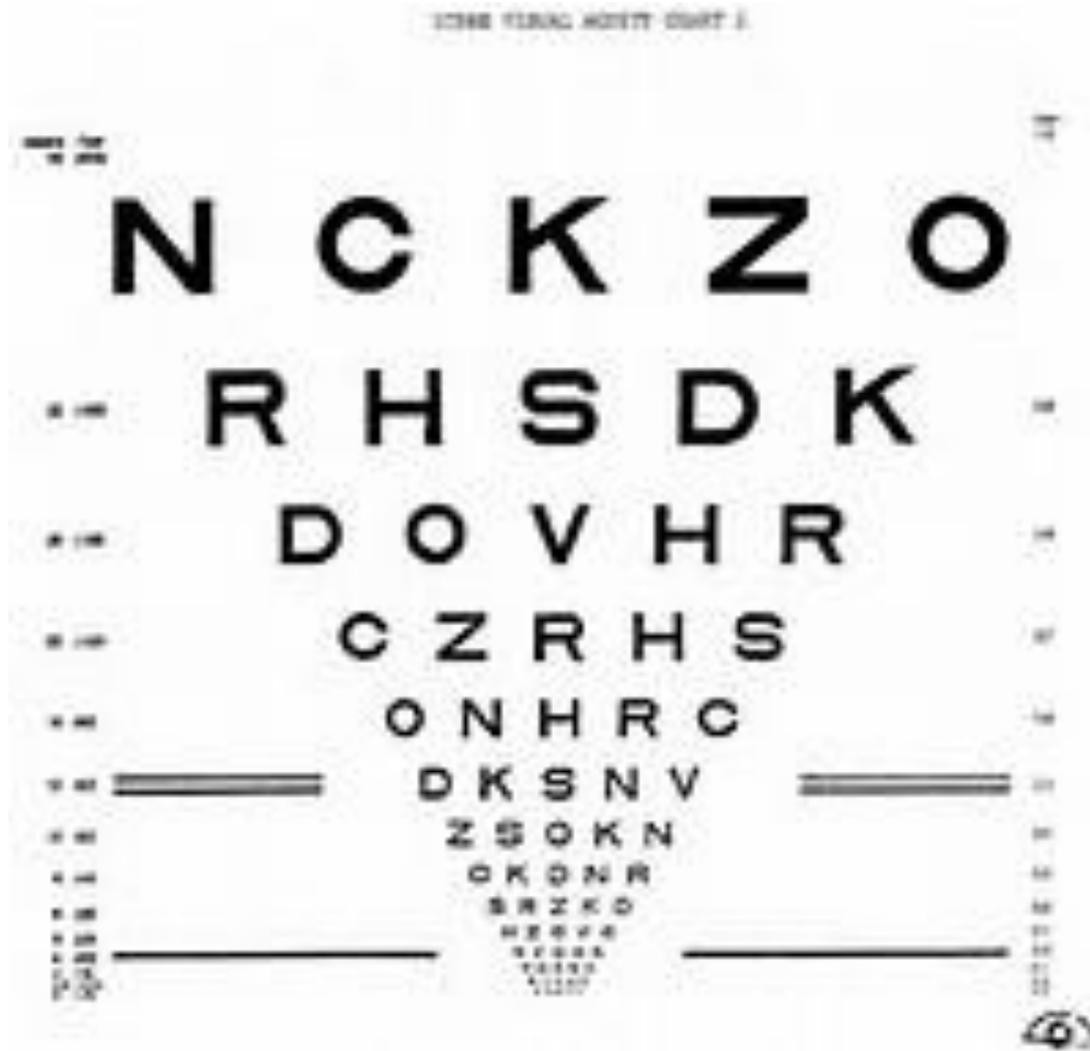
of the vestibular system.

VOR- Vestibular Ocular Reflex

- **Head thrust/ Head impulse test**
 - Positive test rules in – Normal test does not rule out.
- **Dynamic Visual Acuity**
 - Difference between static and visual acuity during 2 Hz oscillations
 - Use of Metronome ensures 120 cycles per second
 - 2 line or less difference is considered normal



EDTRS eye charts



Vestibular/Ocular Motor Screening (VOMS)

A Standardized Screening Examination



Vestibular/Ocular Motor Screening (VOMS)

- **Developed by UPMC**
- **64 subjects approximately age 14 and 78 controls were administered the screen including 5 domains.**
- **61 percent of patients reported symptoms provocation after at least 1 VOMS item all VOMS items were positively correlated to the PCSS total symptoms score.**
- **The VOR and VMS components were most predictive of being in the concussed group.**
- **VOMS demonstrated internal consistency as well as sensitivity in identifying patients with concussion.**



Vestibular/Ocular Motor Screening (VOMS)

- **In addition subjects were asked to complete the Post-Concussive Symptoms Scale (PCSS). This scale is used to measure concussion related symptoms. The scale consists of 22 self-reported symptoms items rated on a scale from 0 to 6. Total scores on the PCSS range from 0 to 132**



Vestibular/Ocular Motor Screening (VOMS)

- **5-8 minute assessment to determine possible vestibular and/or non-vestibular causes of dizziness**
- **Equipment needed**
 - Tape measure
 - Metronome
 - Target with 14 point font print
- **Assessment of 5 domains**
 - Smooth pursuits
 - Horizontal and vertical saccades
 - Convergence
 - Horizontal and vertical vestibular ocular reflex(VOR)
 - Visual motion sensitivity

*Mucha et al, Am J Sports Med published online
August 8, 2014*



Vestibular/Ocular Motor Screening (VOMS)

- **As a baseline the patient rates on a scale of 0-10 symptoms of:**
 - Headache
 - Dizziness
 - Nausea
 - fogginess
- **Following each VOMS assessment the patients rates each of the 4 categories on as scale of 0-10.**



UPMC Vestibular/Ocular Motor Screening Form (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) Measurement 1: _____ Measurement 2: _____ Measurement 3: _____
VOR- Horizontal						
VOR- Vertical						
Visual Motion Sensitivity Test						

*Mucha et al, Am J Sports Med published online
August 8, 2014*

Assesses ability to follow slow moving target

- **Target should be 3 feet from patient**
- **Horizontally 1.5 feet each direction/ Vertically 1.5 feet each direction- H pattern**
- **Diagonally (Upward/Outward)**
- **Hold at end range to assess behavior here**
- **Speed is 2 seconds in each direction**
- **Perform 2 complete repetitions**

Abnormal findings: Indicating a Central Issue

- **Saccadic Correction**
- **Gaze evoked nystagmus**
- **Down beating nystagmus**

Other considerations:

- **Spontaneous and Gaze Evoked Nystagmus**
 - Looking for presence of Nystagmus without movement of head
 - Have patient look straight ahead-Spontaneous Nystagmus
 - Look 30 degrees to right and left-Gaze Evoked Nystagmus



VOMS-Horizontal and Vertical Saccades

Tests ability of eyes to move quickly between targets

- **Targets should be 3 feet from patient**
- **Horizontally 1.5 feet each direction (30° left/ 30° right)**
- **Vertically 1.5 feet each direction (30° upward / 30° downward)**
- **Instruct patient to move eyes as quickly as possible from one target to the next.**
- **Perform 10 repetitions-**
 - One repetition is when eyes move back and forth to the starting point.

Abnormal findings indicating a Central Issue may be:

- **Hypermetric- overshoot the target- Can indicate a cerebellar problem**
- **Hypo metric- under shoot the target- Commonly seen in concussion.**

Measure the ability to view a near target without double vision.

- **Examiner seated in front of patient**
- **Patient focuses on small target (14 point font) and starting at arms length brings the target towards the tip of their nose.**
- **Patient is instructed to stop moving the target when they see 2 distinct images or when examiner sees outward deviation of one eye.**
- **Distance in cm is measured between tip of the nose and the target.**
- **Abnormal if more than 6 cm. or eye unable to hold target**
- **Repeat 3 times**

Vestibular-Ocular Reflex Test

- **Assesses ability to stabilize vision while the head moves**
- **Patient is instructed to rotate their head horizontally while maintaining focus on examiner's finger.**
- **Head is moved 20° to each side**
- **Metronome is used to ensure speed is 180 beats per minute.**
- **One repetition is complete when head moves back and forth to the starting position. Perform 10 repetitions**
- **Repeat the test vertically**

VOMS - Visual Motion Sensitivity

VOR Cancellation

Tests ability to inhibit Vestibular-Ocular Reflex and visual motion sensitivity

- **Patient standing, feet shoulder width apart**
- **Patient holds arm outstretched and focuses on their thumb**
- **Patient is instructed to maintain focus on their thumb while they turn their head, eyes and trunk together as a unit.**
- **A metronome is used to ensure the speed is maintained at 50 BPM**
- **Rotate 80° to the right and 80° to the left.**
- **One repetition is complete when trunk rotates back and forth to the starting point. Perform 5 repetitions**



VOMS - Interpretation

- Cutoff scores of 2 total symptoms after any VOMS item or an NPC distance of 6 cm resulted in high rates (96% and 84%, respectively) of identifying concussions.
- Moreover, a combination of VOR, VMS, and NPC distance scores (controlling for age) resulted in a positive prediction rate of 0.89 for identifying this injury.
- The VOMS appears to assess distinct vestibular and ocular motor symptoms, which are unrelated to current clinical balance measures.
- The VOMS may help clinicians to identify patients for vestibular and ocular referrals and more targeted treatment, thereby enhancing recovery from this injury.



King Devick Test

- **King-Devick Test** in association with **Mayo Clinic** is a validated, accurate and objective remove-from-play sideline concussion screening test. With results in less than two minutes, trained parents, coaches, athletic trainers, and medical professionals can quickly assess if an athlete requires additional medical attention.
- On the sidelines it has been used as a visual performance measure that incorporates eye movements and increases the sensitivity in detecting possible concussion in conjunction with standard sideline tests of cognition, symptom checklists and balance.



King Devick Test

- Recommended for subjects older than 9
- Recommend a baseline testing score be obtained.
- Baseline testing should be completed twice.
- Baseline testing should be completed without errors
- For concussion screening test the subject once using the same number of cards used in the Baseline Testing



King Devick Test

- Subject holds test card at normal reading distance. If glasses are worn, it should be noted on test sheet.
- “You will be reading a series of number aloud as quickly as you can without making any mistakes.”
- Utilize the demonstration card and the arrows to show the direction the subject should read.
- The test cards are explained
 - **Increasing difficulty**
 - **Cannot use fingers to follow**
 - **Questions**



King Devick Test

- Tester instructs subject to go to test card 1.
- The tester starts the stopwatch when the subject reads the first number.
- The tester monitors and records any errors
- The tester stops the stopwatch when the test card is complete.
- The subject then flips to the next test card, etc.
- The tester records the **TOTAL TIME** to complete all the test cards.

King Devick Test

<p style="text-align: center;">DEMONSTRATION CARD</p>	<p>2 — 5 — 8 — 0 — 7</p> <p>3 — 7 — 9 — 4 — 6</p> <p>5 — 3 — 1 — 6 — 4</p> <p>7 — 9 — 7 — 3 — 5</p> <p>1 — 5 — 4 — 9 — 2</p> <p>6 — 5 — 5 — 7 — 3</p> <p>3 — 1 — 8 — 6 — 4</p> <p>5 — 3 — 7 — 5 — 2</p> <p style="text-align: center;">TEST I</p>
<p>3 7 5 9 0</p> <p>2 5 7 4 6</p> <p>1 4 7 6 3</p> <p>7 9 3 9 0</p> <p>4 5 2 1 7</p> <p>5 3 7 4 8</p> <p>7 4 6 5 2</p> <p>9 0 2 3 6</p> <p style="text-align: center;">TEST II</p>	<p>5 4 1 8 0</p> <p>4 6 3 5 9</p> <p>7 5 4 2 7</p> <p>3 2 6 9 4</p> <p>1 4 5 1 3</p> <p>9 3 4 8 5</p> <p>5 1 6 3 1</p> <p>4 3 5 2 7</p> <p style="text-align: center;">TEST III</p>

King Devick Test

5 4 1 8 0
4 6 3 5 9
7 5 4 2 7
3 2 6 9 4
1 4 5 1 3
9 3 4 8 5
5 1 6 3 1
4 3 5 2 7

TEST III



King Devick Test

- Youth league Rugby players
 - No witnessed concussion occurred during play.
 - 6 players recorded pre to post match changes with a mean delay of 4 s resulting in concussion subsequently confirmed post-match by health practitioners.
- College level football and basketball players
 - Showed worsening of K-D test score following concussion .
 - High test-retest reliability

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Leong DF, et al J Optom 2015 Apr-Jun; 8 (2) 131-9



Thank You!

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