Evolution of the Vestibular Ocular Motor Screen (VOMS): Implications for Athletic Training Clinical Practice

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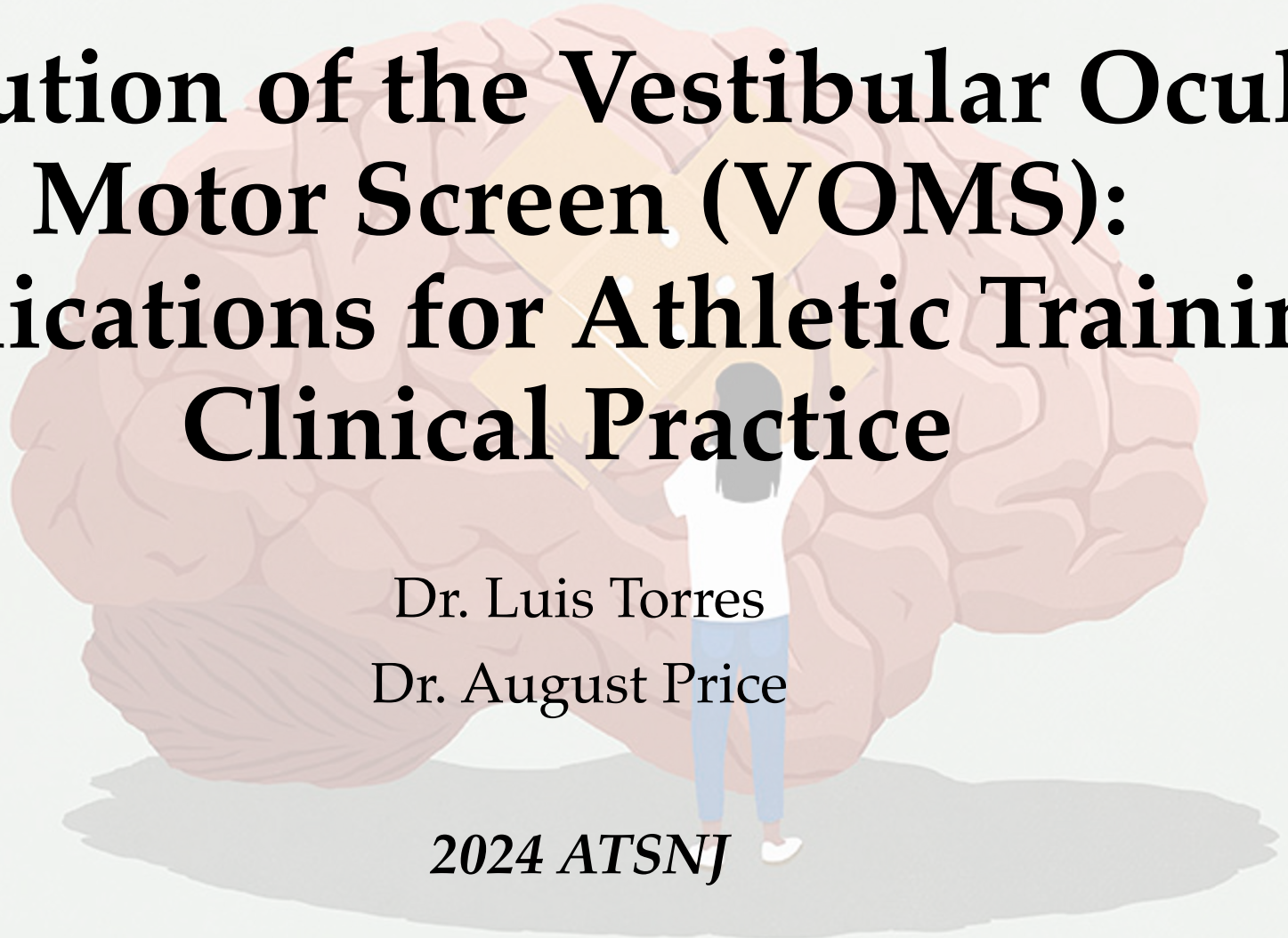

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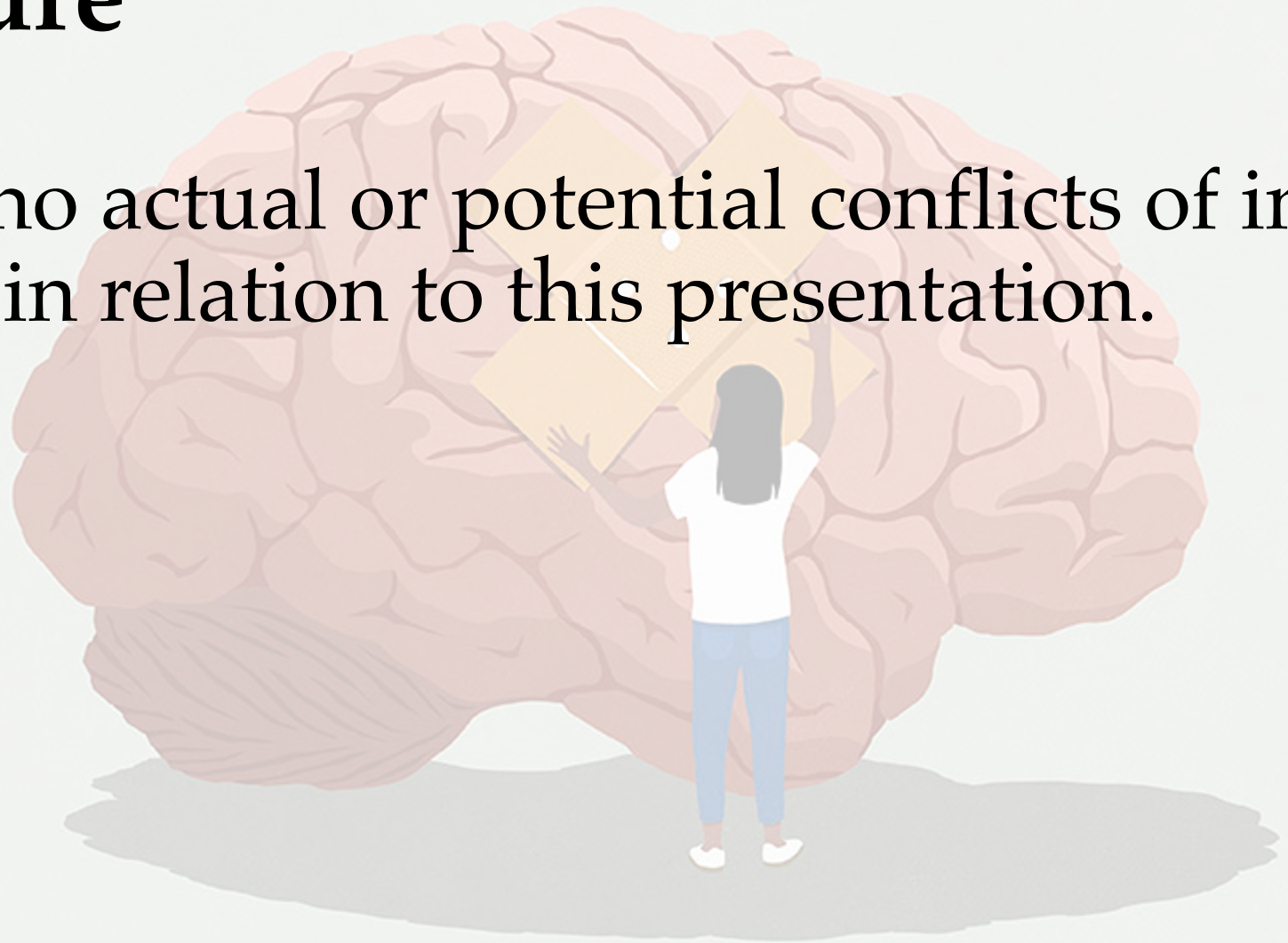
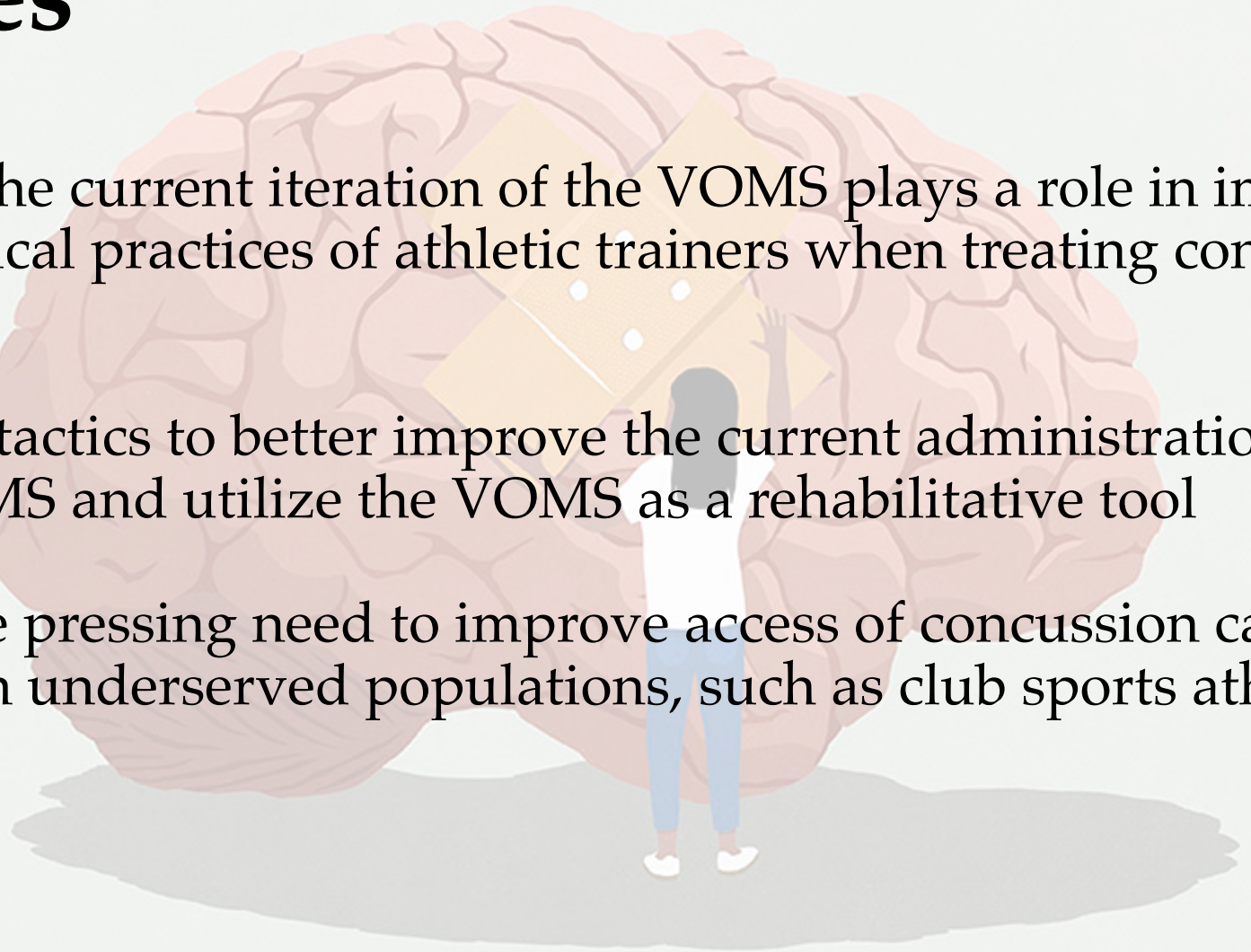
Disclosure

We have no actual or potential conflicts of interest in relation to this presentation.



Objectives



- Evaluate how the current iteration of the VOMS plays a role in improving the current clinical practices of athletic trainers when treating concussed patients
- Apply learned tactics to better improve the current administration of the traditional VOMS and utilize the VOMS as a rehabilitative tool
- Understand the pressing need to improve access of concussion care services to often underserved populations, such as club sports athletes

Why?

- Sports-related concussions (SRCs), defined as temporary disruptions of brain function implicating complex pathophysiological processes because of trauma sustained during sports participation, affect up to **3.8 million** people in the United States alone[1,2]
- According to the UPMC, **5 in 10 go unreported or undetected**
- In 2014 (and some cases still now), we primarily relied on self-reported symptom questionnaires as markers for full physiological recovery (e.g., symptom portion of the SCAT, PCSS, etc.)
- A focus on **symptom provocation** came to be to not delay or miss any appropriate concussion discovery and eventual diagnosing[3]

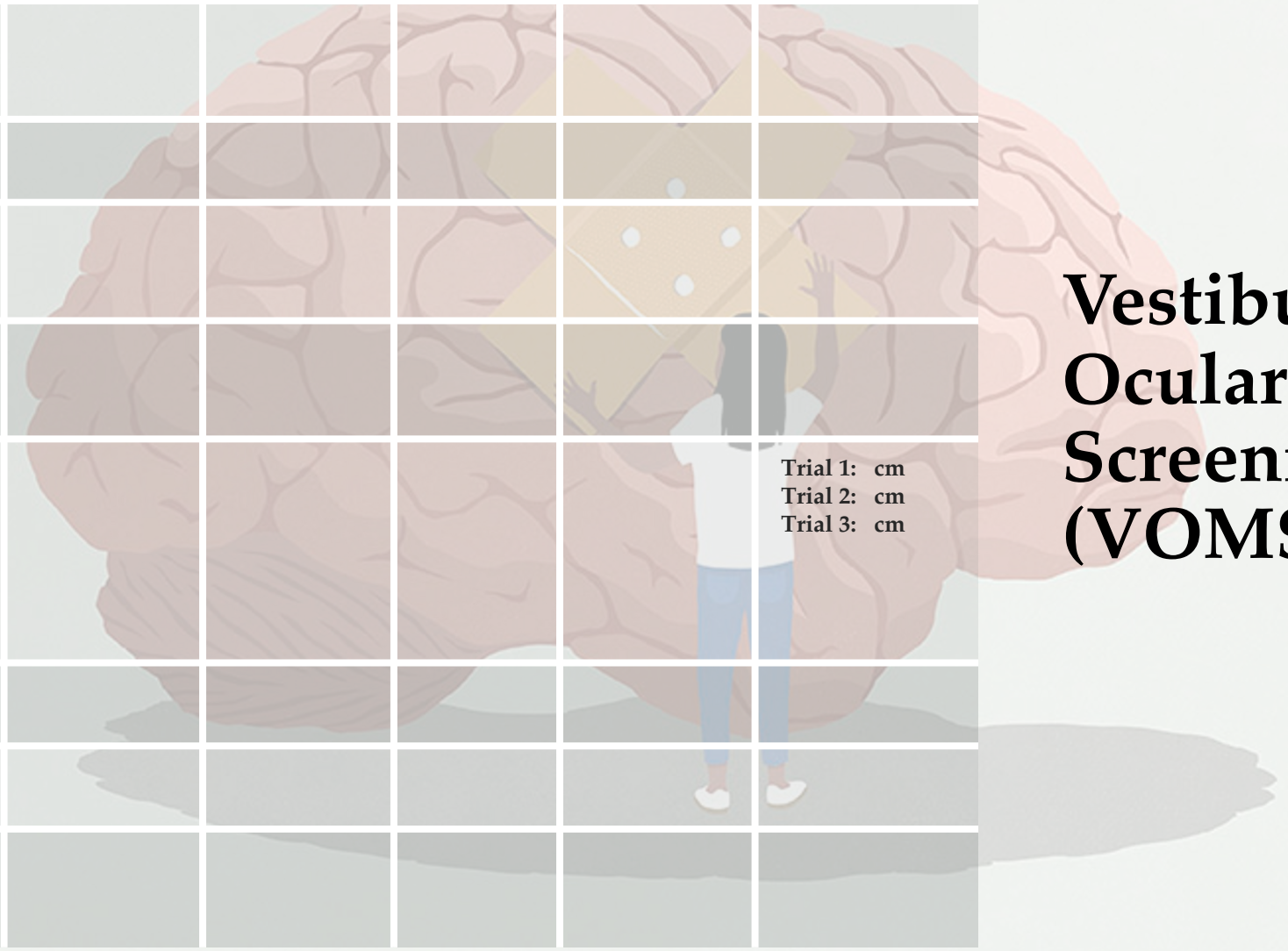
The VOMS as we know it…

- University of Pittsburgh Medical Center developed the Vestibular Ocular-Motor Screening (VOMS) in 2014 to identify the presence of specifically vestibular ocular symptoms (i.e., headache, dizziness, nausea, and fogginess) during the completion of 5 vestibular and ocular function tasks (7 total subtests)[4,5]
  - Smooth Pursuits *[horizontal and vertical]*
  - Saccades *[horizontal and vertical]*
  - Near point of convergence (NPC) *[average distance measurement of 3 attempts]*
  - Vestibular ocular reflex (VOR) *[horizontal and vertical]*
  - Visual Motion Sensitivity

  - Severity of the 4 vestibular ocular symptoms are rated on a scale of 0 (none) to 10 (most severe) both at baseline and at the conclusion of each subtest

Vestibular Ocular Motor Screening (VOMS)

VOMS	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						
Near-point Convergence						Trial 1: cm Trial 2: cm Trial 3: cm
VOR – Horizontal						
VOR – Vertical						
Visual Motion Sensitivity						



10 years later…

- 2014-2017: The VOMS demonstrates a high internal consistency (.92) as well as good sensitivity in identifying patients with SRCs compared to healthy controls[5,6]
- 2017: Decreased symptom provocation over time within all VOMS subtests, except the NPC subtest, is even associated with an increased recovery time after a SRC in youth and adolescent athletes[7]
- 2021: Individual VOMS subtest symptom scores have been shown to be useful in identifying concussions in patients, especially collegiate athletes[8]

10 years later…

- 2022: Some strong existing contradictory evidence relevant to the VOMS does point to a high level of within-individual variability that directly questions its potential lack of meaningfulness in diagnosing[10]
- 2022: The VOMS remains underutilized in its potential applicability given that it is still dependent on the subjective reporting of provoked symptoms[2]
- Aside from NPC measurements, ATs who are currently utilizing the VOMS in clinical practice are usually not collecting any additional relevant objective information from the vestibular and ocular tasks that are being conducted

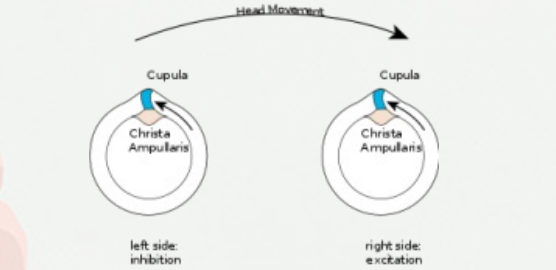
How can we improve the VOMS?

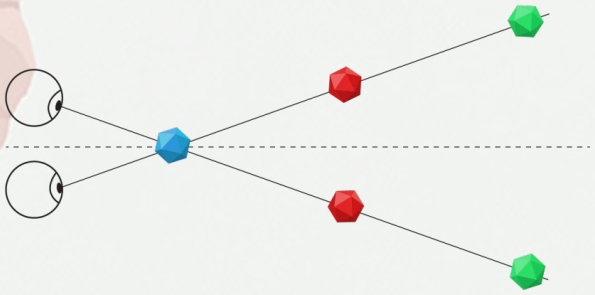
- Expand beyond its diagnostic capabilities
  - Neurorehabilitation!
- Embrace contemporary technology
  - Are patients and clinicians listening to VOMS instructions?
  - Can we get new information from the VOMS? Yes!

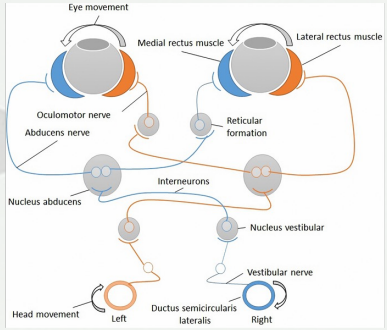
Neuro-Rehabilitation Program

Ocular-motor/vestibular rehabilitation protocol

- **Smooth Pursuits:** a type of visual tracking that allow the eyes to smoothly follow a moving object while the head remains stationary
- **Saccades:** rapid eye movements that allow for quick changes in visual fixation and occur in both the horizontal and vertical plane
- **Convergence:** when the eyes move simultaneously inward (towards the nose) to focus on a near object and / or task
- **Vestibular-Ocular Reflex:** allows for proper coordination of eye movement with head movement
- **Visual Motion Sensitivity:** allows for suppression of the vestibular-ocular reflex so that combined head-eye tracking of a moving object is possible







Comparison of Prescribed Physical Therapy to a Home Exercise Program for Pediatric Sports-Related Concussion Patients

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Abstract: The purpose of this retrospective chart review was to compare sports-related concussion (SRC) recovery time in protracted recovery (≥28 days) patients who were prescribed physical therapy (PPT) with those who were only provided a home exercise program (HEP). We hypothesized PPT would be associated with shorter recovery times relative to HEP. Associations were evaluated with multivariable zero-truncated negative binomial regressions. Among the 48 (30.2%) PPT and 111 (69.8%) HEP patients, the majority were female (57.9%), the mean age was 15.3 ± 1.4 (PPT) and 14.2 ± 2.8 (HEP), and time to clinic was a median 6.0 (IQR = 3.0–27.0; PPT) and 7.0 (IQR = 3.0–23.0; HEP) days. After adjusting for demographic (age, sex) and clinical measures (concussion history, convergence, VOMS, PCSS score, and days to clinic), PPT unexpectedly was associated with 1.21 (95% CI: 1.05, 1.41) additional recovery days compared with HEP. One reason for this could be related to patients adhering to the number of a priori prescribed PT sessions which may or may not have aligned with the patient's symptom resolution. Future research should explore this hypothesis while aiming to evaluate the effect of PPT versus HEP using a randomized design. If confirmed, these findings are encouraging for patients who could not otherwise access or afford specialty rehabilitation.

Citation: Price, A.M.; Arvin, N.; Seagraves, B.; Burkhart, S.O.; Knell, G. Comparison of Prescribed Physical Therapy to a Home Exercise Program for Pediatric Sports-Related Concussion Patients. *Children* **2022**, *9*, 1371. https://doi.org/10.3390/

What are we trying to accomplish?

1. **Improving neuronal communication**
   - ❖ Vestibular nuclei (central and to a lesser extent peripheral) are in constant communication with the ocular motor system
   - ❖ Disruption of neuronal signaling can cause miscommunication between networks (remember the network problem…)
   - ❖ By forcing these networks to better communicate with each other we improve signaling and reduce the sensation of dizziness, nausea, etc.

2. **Desensitization / habituation**
   - ❖ With repeated exposure, individuals become desensitized to symptoms and experience
   - ❖ They "get used to it" → think soldiers in combat
   - ❖ This is also how certain phobias (e.g., arachnophobia) are treated

BOSM Home Exercise Program

☐ **Smooth Pursuits**

Moving Target Pursuits: 3 sets of 10 repetitions x 3 – 5 times per day

Swinging Ball Pursuits: 2 repetitions lasting 30 seconds each x 3 – 5 times per day

Ball Toss Pursuits: 3 sets of 10 repetitions x 3 – 5 times per day

Clock Pursuits: 2 sets of 1 repetitions x 3 – 5 times per day

☐ **Saccades**

Notecard Saccades: 30 seconds horizontally, 30 seconds vertically x 3 – 5 times per day

Matching: 1 sets of 1 repetitions x 3 – 5 times per day

Clock Saccades: 2 sets of 1 repetitions x 3 – 5 times per day

Letter Grid: 2 sets of 1 repetitions x 3 – 5 times per day

☐ **Convergence**

Pencil Push-ups: 2 sets of 1 repetitions x 3 – 5 times per day

Jump Convergence: 2 sets of 1 repetitions x 3 – 5 times per day

Brock String: 2 sets of 1 repetitions x 3 – 5 times per day

☐ **Vestibular-Ocular Reflex (VOR)**

Head Nods: 3 sets of 10 repetitions x 3 – 5 times per day

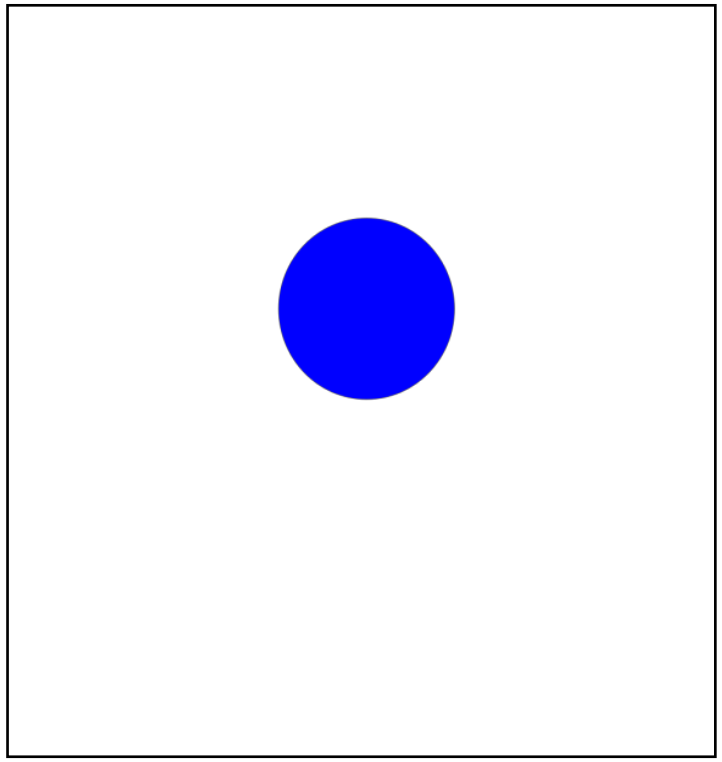
Horizontal Gaze Stabilization Letter Notecards: 3 sets of 10 repetitions x 3 – 5 times per day

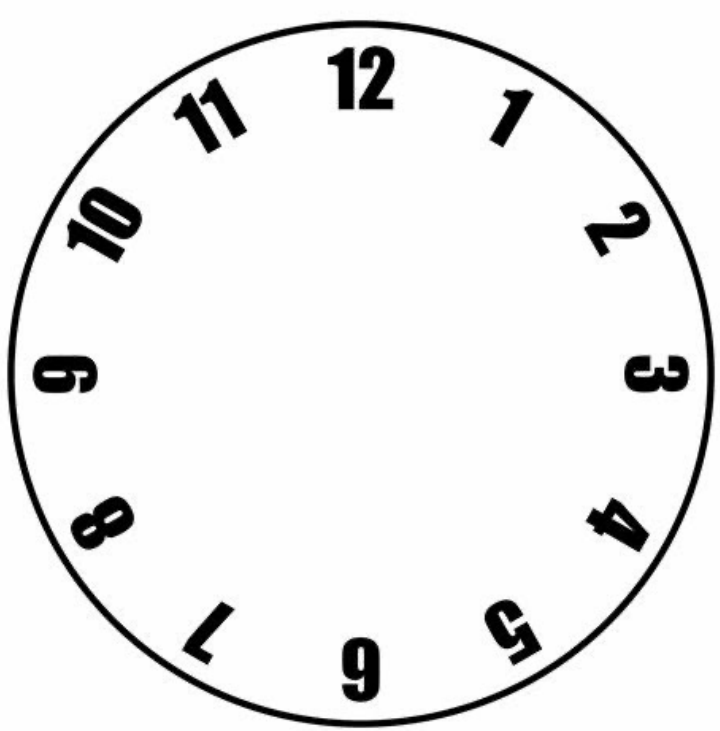
Vertical Gaze Stabilization Letter Notecards: 3 sets of 10 repetitions x 3 – 5 times per day

☐ **Visual Motion Sensitivity (VMS)**

Horizontal VOR Cancellation Letter Notecards: 3 sets of 10 repetitions x 3 – 5 times per day

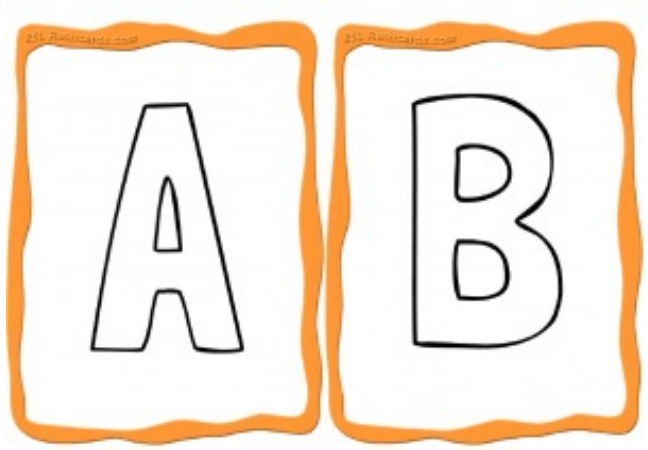
Vertical VOR Cancellation Letter Notecards: 3 sets of 10 repetitions x 3 – 5 times per day

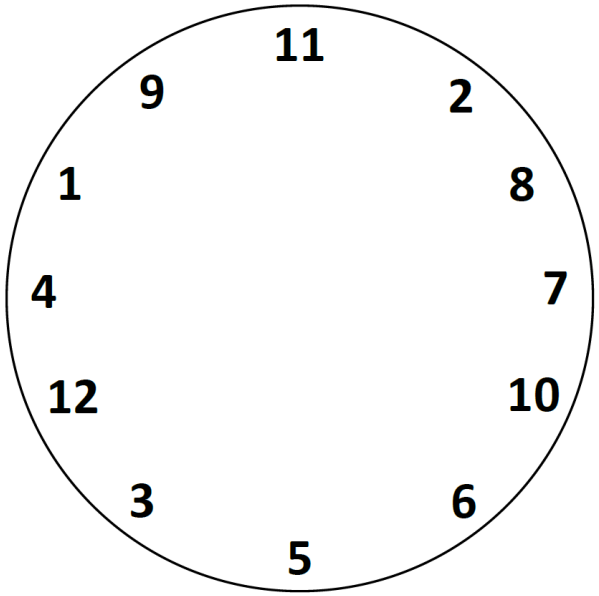


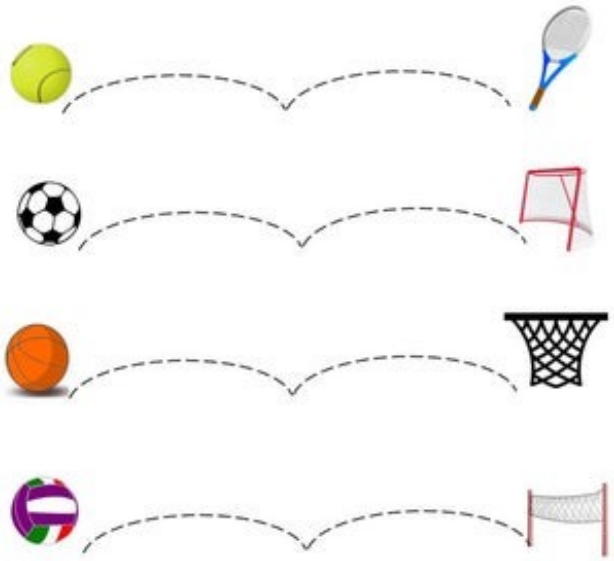


Smooth Pursuits

Saccades

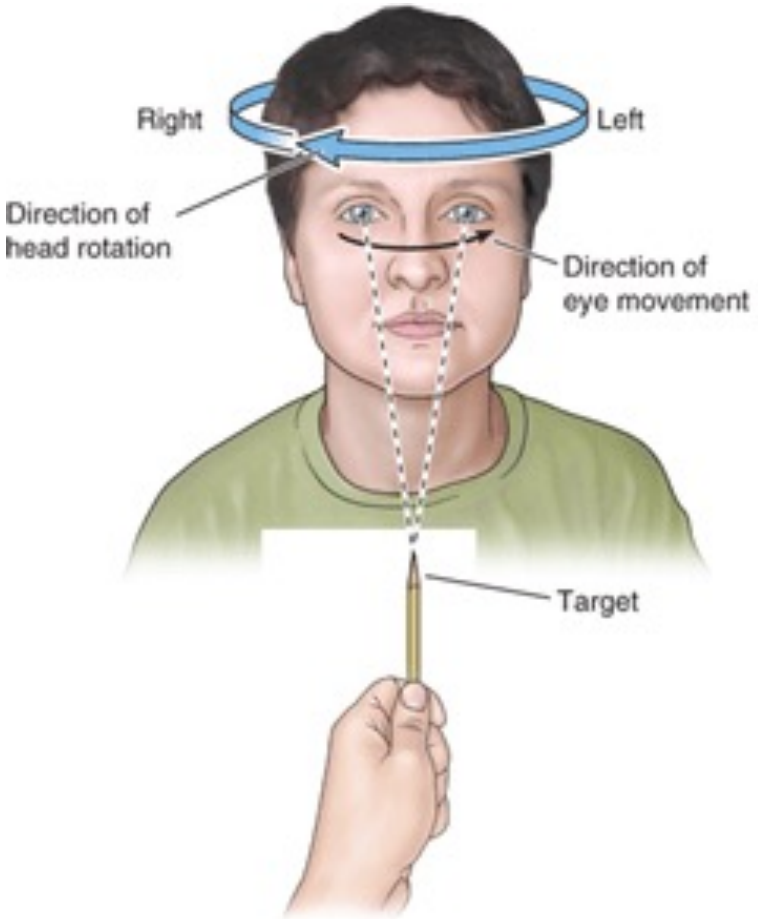


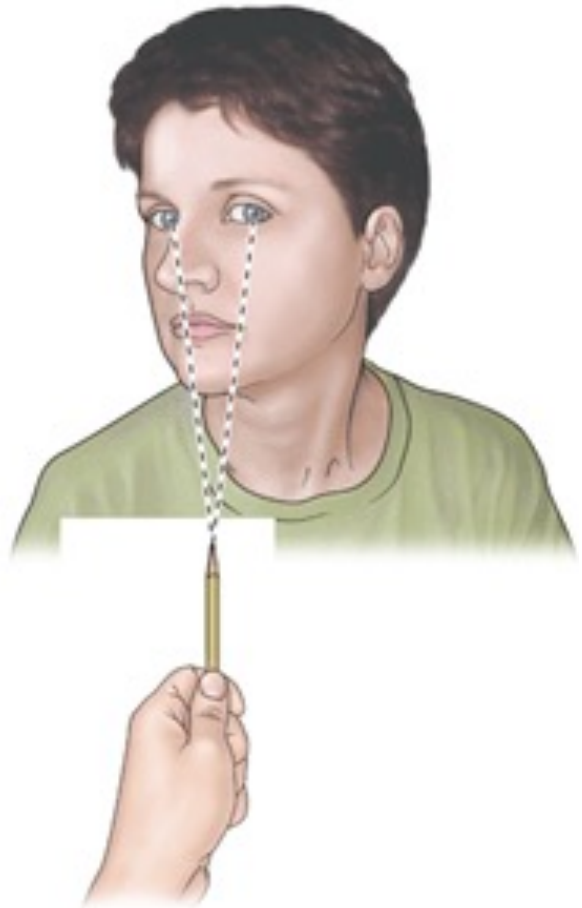




Convergence

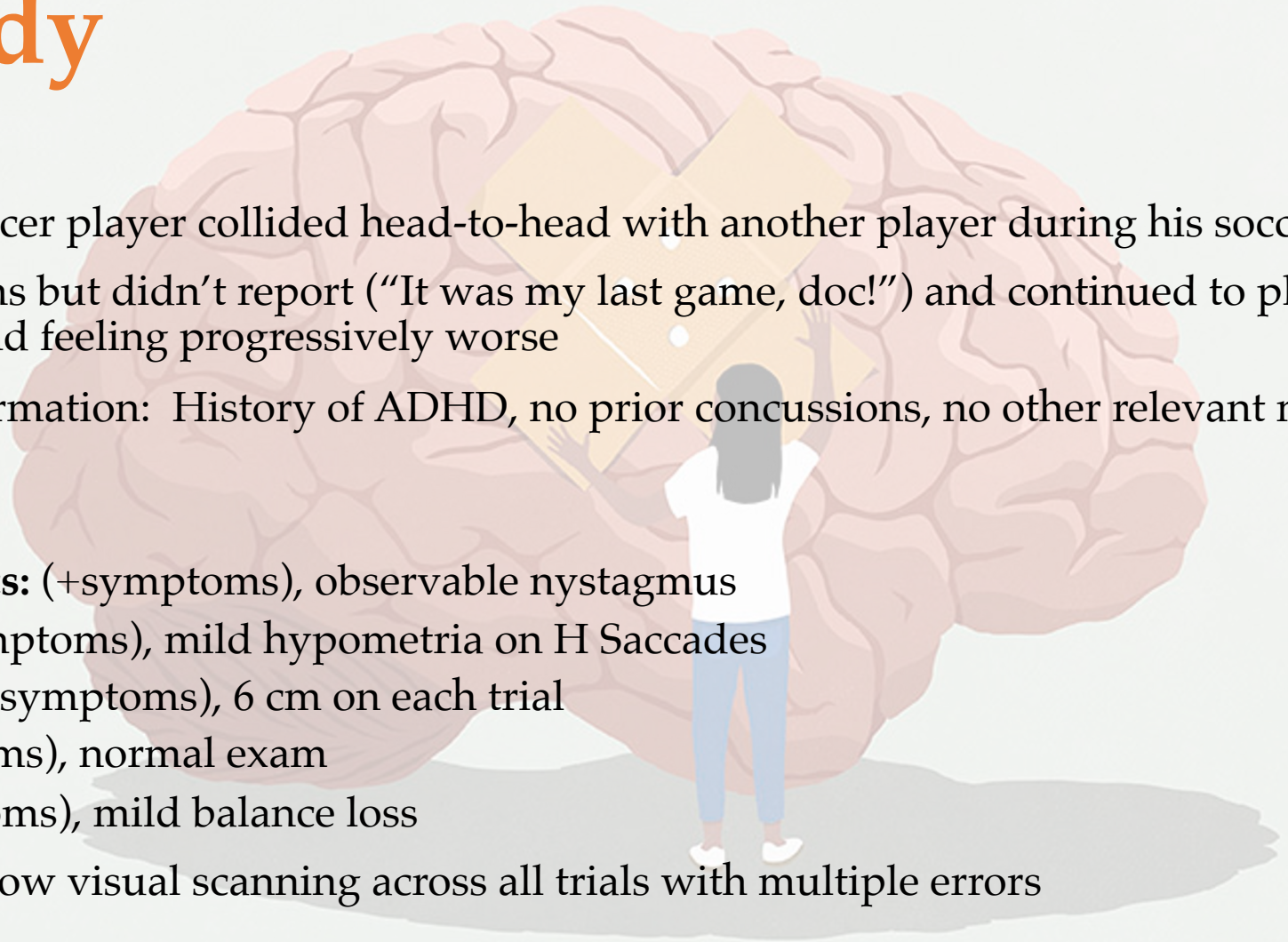
Vestibular-Ocular Reflex





Visual Motion Sensitivity

Case Study



- 16-year-old male soccer player collided head-to-head with another player during his soccer game
- He noticed symptoms but didn't report ("It was my last game, doc!") and continued to play, taking several head balls and feeling progressively worse
- Relevant intake information: History of ADHD, no prior concussions, no other relevant medical or psych history
- VOMS
  - **Smooth Pursuits:** (+symptoms), observable nystagmus
  - **Saccades:** (+symptoms), mild hypometria on H Saccades
  - **Convergence:** (-symptoms), 6 cm on each trial
  - **VOR:** (-symptoms), normal exam
  - **VMS:** (+symptoms), mild balance loss
- King-Devick Test: slow visual scanning across all trials with multiple errors

Neurorehabilitation Remarks…

Generally, concussions cause an energy crisis in the brain resulting in a network disruption problem

The VOMS is an accurate diagnostic, prognostic, AND rehabilitation tool

Consider administering the VOMS each time you check in with an athlete.
The more you practice with it, the more you will gain from it.

Neuro-rehabilitation is effective because it targets neuronal communication and results in desensitization

Start low and go slow with your rehab, discontinue/reduce exercises as indicated

Ensure the athlete is aware that they will not feel great while doing the exercises, that means it's working.
Point out how much they are improving as you go, always convey optimism.

The future of the VOMS…

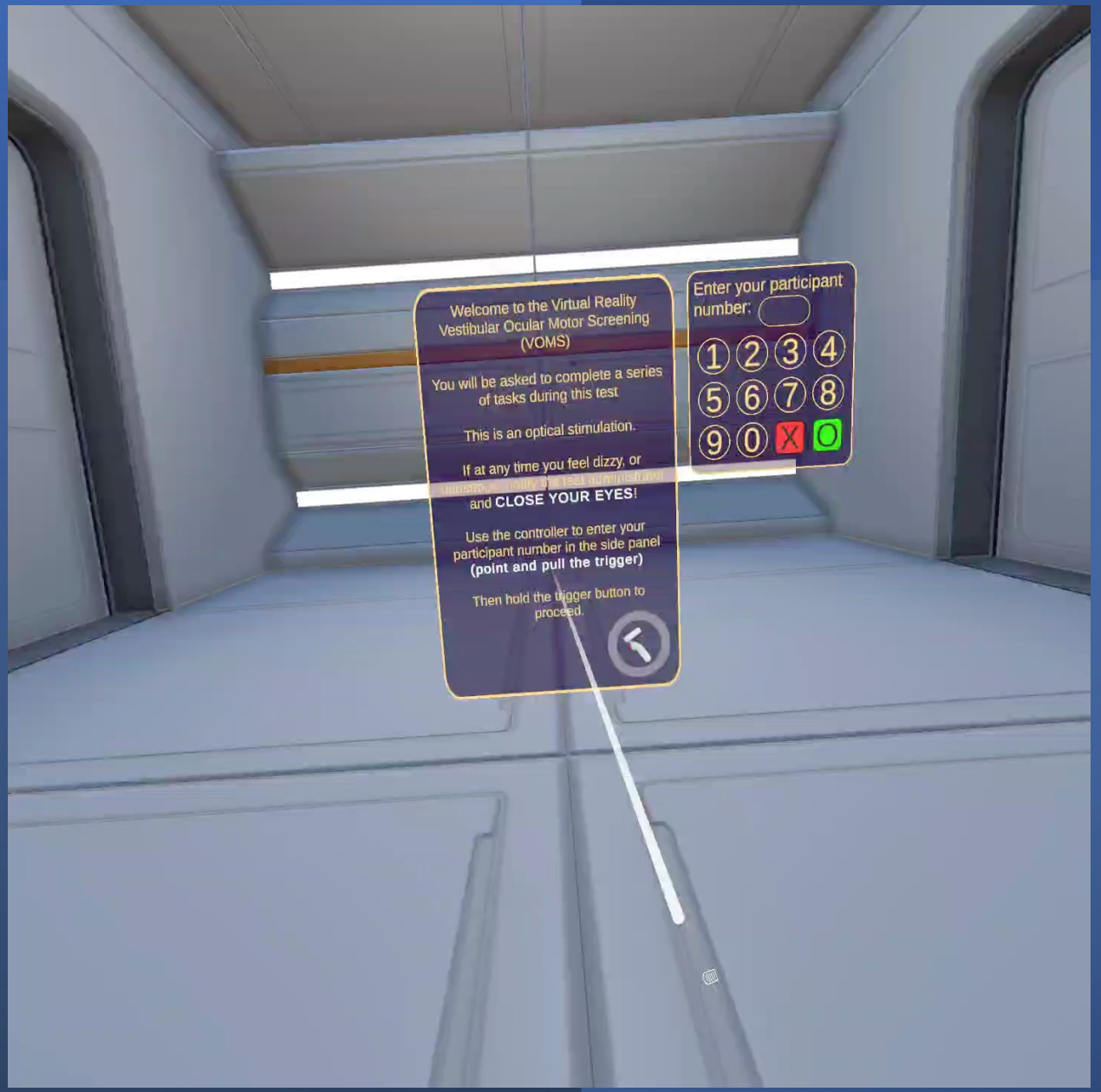
- As the use of the VOMS continues to grow, it needs to be fully established that patients are objectively completing the subtests in the way they are intended
- This could be determined with the use of contemporary eye-tracking technology, particularly during the smooth pursuit, saccadic, and VOR tasks of the VOMS
- The lack of standardization of the traditional VOMS administration also needs to be addressed, given that the arms lengths and distance perceptions of clinicians can vary[2]
- Virtual reality (VR) headset technology has emerged as a potential solution to enhance the objectivity and downplay the subjectivity of the VOMS assessment[2,11]

Our Future Study

- We are considering collegiate club sports athletes as those who may be among those most in need for improved SRC surveillance and treatment
- These athletes are important to study because as many as **40% of collegiate club-sport athletes fail to report concussions** and, in some cases, collegiate club sports athletes face higher injury rates than traditional collegiate athletes[12,13]
- Collegiate club sports athletes are also at an increased risk of head injury when playing a sport different from what they participated in during high school[14]
- Access to concussion care services needs to be summarily improved for all collegiate club sports athletes

Comparison of Traditional and Virtual Reality Vestibular Ocular Motor Screening (VOMS) Application in Collegiate Athletes Before and After Sports-Related Concussion

Torres L, Sandri-Heidner G
Horn R, Price AM, Gardin FA



Clinical Bottom Line

- ATs should re-evaluate the current role of the VOMS in their current clinical practice when dealing with concussed athletes
- Through appropriate training, guidance, and discussion with their plan of care physicians, they should not shy away from utilizing vestibular and ocular elements of the VOMS subtests as post-concussive rehabilitative tools
- Additionally, ATs should begin to see contemporary technology as a growing supplement to the current iteration of the VOMS, not a hindrance

Thank you!

MONTCLAIR STATE UNIVERSITY

Bellapianta Orthopaedics Sports Medicine

ATSNJ Athletic Trainers' Society of New Jersey

References

1. Harmon J, Drezner M, Gammons K, et al. American medical society for sports medicine position statement. Clin J Sports Med. 2013;23(1):1-18.
2. Hossain KF, Kamran SA, Sarker P. Virtual-reality based vestibular ocular motor screening for concussion detection using machine learning. Adv Comput. 2022:229-241.
3. Powell D, Stuart S, Godfrey A. Wearables in rugby union: a protocol for multimodal digital sports-related concussion assessment. PLOS One. 2021;16(12):1-17. doi:10.1371/journal.pone.0261616
4. Bliss RA, Carr WD. Knowledge of vestibular ocular dysfunction and utilization of vestibular ocular motor screen (VOMS) tool components among professional league athletic trainers. Int J Sports Phys Ther. 2020;15(4):603-610. doi:10.26603.ijspt.20200603
5. Mucha A, Collins MW, Furman JM, et al. A brief vestibular/ocular motor screening (VOMS) assessment to evaluate concussions. Am J Sports Med. 2014;42(10):2479-2486. doi:10.1177/0363546514543775
6. Yorke AM, Smith L, Babcock M, Alsalaheen B. Validity and reliability of the vestibular/ocular motor screening and associations with common screening tools. Sports Health. 2017;9(2): 174-180. doi:10.1177/1941738116678411
7. Anzalone AJ, Blueitt D, Case T, et al. A positive vestibular/ocular motor screening (VOMS) is associated with increased recovery time after sports-related concussion in youth and adolescent athletes. Am J Sports Med. 2017;45(2):474-479. doi:101177/0363546516668624

References

8. Kontos AP, Eagle SR, Marchetti G, et al. Discriminative validity of vestibular ocular motor screening in identifying concussion among collegiate athletes. Am J Sports Med. 2021;49(8):221-2217. doi:10.1177/036354652110123 59
9. Kaae C, Cadigan K, Lai K, Theis J. Vestibulo-ocular dysfunction in mTBI: utility of the VOMS for evaluation and management - a review. NeuroRehabilitation. 2022;50(1):279-296. doi:10.3233/NRE-227012
10. Ferris LM, Kontoa AP, Eagle SR, et al. Optimizing VOMS for identifying acute concussion in collegiate athletes: findings from the NCAA-DoD CARE consortium. Am J Sports Med. 2022;50(4):1106-1119. doi:10.1177/03635465211072261
11. Pavilionis P, Adhanom IB, Moran R, Taylor MR, Murray NG. Virtual reality application for vestibular motor screening: current clinical protocol versus a novel prototype. Sports Health. 2023
12. Beidler E, Bretzin AC, Hancock C, Covassin T. Sports-related concussion: knowledge and reporting behaviors among collegiate club-sports athletes. J Athl Train. 2018;53(9):866-872. doi:10.4085/1062-6050-266-17
13. Arthur-Banning SG, Jameyson D, Black K, Mkumbo P. An epidemiology of sport injury rates among campus recreation sports programs. J Rehabil Sci. 2018;3(2):38-42.
14. Moran RN, Guin JR, Louis M, Rhodes K. Concussion-like symptom evaluation and modifying factors for assessment in collegiate club-sports athletes. J Athl Train. 2023. doi:10.4085/1062-605–0645.22