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brain + performance

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**Date of Evaluation:**

**Client:**
John Joseph Doe (DOB: 2006-08-20)
298th Crescent SE
Melbourne, FL, USA
3212313213

**Emergency contact:**
Sam Doe
3212312313

**Deliver Report to:** samdoe@outlook.com

# Background:

John (“John”) Joseph Doe (DOB: 2006-08-20) is a 16 year-old Male, residing in Melbourne, FL, USA. They are Single. Their dependency status was reported as Minor.  Their highest level of education was reported to be 9th Grade. Their current occupation is a student at Holy Trinity. They stated that they participate in Basketball this year/season.

Their primary care provider was reported as Dr. Cynthia Williams. When asked if they had a medical physical this season, they said their last medical evaluation/ physical was reported to be on 2022-01-10. When asked what their current challenges are, they stated Auditory Processing, Communicating, Focus/Attention, Making Decisions, and Spatial Awareness; and they had the following diagnoses: None of the Above. They report that they suspect that they have sustained 12 concussions, and 8 were documented. When asked about COVID-19, they responded that they Tested Positive at Some Point. They are taking the following medications: Accutane and supplements: creatine, iron, and vitamin D. They follow No Special Diet. They were asked about their smoking, alcohol, and drug use status and reported that they have never used it.

John was checked in by Sam Doe, who gave the authorization to participate in a brain health assessment and concussion baseline, under the direction of Dr. Matthew Antonucci. When Sam Doe was asked if they consented to permission to share information, they responded with Yes. Regarding permission to use anonymous data for research purposes, they responded with Yes. When asked about permission to allow observation by others, they responded with Yes. All consent forms were read, and executed.

John was asked about their medication usage within the last 12 hours and reported taking Accutane within the 12 hours prior to the assessment.  At the time of the evaluation, they were wearing Neither Glasses nor Contacts.

A series of standardized questionnaires and neurological assessments were administered to collect data on all topics outlined by the 2017 Berlin Concussion Consensus, and those used in common practice, including the following domains: demographics, anthropometrics, medications, quality of life, sleep quality, cardiovascular/autonomic nervous system function, subjective symptom evaluation, balance, multiple domains of cognitive function, visual acuity, visual fields, stereopsis, ocular alignment, oculomotor function, cervical proprioception, and vestibular function. The results of these evaluations are detailed in this report.

# Anthropomorphology:

| Measurement | Value | Unit | |
|---|---|---|---|
| **Height** | 69 | Inches | |
| **Weight** | 132 | Pounds | |
| **Body Temperature** | 98.5 | ºF | 98.6º ± 0.6 |
| **Body Mass Index (BMI)** | 19.49 | | 18.5 - 24.9 |

# Quality of Life

**Youth Quality of Life Instrument- Research (YQOL-R).** This instrument is a questionnaire that is completed by the athlete, that has been validated on youths from ages 12-18, and assesses 5 domains: total Quality of Life, sense of self, social relationships, culture and community environment, and general QOL. The items are designed to assess the youths' "position in life" as defined by the World Health Organization Quality of Life (WHOQOL) group. Psychometrics on the YQOL-R perceptual scales have yielded acceptable internal consistency (Cronbach α range, .77–.96), reproducibility (intraclass correlation coefficient range, .74–.85), associations with similar concepts (r=.73), and ability to distinguish among groups with disabilities (Cronbach α range, .77–.96). (PMID: 18164341).

The overall score is reported on a scale of 0 to 100. The 50th percentile score is 91.2. A higher score indicates a higher quality of life. A score of **greater than 82 is desirable**. A score less than 75 warrants a discussion with your pediatrician.

## Athlete's YQOL-R Score: 94

# Symptom Analysis:

**Graded Symptom Checklist:** GSC is a 27-symptom subjective inventory, completed by the athletes, that allows them to rate each symptom on a scale of 0 (none) to 6 (severe). Symptoms are analyzed by a) Total Symptom Burden, b) Symptom Count, c) Defined Symptom Clusters. Lower scores in all categories indicate fewer symptoms. Symptoms have been observed to negatively correlate with the quality of life (the higher the symptoms, the lower the quality of life). There have been a number of symptoms connected with concussions, too. However, it has been reported that as much as 19% of high school boys and 28% of high school girls report having a symptom profile similar to post-concussion syndrome (PMID: 30785950). This is why concussion cannot be diagnosed off symptoms alone.

**Symptoms identified as absent (0):** More emotional, Irritability, Sadness, Nervous or anxious, Headache, Pressure in head, Sensitivity to light, Sensitivity to noise, Numbness or tingling, Ringing in the ears, Neck Pain, Feeling slowed down, Feeling like in a fog, Sleeping more than usual, Trouble falling asleep, Sleeping less than usual, Difficulty sleeping soundly, Nausea or vomiting, Don't feel right, Dizziness, Balance Problems, Blurred vision

**Symptoms identified as minor (1-2)**: Drowsiness, Confusion

**Symptoms identified as moderate (3-4):** Difficulty concentrating, Difficulty remembering, Fatigue or low energy

**Symptoms identified as severe (5-6):**

| Measurement | Value | 50th Percentile | Unit |
|---|---|---|---|
| Total Symptom Burden | 13 | <2 | Points |
| Symptom Count | 5 | <2 | Symptoms |
| Avg Symptom Severity | 0.5 | <1 | Points |
| Symptoms Category: Autonomic | 0.1 | <1 | Points |
| Symptoms Category: Affect/Mood | 0 | <1 | Points |
| Symptoms Category: Cervicogenic | 0 | <1 | Points |
| Symptoms Category: Cognitive | 1.7 | <1 | Points |
| Symptoms Category: Sleep | 0 | <1 | Points |
| Symptoms Category: Vestibular | 0 | <1 | Points |
| Symptoms Category: Visual/Ocular | 0 | <1 | Points |

# Sleep:

**Pittsburgh Sleep Quality Assessment (PSQI).** This instrument is a questionnaire with very specific questions about sleep, that was completed by the athlete. It is one of the most validated tools to measure sleep quality, with the ability to predict outcomes of sleep studies, and over 21,000 research citations since its inception in 1989. The PSQI displays acceptable measures of internal homogeneity, consistency (test-retest reliability), and validity have been obtained.

A global PSQI score that is greater than 5 yields a diagnostic sensitivity of 89.6% and specificity of 86.5% in distinguishing good and poor sleepers (kappa = 0.75, p less than 0.001) (PMID: 2748771). Therefore, a **normal score is less than 5.**

## Athletes PSQI Score: (Was Not Completed)

# Autonomic Function

**Composite Autonomic Symptom Score (COMPASS-31).** The COMPASS-31 is a more time-efficient, simplified version of the statistically robust and well-validated, 169 question ASP (Autonomic System Profile) developed by the Mayo Clinic in 1999. The COMPASS-31 is a 31-question survey completed by the athlete, that probes 6 domains of autonomic function: Orthostatic Intolerance, Vasomotor function, Secretomotor function, Gastrointestinal function, Bladder function, Pupillomotor function, and it provides a total autonomic score. Following appropriate weighting, this instrument provides an autonomic symptom score from 0 to 100.

A normal score is **less than 12.** Higher scores represent greater autonomic dysfunction (PMID: 23218087)

## Athlete's COMPASS-31 Score: 10

**Autonomic Testing**

Finger pulse oximetry was performed to screen for hypoxia. Heart rate and blood pressures of the patient's right arm were assessed in the seated position, after 3 minutes supine, and then 30 seconds after standing. An appropriate physiological response is a decrease in heart rate, systolic, and diastolic blood pressure when lying down, then an increase of approximately 20-30%, 30 seconds after standing. (PMID: 8089249). In addition to the above-listed cardiovascular measurements, the athlete's heart and carotid vessels were auscultated after standing, for murmur and arrhythmia. (PMID: 27372849). These reflexes are a measurement of autonomic (brain) control over the heart and blood vessels.

| Auscultation Region | Finding | Desired Finding |
|---|---|---|
| Aortic | Normal | Normal |
| Pulmonic | Normal | Normal |
| Erbs | Normal | Normal |
| Tricuspid | Normal | Normal |
| Mitral | Normal | Normal |
| Overall Rhythm | Normal | Sinus Rhythm |
| TERC Murmur | Normal | Absent |

| Measurement | Value | Ideal Range | Unit |
|---|---|---|---|
| Finger Oximetry | 100 | 96-100 | SpO2 % |
| Heart Rate (Seated) | 85 | 60-80 | BPM |
| Systolic BP (Seated) | 135 | 110-120 | mmHg |
| Diastolic BP (Seated) | 83 | 70-80 | mmHg |
| Heart Rate (3 min Supine) | 83 | 55-75 | BPM |
| Systolic BP (3 min Supine) | 135 | 105-115 | mmHg |
| Diastolic BP (3 min Supine) | 74 | 65-75 | mmHg |
| Heart Rate (Standing + 30 sec) | 88 | 70-90 | BPM |
| Systolic BP (Standing + 30 sec) | 147 | 115-125 | mmHg |
| Diastolic BP (Standing +1 min) | 83 | 75-85 | mmHg |
| (Standing-Supine)/Supine HR | 6 | + 10-25 | % |
| (Standing-Supine)/Supine BP(s) | 8.9 | - 20-25 | % |
| (Standing-Supine)/Supine BP(d) | 12.2 | - 20-25 | % |

# Cognitive Function

**C3 Logix:** This iPad-based neurological assessment suite was created by the Cleveland Clinic's Concussion ("C3") program to provide baseline neurological testing, incident reporting, and return to play management. It complies with the 2017 Berlin Concussion Consensus as a standalone concussion suite, is used by the National Hockey League as well as the National Football League. It also allows customized workflows to add greater diagnostic resolution. The workflow that Dr. Antonucci created includes the **Standardized Assessment of Concussion (SAC), Balance Error Scoring System (BESS), Trail Making Test (TMT-A, TMT-B), Digit-Symbol Substitution Test (Processing Speed), and Reaction Speed Testing (SRT, CRT).**

**The SAC** is an evaluation that was created at the latest international concussion consensus (2017 in Berlin) to measure common cognitive functions that are compromised in concussion. These functions are orientation, concentration, immediate memory, delayed memory. 5 points are possible for each of the following: orientation, concentration, and delayed memory. 15 points are possible for immediate memory. The points are added together and the highest (best) possible score is 30/30. (PMID: 26159882)

| Function | Points | Normative Value |
|---|---|---|
| Orientation | 15 | ≥ 4 |
| Concentration | 5 | ≥ 4 |
| Immediate Memory | 4 | ≥ 14 |
| Delayed Memory | 5 | ≥ 4 |
| Total Score | 29 | ≥ 26 |

**TMT** is one of the most popular neuropsychological tests, designed in 1944, with over 3,000 publications citing its validity for visual search, scanning, speed of processing, mental flexibility, and executive function. (PMID: 15010086). The test consists of two parts: Part A, and Part B. Part B should take no more than approximately twice as long as Part A.  Faster times indicate better performance.

| Measurement | Value | Normative Value |
|---|---|---|
| TMT-A Time | 25.2 | ≤ 22 seconds |
| TMT-B Time | 51.3 | ≤ 48 seconds |
| B/A | 2.04 | ≤ 2.2 |

**Digit Symbol Substitution Test (Processing Speed)** is perhaps the most commonly used test in all of neuropsychology, owing to several inherent properties: brevity, reliability, and the minimal impact of language, culture, and education on test performance. Good performance on the DSST requires intact motor speed, attention, and visuoperceptual functions, including scanning, associative learning, working memory, attention, and other executive functions. (PMID: 30124583) The number reported is the number of symbols and digits matched in 120 seconds. The better the athlete's processing speed, the more matches they will be able to make.

| Measurement | Value | Normative Value |
|---|---|---|
| Digits and Symbols Matched | 54 | ≥ 57 symbols |

**Reaction Time** is defined as the interval of time between the presentation of the stimulus and the appearance of appropriate voluntary response in the subject. We tested both simple and choice reaction times. Simple RT: one stimulus and one response. Choice RT: multiple stimulus and multiple responses. Fast RTs can produce rewards (e.g. in sports) whereas slow RT can produce grave consequences (e.g. driving and road safety matters). Concussions have shown to slow both simple and choice reaction times, even once symptoms have abated. Choice reaction times have been found to be slower than baseline for up to 22 months after sustaining a concussion (PMID: 11502926)

| Measurement | Value | Normative Value |
|---|---|---|
| Simple Reaction Time (ms) | 301 | ≤ 284 milliseconds |
| Choice Reaction Time (ms) | 459 | ≤ 412 milliseconds |
| Choice-Making Speed (ms) | 158 | ≤128 milliseconds |

**Anti-Saccades** are a type of eye movement in which a person ignores a stimulus and purposefully performs a movement in the opposite direction. One of the hallmarks of cognitive control is the suppression of prepotent but inappropriate responses. This task requires integrity in the frontal lobe's ability to produce attention, focus, short-term memory, and impulse suppression. 20 trials were performed and correct responses were recorded.

| Measurement | Value | Normative Value |
|---|---|---|
| Correct Antisaccades | 11 | ≥ 16 out of 20 |

**Cambridge Brain Science (CBS):** With 25+ years of supporting research, CBS has performed more than 10 million (and counting) assessments, and has been used in 300+ peer-reviewed academic papers. It is one of the leading online platforms for cognitive assessment with one of the largest secure cognitive databases. They offer 12 different tests that cover 4 major cognitive areas: Memory, Reasoning, Verbal Ability, and Concentration. For time efficiency, Dr. Antonucci selected 6 tasks that have the most relevance for academic and sports performance, as well as issues that might affect high school students: concussion, AD/HD, Dyslexia, Frontal Lobe Dysfunction, Temporal Lobe Dysfunction, PTSD, and Depression.

Examples of these different types of cognitive skills include:

**Grammatical Reasoning** (Verbal Reasoning): Understanding complex everyday speech—e.g., "I didn't know that he wasn't going to show up."; Giving clear verbal or written instructions to people at work or school; Reading a contract and understanding what you are agreeing to; Writing a clear description of an item to explain it.

**Token Search** (Working Memory): Systematically searching for a lost item in your home. Solving a mystery by remembering a set of clues, then rearranging them in your mind. Tell a story and form a theory. Find the most efficient way to complete a to-do list of tasks around your home before leaving in the morning. Efficiently navigating shifting priorities.

**Spatial Span** (Spatial Short-Term Memory): Watching somebody perform a task step-by-step, then doing the same task yourself, such as in sports or gym classes. Navigating after getting directions from somebody pointing on a map. Implementing a strategy you have in memory, like an opening move in chess. Remember the positions of cars on the road while you make a difficult driving maneuver. Following a set of dance moves or a play in sports, or giving directions to someone for a route you just took.

**Polygons** (Visuospatial Processing): Performing actions that require precise assessment and reasoning about objects. Repair items by spotting what is wrong with them and applying the right fix. Identifying a mistake in a document at work. Doing graphic design work or creating a website.

**Odd One Out** (Deductive Reasoning): Evaluating a complex argument and deciding if you agree. Applying government rules to your finances to properly do your taxes. Noticing the details of a story and making inferences beyond what is directly stated— such as a character's emotions, or the story's message. Creating effective arguments for a position in a debate or essay.

**Double Trouble** (Response Inhibition): Keeping your eyes on the road when driving, despite receiving a text message, or passing distracting signs/people. Blocking out background conversations when you're on the phone. Inhibiting your emotional gut reaction to a social media post to formulate a more rational response.

Scores are reported in a raw score, a percentile, and a 3 category (below average, average, above average) stratification.

After performing these tasks, the athlete was asked which tasks they found difficult. They replied with: Verbal Reasoning

| Task | Raw Score | Percentile | Interpretation |
|---|---|---|---|
| **Grammatical Reasoning** (Verbal Reasoning) | 84 | 15 | Below Normal |
| **Token Search** (Working Memory) | 102 | 54 | Average |
| **Spatial Span** (Spatial Short-Term Memory) | 97 | 43 | Average |
| **Polygons** (Visuospatial Processing) | 109 | 72 | Average |
| **Odd One Out** (Deductive Reasoning) | 107 | 68 | Average |
| **Double Trouble** (Response Inhibition) | 98 | 44 | Average |

# VISION/OCULAR ASSESSMENT

**Ocular Dominance:** 95% of the population has a dominant eye. It tends to be on the same side as their hand and foot dominance. 5% of the population do not have a dominant eye and they are termed to be “ambi-ocular”, similar to being ambidextrous. Having mixed dominance is not an issue, but it tends to lead to lower neurological efficiency. Assessing dominance is important for certain tests, but it is also important to document prior to an injury to see if dominance has shifted.

**Dominant Hand: Right**
**Dominant Foot: Right**
**Dominant Eye: Left**

**Visual Suppression** is evaluated to ensure that an individual is utilizing both of their eyes to see. Seeing with two eyes is called “stereopsis”, and when someone is only using one eye to see, it is called visual suppression. Visual suppression is a lot more common than you might think. There are generally 3 types of visual suppression. A person can 1) suppress vision from an entire eye, 2) suppress vision of distant objects while preserving near objects, 3) suppress vision of near objects and preserve the vision of distant objects. Visual suppression can easily be measured utilizing a test that is called Thumb-Thing.

Findings of Thumb-Thing Test: Looking at Thing: 2 Thumbs, and Looking at Thumb: 2 Things

**Suppression Status:** No suppression

**Brock Bead String Evaluation:** Using a 3-meter string with beads placed at 5 cm, 33 cm, 100 cm, 200 cm, and 300 cm, it is possible to assess an individual’s ability to converge, accommodate, maintain binocular vision (stereopsis). At all distances, an individual should be able to see the bead clearly (proper alignment and accommodation at 5 cm), see two strings (false images) going into the bead, and two strings (false images) coming out of the bead, except at 300 cm.

- **5 cm bead:** One Bead Observed, The Bead Was Clear, 2 Strings Were Observed Into The Bead (Near Stereopsis), and 2 Strings Were Observed Out of The Bead (Far Stereopsis)
- **33 cm bead:** One Bead Observed, The Bead Was Clear, 2 Strings Were Observed Into The Bead (Near Stereopsis), and 2 Strings Were Observed Out of The Bead (Far Stereopsis)
- **100 cm bead:** One Bead Observed, The Bead Was Clear, 2 Strings Were Observed Into The Bead (Near Stereopsis), and 2 Strings Were Observed Out of The Bead (Far Stereopsis)
- **200 cm bead:** One Bead Observed, The Bead Was Clear, 2 Strings Were Observed Into The Bead (Near Stereopsis), and 2 Strings Were Observed Out of The Bead (Far Stereopsis)
- **300 cm bead:** One Bead Observed, The Bead Was Clear, 2 Strings Were Observed Into The Bead (Near Stereopsis), and 2 Strings Were Observed Out of The Bead (Far Stereopsis)

**Visual Acuity:** The ability to target, control, and process visual images is heavily influenced by neurological integrity. In this assessment, we measured visual acuity, both static and dynamic (with the head moving) in a unit called LogMAR ( the Logarithm of the Minimum Angle of Resolution). We then compared both static and dynamic visual acuity to each other. 0.00 logMAR is considered 20/20 vision. Lower numbers equate to higher visual acuity, while higher numbers equate to poorer visual acuity. C3 Logix compares static and dynamic visual acuity to generate a value called “Line Difference”. This measurement is a proxy to the vestibular ocular reflex. The larger this value is, the poorer the vestibular ocular reflex is functioning.

| Measurement | Value | Normative Value |
|---|---|---|
| Static Visual Acuity | -.26 | ≤ 0.00 LogMAR |
| Dynamic Visual Acuity | -.08 | ≤ 0.10 LogMAR |
| Static-Dynamic Line Difference | 1.8 | ≤ 0.5 |

**Ocular Alignment** is assessed at two distances; 33 cm (near) and 300 cm (far). During binocular vision (using 2 eyes), the eyes are supposed to be pointed at the object of interest. When this happens, the eyes are termed “ortho”. When the eyes are transiently not aligned in the horizontal plane, one eye can be either pointing in (esophoria) or pointing out (exophoria). The same principle applies in the vertical plane, where one eye can be pointing up (hyperphoria), or pointing down (hypophoria). Assessment for ocular torsion is assessed with a Maddox rod test. In this evaluation near alignment using a Maddox rod covering the right eye (OD), and the Modified Thorington Card method at 40 cm, confirming with a prism correction. We assessed far alignment using a Maddox rod covering the right eye (OD), with an illuminated target at 3 meters, and established deviation by correcting alignment utilizing a prism. Ocular misalignment is measured in a unit called diopters.

| Measurement | Deviation (in Diopters) | Ortho/Eso/Exo | Normative Value |
|---|---|---|---|
| Near Vision (Horizontal) | 2.5 | Exophoria | Ortho / <1.00 D |
| Near Vision (Vertical) | 0 | Orthophoria | Ortho/ 0.00 D |
| Far Vision (Horizontal) | 0 | Orthophoria | Ortho / <1.00 D |
| Far Vision (Vertical) | 0 | Orthophoria | Ortho/ 0.00 D |
| Ocular Cyclotorsion (Near) | Present and Corrects with Right Head Tilt | | Absent |
| Ocular Cyclotorsion (Far) | {{maddoxOd3MTorsion}} | | Absent |

**Horizontal Visual Field Assessment** is a procedure to measure an individual’s field of view from left to right. This type of vision is often referred to as peripheral vision. Three components of horizontal visual field assessment were evaluated:

monocular recognition (seeing something), identification (identifying its color), with Red, Green, and Blue (the three colors of cones in our eye).

| Color | Field | Recognition Value | Recognition Normal | Color ID Value | Color ID Normal |
|---|---|---|---|---|---|
| Red | Right | 70 | 75-95º | 60 | ≥ 60º |
| | Left | 85 | | 50 | |
| Green | Right | 90 | | 80 | |
| | Left | 85 | | 50 | |
| Blue | Right | 90 | | 70 | |
| | Left | 85 | | 70 | |

**The King-Devick Test** was used as an assessment that tests for impairments in the following areas: saccades, attention, concentration, reading ability, and speech/language. This test requires the participant to read aloud a series of single-digit numbers, as quickly and accurately as possible, in order according to an established direction. The digits were printed on a card, and each series/card became increasingly more difficult via the removal of guidelines connecting the numbers and then spacing the numbers closer together. (PMID: 21849171) Scoring is established by taking the elapsed time to read each card individually, then adding them together to achieve a total "3-Card Time" in seconds. If the athlete makes an error and does not correct it before moving on to the next number, the test is restarted. If an error is made, but it immediately corrected, they are able to proceed and an error is counted.

| Measurement | Value | Normative Value |
|---|---|---|
| 3-Card Time (seconds) | 52.31 | ≤ 43 seconds |
| # of Errors | 0 | ≤ 3 |

**VOMS:** Visual Oculo-Motor Screening is a very commonly performed evaluation in neurology. It involves checking the neurological control of the eyes by having an individual utilize their eyes to follow a moving target and shift their gaze from one target to another. These movements are called saccades (gaze shifting movements), and pursuits (tracking movements). They can be performed in the coronal plane (right, left, up, down, and any variation of the 4), and in the sagittal plane (vergence movements: towards and away from the nose). The VOMS test is very sensitive to detecting neurological dysfunction, particularly concussion. (PMID: 25106780).

**VOMS Results:**

| Outcome | Movement Type | Normative Value |
|---|---|---|
| Pursuits | Abnormal Horizontal Tracking, and Abnormal Vertical Tracking | No Abnormalities |
| Saccades | Abnormal Horizontal Saccades, and Abnormal Vertical Saccades | No Abnormalities |
| Vergence | Abnormal Convergence, and Abnormal Divergence | No Abnormalities |
| Symptom Producing | Vertical Tracking, and Convergence | No Symptoms |

**Near Point of Convergence (NPC)** is an assessment that involves both oculomotor and neurological control. When a healthy individual looks at an object less than 33 cm from their face, their eyes have to turn in (convergence) in order for them to maintain clear vision. The distance from an individual's nose where this reflex fails is called the point of convergence break, and where it recovers is called the point of recovery. When an individual cannot clearly see a target less than the cutoff distance, they have convergence insufficiency. (PMID: 12637833)

| Measurement | Value | Normative Value |
|---|---|---|
| NPC Break (Average of 3 Trials) | 10.67 | ≤ 5 cm |
| NPC Recovery (Average of 3 Trials) | 12 | ≤ 9 cm |

# Proprioception and Coordination

A **Cervical Repositioning Test** was performed to measure the athlete's ability to interpret head position via neck muscles and joint position receptors. An 8-inch target made of 6 concentric rings of 1-inch decreasing diameter was hung 20 inches from the athlete's face. The athlete was asked to close their eyes and place their head in a neutral position. A head-mounted laser was adjusted so that it localized in the center of the target. Point values were assigned to each concentric ring with a bull-eye being worth 10 points, and each concentric ring decreasing by one point. The athlete was asked to keep their eyes closed and turn their head in a direction and then return back to the center. Their location on the concentric target dictated the number of points they earned. If the athlete returned outside of the concentric target, they were given a score of 0. The score was analyzed individually. Normative data suggests that healthy individuals (without neck pain) should be able to reposition within 4.7º (1.75 inches a 20-inch distance) from their starting point (PMID: 26438174)

| Movement | Deviation | Normative Value |
|---|---|---|
| Returning Center from Right | 7 | ≥ 9 points (5º) |
| Returning Center from Left | 9 | ≥ 9 points (5º) |
| Returning Center from Up | 8 | ≥ 9 points (5º) |
| Returning Center from Down | 7 | ≥ 9 points (5º) |

The **Finger-Nose-Finger Test** (PMID 1135616) has long been part of the standardized neurological exam. It measures both the awareness of self (proprioception), spatial awareness, motor speed and coordination. This test is also part of the SCAT5 assessment for concussion.

We perform the test in the standardized way (eyes open) and a modified way biasing the functions of both the proprioceptive and spatial orientation systems (eyes closed).

| Side | Eyes | Hits | Normal | Quality | Normal |
|---|---|---|---|---|---|
| Right | Open | 3 | 3 | Smooth, Accurate, and Fast | Smooth, Accurate, Fast |
| | Closed | 2 | ≥8 | Smooth, Dysmetric, and Fast | Smooth, Accurate, Fast |
| Left | Open | 3 | 3 | Smooth, Accurate, and Fast | Smooth, Accurate, Fast |
| | Closed | 3 | ≥8 | Smooth, Dysmetric, and Fast | Smooth, Accurate, Fast |

# Vestibular and Balance

**rHIT (Rotational Head Impulse Testing)** is perhaps the most common bedside vestibular assessment performed in medicine. It involves testing the vestibular ocular reflex (VOR) by passively rotating the patient's head in a high velocity, low amplitude fashion, while they attempt to maintain fixation on a stationary object. The proper performance of this task requires an intact reflex between the vestibular apparatus (in the inner ear), the cerebellum (part of the brain), and the eye muscles. If the reflex is intact, the individual should be able to maintain fixation on the target of interest. If the individual needs to reposition their eyes after the maneuver, the reflex is deficient. (PMID: 18250290)

| Movement | Result | Normal Response |
|---|---|---|
| Right rHIT | Decreased Gain with Redress Saccade Back to Target | No Refixation Saccade |
| Left rHIT | Decreased Gain with Redress Saccade Back to Target | No Refixation Saccade |
| Anterior rHIT | Normal Gain | No Refixation Saccade |
| Posterior rHIT | Normal Gain | No Refixation Saccade |

**Visual-Vestibular Sensitivity Test**
A test of visual-vestibular sensitivity was performed as part of the VOMS assessment (PMID: 25106780). This test is performed by having the client sit in a chair with their dominant arm outstretched, in a "thumbs-up" position. They are asked to fixate their vision on their thumb and perform 3 oscillations of their torso to 90º to the right and left, then returning sharply back to the starting position. They should be able to keep their eyes on their thumb (VOR cancellation) and not have any symptoms.

**Athlete's Performance of Visual-Vestibular Sensitivity Test:** Nausea

**Is Athlete Abie to Inhibit their Vestibular Ocular Response and Maintain Fixation?** {{ableToCancelVOR}

**The BESS Test** is a balance test that incorporates the three components of balance: vision, proprioception, and vestibular function. This test consists of six 20-second tests performed by having an athlete stand in their socks, with their eyes closed and hands on their hips, in three different configurations: a) with their feet together, b) on their non-dominant foot, c) in a tandem stance with the non-dominant foot in back of the dominant foot. These tests are performed on two surfaces: a) solid ground, b) on an Airex pad.  (PMID: 23016020). A lower number of errors indicates better balance.

**Dominant Foot:  Right**

| Surface | Position | Points | Normative Value | Normative Value for Age |
|---|---|---|---|---|
| Firm | Feet Together | 0 | 0 | ≤ 4 |
| | Single Leg (ND) | 4 | ≤ 2 | |
| | Tandem (ND Back) | 0 | ≤ 2 | |
| Foam | Feet Together | 0 | 0 | ≤ 10 |
| | Single Leg (ND) | 4 | ≤ 5 | |
| | Tandem (ND Back) | 1 | ≤ 5 | |
| Combined | All | 9 | ≤ 15 | |

**Gait Assessment:**

Gait, or a person's manner of walking, along with balance have been recommended as key features of a clinical concussion evaluation. Gait occurs by maintaining upright posture during bipedal (two-leg) locomotion and is a relatively challenging task for the balance control system. This is why it takes many years to develop during childhood. Gait also utilizes considerable cognitive resources. This is where the saying that someone "can't chew gum and walk at the same time" originates from. In the neurological assessment we compare gait (a single-task activity) to gait with the performance arithmetic, slightly more challenging than rote memorization (serial 7 subtraction), also called the "dual-task" activity. From the time of injury and throughout the ensuing recovery, concussed individuals consistently show greater deficits during dual-task walking relative to single-task walking after a concussion. (PMID: 30202596) Other neurological disorders also exhibit poor dual-task walking, such as AD/HD, autism, Parkinson's, dementia.

| Gait Scenario | Result | Normal Qualities |
|---|---|---|
| Normal Gait | Decreased Right Arm Swing | Symmetrical, Normal Speed |
| Gait with Dual Tasking | Decreased Right Arm Swing | Symmetrical, Normal Speed, No Change from Normal Gait |

Thank you for the opportunity to perform this assessment. It was my pleasure to provide you with the most comprehensive brain health and concussion baseline screening.

Based upon the data collected, it appears that John has some mild cognitive, autonomic, and vestibular dysfunction. This is nothing to be alarmed about, nor anything to seek further testing for, but should be addressed through therapeutic exercises.

Exercises recommended after therapeutic trial

1) Times 1 Viewing Exercises: Sit in a chair with back support and look at a focal point at least 3 feet away, at eye level. Slowly rotate your head to the left while maintaining focus on the fixation point. Quickly (faster than to the left, but not too quickly) turn your head to the right. Return back to the left slowly. Repeat this either until your next gets tight or 10 times (whichever comes first).
2) Watch the pinwheel video that was provided, 3-5 times.
3) Marching: Focus your eyes on a target across a room while standing. Using exaggerated arm movements, begin marching like a soldier across the room. Each time your right foot hits the ground, tilt your head to the right (tilt, no rotation). Take approximately 10 steps total. (If turning around, turn right)

Repeat this set of exercises 3 times per session. Perform 3 sessions per day, for about a week, then schedule a time to meet with me by visiting: http://calendly.com/drantonucci

If you have any questions about the information provided, I would be happy to try to answer them for you. I am obligated to keep this medical information for 7 years, so if they happen to sustain a suspected concussion, I will make myself available to perform a reassessment and compare the data. Remember, baseline data changes with time, age, training, and injury, so I recommend you perform this baseline at the beginning and end of each season.

If you would like me to consult with your primary care doctor, or anyone else regarding these results, I would be happy to do so. I would just need a signed release from you. I can send this to you electronically. You also have the ability to share this report directly with them.

Thank you again.

Sincerely,

Matthew M. Antonucci, DC, DACNB, FACFN, FABCDD, FABNN, FABVR, FABBIR, FICC

Professor of Neurology, Carrick Institute
President, American Board of Brain Injury and Rehabilitation
Member, University of Central Florida College of Medicine's Dean's Society

Scheduling: 321.231.0974