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TBI and Vision-Vestibular Assessment

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BACKGROUND

According to Brain Injury Association of America, traumatic brain injury (TBI) is one of the two types of acquired brain injury (ABI) with the other being non-traumatic. TBI is when an alteration in brain function occurs as a result of external forces (e.g. falls, assault, motor vehicle accidents, sports injuries, etc.) (BIAA, n.d.). The American Association of Neurological Surgeons (2020) reports a prevalence in TBI in the United States as 1.7 million cases annually. Additionally, 5.3 million individuals in the United States have been living with a disability as a result of TBI alone (AANS, 2020). In 2017, Defense and Veterans Brain Injury Center (DVBIC) reported about 350,000 TBI cases present in the U.S. military since 2000. As of 2019, this number has increased to a total of 413,858 from 2000-2019, with mild TBI cases at 342,747 (DVBIC, 2019).

Servicemembers that are returning from deployment or are performing their duties in the country present vulnerability to injuries such as TBI. According to DVBIC, most servicemembers that sustain a mild TBI return to full duty within 7-10 business days. Mild TBI may still present deficits that are not obvious at the time. An area that could be explored more in-depth is visual limitation. Vision rehabilitation and education appear to be a need within this population as the main domains focused on are (but not limited to) PTSD, mental health, executive functioning, coordination, etc. While vision problems could occur with TBI cases, there has been insufficient literature exploring this concern (Sen, 2017). Traumatic brain injury affects an individual's vision function such as saccades, smooth pursuit, vergence, accommodation, the vestibular–ocular reflex, and photosensitivity (Ventura, Jancuska, Balcer & Galetta, 2015).

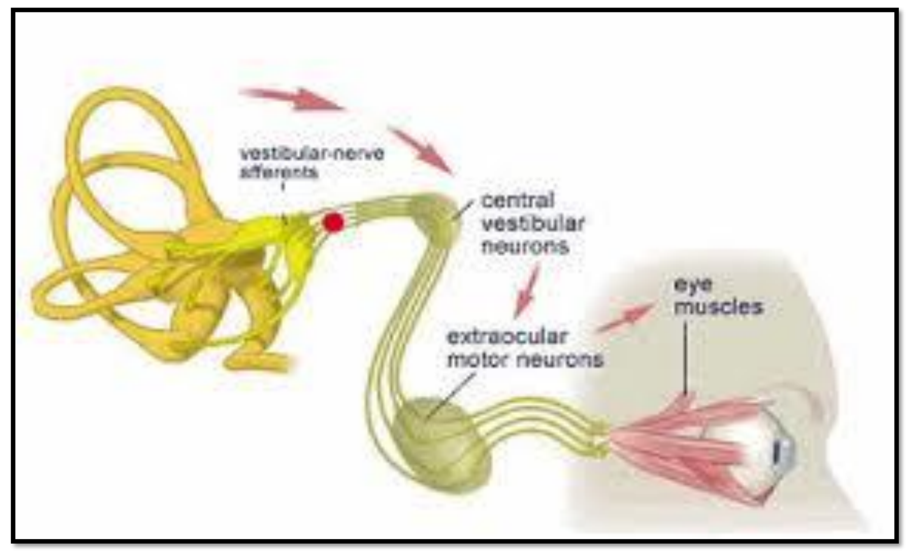
In the years 1995-2009, the estimated cost of TBI to the community is $76.5 billion as a result of medical costs and loss of productivity (Coronado, McGuire, Sarmiento, Bell, Lionbarger, Jones, 2012).

Vestibulo-ocular reflex dysfunction, a sequelae of TBI, remains problematic in TBI in all severities (Wallace & Lifshitz, 2016), however very few literature regarding the involvement of occupational therapy have been reported regarding this specific phenomenon.

FOCUSED QUESTION

What is the effectiveness of utilizing sensory integration, specifically vestibular-ocular, in the vision rehabilitation plan for clients that experienced TBI?

METHODS



Vestibular-ocular reflex (VOR) impairment presents symptoms such as vision disturbances, vertigo nausea, hearing changes, and unsteadiness in balance/gait . Various assessment methods are implemented by the Department of Defense, Department of Veterans Affairs, and other entities to assess for VOR dysfunction. Research shows that assessments are led by physical therapists partnered with either optometrists and/or audiologists/otolaryngologist. These assessments are not standardized practice in all of the facilities, rather a report on all that have been used collectively among the sites.

Wallace & Lifshitz (2016) focused on the dysfunction of vestibulo-ocular function as a result of TBI and noted the scarcity in research. Assessments recommended for VOR dysfunction include: "graded symptom checklist scale, review of past medical history to identify risk factors associated with a prolonged recovery, cognitive testing, cranial nerve assessment (with a focus on oculomotor control, including vergence), cervical range of motion, balance, gait, and vestibular testing" (Wallace & Lifshitz, 2016, p. 161). Assessments are completed either in clinical or laboratory settings. Clinical setting assessments include the Trail Making Test, King-Devick (K-D) test, and the Dizziness Handicap Inventory (DHI), a validated tool of self-reported survey on dizziness-related disability and its impact to the client's daily living, and the Vestibular Disorders Activity Living Scale (Weightman & Leuty, 2014). Another self-report questionnaire, the Vestibular/Ocular Motor Screening (VOMS) assessment, is used when symptoms are reported while soldiers undergo a series of tests meant to incite vestibular and ocular signs (Weightman & Leuty, 2014). VOMS consists of "smooth pursuit, horizontal and vertical saccades, near point of convergence (NPC) distance, horizontal vestibular ocular reflex (VOR), and visual motion sensitivity" (Mucha et al., 2014, p. 2481).

Other provocative tests completed in clinic are Dix-Hallpike maneuver, roll test, head impulse/thrust test, head shaking nystagmus test, dynamic acuity test, and positional test. The Naval Medical Center uses a Computer-Assisted Rehabilitation Environment (CAREN) that provides an immersive virtual reality type of setting wherein a client's balance, locomotion, coordination are tested concurrently (Onakomaiya, Kruger, Highland, Kodosky, Pape, & Roy, 2017).

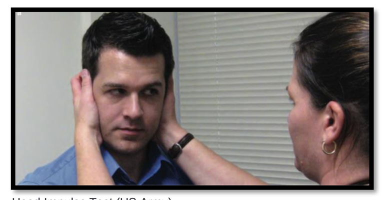
RESULTS

A study by Wallace & Lifshitz (2016) reports that limited research is available focusing on the VOR impairments secondary to TBI (Wallace & Lifshitz, 2016) which affects the validity of the collective assessments listed. Further research on visual-vestibular screening performed on mild TBI and sports-related concussion generated alternate perspectives. According to Yorke, Smith, Babcock, & Alsalaheen (2017), the five domains involved in the VOMS assessment are significantly correlated to each other while exploring unique aspects of vestibular dysfunction. The symptoms score in each component of VOMS was able to correctly identify patients with mild TBI, resulting to a recommendation of VOMS as a standard clinical assessment (Mucha et al., 2014)

Dynamic visual acuity also showed excellent sensitivity, specificity, and reliability according to Rine et al. (2012) as well as "emerging as the most discriminating balance condition" assessment in brain injury cases (Wright, Tierney, & McDevitt, 2017, p. 34).

Wright, Tierney, & McDevitt (2017) reported that the oculomotor assessment such as smooth pursuit, K-D test, and rapid horizontal eye saccade showed lack of sensitivity relative to the health status, except for the vergence test. The group noted that the difficulty reproducing symptoms consistent to suggest a dysfunction may be due to the screening not demanding enough. Another instance could be a flaw on the providers ability to notice minute anomaly.

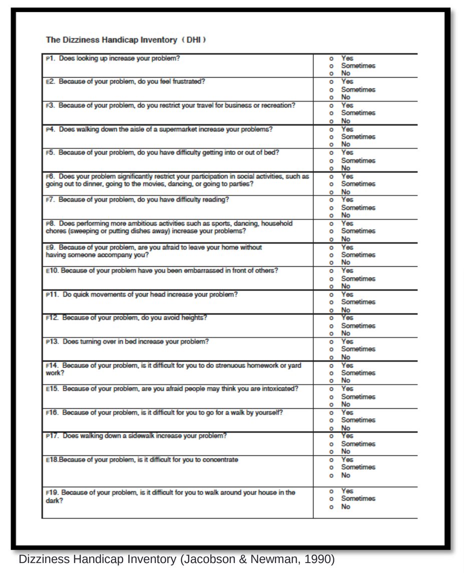
It appears that even with recent research, there is still conflicting findings on the validity of the assessments. The use of a virtual-reality rehabilitation such as CAREN, in large military rehabilitation facilities is championed by providers due to its ability to address multi-faceted aspects of TBI particularly vestibular disturbances (Onakomaiya, Kruger, Highland, Kodosky, Pape, & Roy, 2017). The researchers noted that servicemembers are more engaged in CAREN regardless of the severity of TBI or PTSD due to its immersive interaction and similarity to real-world activities (Onakomaiya, Kruger, Highland, Kodosky, Pape, & Roy, 2017).



Head Impulse Test (US Army)

Dynamic Acuity Test (US Army)

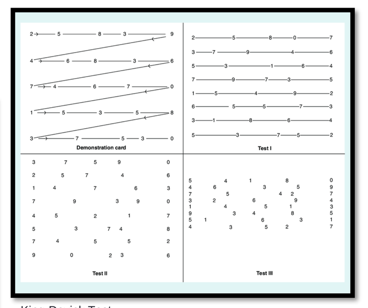
Computer-assisted Rehabilitation Environment (CAREN) (Cleveland Clinic)



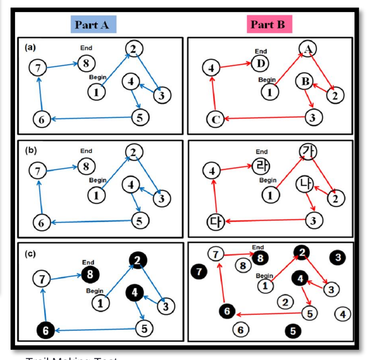
The Dizziness Handicap Inventory (DHI)

- P1. Does looking up increase your problem? ○ Yes ○ Sometimes ○ No
- E2. Because of your problem, do you feel frustrated? ○ Yes ○ Sometimes ○ No
- F3. Because of your problem, do you restrict your travel for business or recreation? ○ Yes ○ Sometimes ○ No
- P4. Does walking down the aisle of a supermarket increase your problems? ○ Yes ○ Sometimes ○ No
- F5. Because of your problem, do you have difficulty getting into or out of bed? ○ Yes ○ Sometimes ○ No
- F6. Does your problem significantly restrict your participation in social activities, such as going out to dinner, going to the movies, dancing, or going to parties? ○ Yes ○ Sometimes ○ No
- F7. Because of your problem, do you have difficulty reading? ○ Yes ○ Sometimes ○ No
- P8. Does performing more ambitious activities such as sports, dancing, household chores (sweeping or putting dishes away) increase your problems? ○ Yes ○ Sometimes ○ No
- E9. Because of your problem, are you afraid to leave your home without having someone accompany you? ○ Yes ○ Sometimes ○ No
- E10. Because of your problem have you been embarrassed in front of others? ○ Yes ○ Sometimes ○ No
- P11. Do quick movements of your head increase your problem? ○ Yes ○ Sometimes ○ No
- F12. Because of your problem, do you avoid heights? ○ Yes ○ Sometimes ○ No
- P13. Does turning over in bed increase your problem? ○ Yes ○ Sometimes ○ No
- F14. Because of your problem, is it difficult for you to do strenuous homework or yard work? ○ Yes ○ Sometimes ○ No
- E15. Because of your problem, are you afraid people may think you are intoxicated? ○ Yes ○ Sometimes ○ No
- F16. Because of your problem, is it difficult for you to go for a walk by yourself? ○ Yes ○ Sometimes ○ No
- P17. Does walking down a sidewalk increase your problem? ○ Yes ○ Sometimes ○ No
- E18. Because of your problem, is it difficult for you to concentrate ○ Yes ○ Sometimes ○ No
- F19. Because of your problem, is it difficult for you to walk around your house in the dark? ○ Yes ○ Sometimes ○ No

Dizziness Handicap Inventory (Jacobson & Newman, 1990)



King-Devick Test



Trail Making Test

BOTTOM LINE FOR OT

Individuals with vision deficits due to acquired brain injury could benefit from addressing VOR integration. Since balance and posture are the main aspects impacted by a dysfunction of VOR, literature retrieved have been authored by physical therapists who have taken a more direct approach to addressing this deficit. Occupational therapists have as much involvement in patients with TBI experiencing VOR dysfunction. VOR integration affects any activity that require fixation of eye gaze with head motion. Tasks involving integrated VOR are required in completing most, if not all, ADLs and IADLs. Occupational therapists may be one of the first specialists to observe these symptoms and could benefit from having a comprehensive knowledge on clinical assessments when clients are suspected to have VOR dysfunction.

Cohen, Gottshall, Graziano, Malmstrom, & Sharpe (2009) found that there is no uniformity in the educational/training standards on vestibular dysfunction rehabilitation among therapists, both physical and occupational therapists, in the United States and internationally. This was supported by a more recent research by Bush & Dougherty (2015) that noted the variability in training/practice of therapists in vestibular rehabilitation, and that a need for certification arises to set standardized practices. Butler & Hollestelle (2017) noted that occupational therapists in New Zealand perform significant work in visual dysfunction rehabilitation, however a post-graduate education is recommended in to practice in this field.

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