Composition of a Vision Screen for Servicemembers With Traumatic Brain Injury: Consensus Using a Modified Nominal Group Technique

Mary Vining Radomski, Marsha Finkelstein, Imelda Llanos, Mitchell Scheiman, Sharon Gowdy Wagener

MeSH TERMS

- brain injuries
- military personnel
- vision disorders
- vision screening

Vision impairment is common in the first year after traumatic brain injury (TBI), including among service members whose brain injuries occurred during deployment in Iraq and Afghanistan. Occupational therapy practitioners provide routine vision screening to inform treatment planning and referral to vision specialists, but existing methods are lacking because many tests were developed for children and do not screen for vision dysfunction typical of TBI. An expert panel was charged with specifying the composition of a vision screening protocol for servicemembers with TBI. A modified nominal group technique fostered discussion and objective determinations of consensus. After considering 29 vision tests, the panel recommended a nine-test vision screening that examines functional performance, self-reported problems, far–near acuity, reading, accommodation, convergence, eye alignment and binocular vision, saccades, pursuits, and visual fields. Research is needed to develop reliable, valid, and clinically feasible vision screening protocols to identify TBI-related vision disorders in adults.

Radomski, M. V., Finkelstein, M., Llanos, I., Scheiman, M., & Wagener, S. G. (2014). Composition of a vision screen for servicemembers with traumatic brain injury: Consensus using a modified nominal group technique. *American Journal of Occupational Therapy, 68,* 422–429. http://dx.doi.org/10.5014/ajot.2014.011445

Mary Vining Radomski, PhD, OTR/L, is Clinical Scientist, Courage Kenny Research Center, 800 East 28th Street @ Chicago (No. 12212), Minneapolis, MN 55407; mary.radomski@allina.com

Marsha Finkelstein, MS, is Senior Scientific Advisor, Courage Kenny Research Center, Minneapolis, MN.

Imelda Llanos, MS, OTR/L, is Vision Impairment Clinic Program Manager, James A. Haley Veterans Hospital, Tampa, FL.

Mitchell Scheiman, OD, is Professor, Pennsylvania College of Optometry, Philadelphia.

Sharon Gowdy Wagener, MAOT, OTR/L, is Occupational Therapist, Courage Kenny Rehabilitation Institute, Minneapolis, MN.

Vision impairment is common in the first year after traumatic brain injury (TBI; Goodrich, Flyg, Kirby, Chang, & Martinsen, 2013; Greenwald, Kapoor, & Singh, 2012), including among servicemembers whose brain injuries occurred during combat deployments in Iraq and Afghanistan (Bulson, Jun, & Hayes, 2012; Capó-Aponte, Urosevich, Temme, Tarbett, & Sanghera, 2012; Lew et al., 2011). Explosive blasts, common in these wars, cause TBI when a servicemember is thrown or struck by shrapnel or when blast waves cause atmospheric pressure changes that displace the brain and impact the skull (Goodrich et al., 2013). Patients with mild, moderate, and severe TBI may experience problems with accommodation, convergence, visual–vestibular interactions, visual field integrity, light–dark adaptation, and vision-related fatigue (Bulson et al., 2012; Goodrich et al., 2013; Greenwald et al., 2012). These problems interfere with patients' ability to read, perform an array of everyday activities, and fully participate in their rehabilitation; the problems may also exacerbate cognitive dysfunction (Greenwald et al., 2012; Lew et al., 2009).

Because of the prevalence of vision-related problems after TBI and their consequences for functional performance, experts recommend screening for vision deficits early in patients' recovery (Greenwald et al., 2012). The Veterans Health Administration (VHA; 2008) published a directive specifying that all patients with a diagnosis of TBI who are admitted to a polytrauma rehabilitation center have a TBI-specific ocular health and visual functioning examination performed by an optometrist or ophthalmologist.

As members of the interdisciplinary team who address functional vision problems (Berger, 2013; Weisser-Pike, 2014), occupational therapy practitioners routinely screen patients' basic visual functions. Occupational therapy TBI vision screenings typically include acuity, visual field deficits, oculomotor skills, and visual attention and scanning. Results inform treatment planning and referrals to vision specialists (Cate & Richards, 2000; Radomski, Davidson, Voydetich, & Erickson, 2009; Weisser-Pike, 2014). Despite agreement regarding the importance of routine screening for vision impairment, no standards exist for the composition of vision screens administered by occupational therapy practitioners to adults with TBI. Moreover, many components of existing occupational therapy vision screens have not been standardized on adults, much less adults with neurological problems, making it difficult for novice clinicians to determine what constitutes better, if not best, assessment practices for this population.

As part of an effort to develop guidance for military clinicians who are providing occupational therapy to servicemembers with mild TBI, a consensus panel was convened and charged with evaluating existing vision tests and proposing the composition of a clinically feasible and psychometrically optimal occupational therapy vision screen for servicemembers with TBI. The panel comprised occupational therapists and optometrists with expertise in assessing vision deficits in servicemembers with TBI.

Method

Participants

Nine experts agreed to participate on the panel, including 2 optometrists (1 from the U.S. Department of Defense [DoD], 1 civilian) and 7 occupational therapists (2 from DoD, 2 from the VHA, and 3 civilians). The consensus process was planned and facilitated by an occupational therapist–researcher and health services researcher, who were familiar with but not expert on the topic.

Procedures

In advance of the 2-day meeting, panel members were invited to recommend vision tests for consideration in each of the domains of interest (symptom self-reports, visual acuity, visual fields, oculomotor function, photosensitivity, functional performance). Background information on the compiled list of tests was sent to panel members for review before the meeting. Panel members established parameters and inclusion criteria for the proposed vision screen before deciding which of the specific test options to include (Table 1). They determined that the purpose of the screen was to help generalist occupational therapy practitioners better understand vision-related factors that might be influencing patients' occupational performance and to ensure that patients with suspected vision dysfunction from mild to moderate TBI are referred to optometrists or ophthalmologists for complete vision examinations.

Table 1. Selection Criteria for Occupational Therapy Vision Screening for Adults With Traumatic Brain Injury

Requirement Category	Specific Criteria
Occupational therapy relevant	
Alignment with philosophy and scope of practice	Screen or assessment of body structures and functions to better understand factors driving occupational performance and make appropriate referrals
Requires skilled services of an occupational therapy practitioner	Requires skilled services of an occupational therapist to administer and interpret the results of assessment methods (standardized, nonstandardized) and infer implications of findings for occupational functioning
Evidence based	
Factors related to typical vision problems after TBI	Acuity: distance Acuity: near (for reading competence only) Binocular vision Eye alignment Eye movement problems: saccades, pursuits Convergence Accommodation Visual fields
Populations on which it has been studied	Prefer adults with TBI
Psychometric properties	Prefer tools with established reliability and validity for adults with TBI
Administrative	
Cost of materials, equipment, and supplies	$300–$900
Time to administer	5–20 min
Training requirements for clinicians	Site leads receive in-person training; generalists trained by site leads in a session of ≤2 hr

Note. TBI = traumatic brain injury.

A modified nominal group technique was used to arrive at consensus regarding the composition of the occupational therapy TBI vision screen. This technique, devised by Delbecq and VandeVen (1971), incorporates small group discussion via brainstorming, collection of ideas, responses by group members to these ideas, and then anonymous scoring by individual members. Panel members were split into two balanced teams on the basis of military and discipline background. During each of two breakout sessions on Day 1, the teams discussed a subset of vision tests and developed preliminary inclusion recommendations.

After each breakout session, the groups presented their inclusion recommendations and rationale. When the full-group discussion was complete, panelists anonymously scored the test options within each vision domain on the basis of the options' alignment with the established selection criteria. A report was then generated describing the mean item scores. A second round of scoring occurred when a minimum mean item score was not attained within a vision domain. We chose the nominal group technique as the basis of our consensus effort because it fostered exchange of opinions among multiple stakeholders in a nonthreatening environment, balanced individual opinions, and prioritization of ideas through a democratic method (Sample, 1984). A technique similar to the one used was later reported (Davies et al., 2011) and was found to be effective in narrowing rating distributions.

Scoring Methods and Statistical Analysis

Panel members scored each item (vision test) for inclusion using a scale ranging from 0 (*definitely not include*) to 10 (*definitely include*). A weighted mean was calculated (4 times the sum of mean, minimum, and maximum scores, divided by 6). This method accounted for possibly strong opinions at the outside margins that could move the mean significantly in either direction. The panel decided to use a weighted item score of 8.0 as the minimum value for inclusion of an item in the occupational therapy TBI vision screen and its operational definition of consensus. If multiple tests within a given vision domain met minimum criteria, the item with the highest score would be selected. It was agreed that further discussion was possible if a test met criteria but members had concerns about its inclusion or exclusion because of an extreme score at either end of the range.

Results

After one round of scoring, the panel achieved consensus on 8 of the 29 possible test inclusions and approaches (see Table 2). During Round 1, the panel came to agreement that some type of reading test should be administered to ensure that patients have adequate near acuity to fully participate in other types of testing (e.g., cognitive assessment) but did not specify which one. Table 3 summarizes the results of the second round of scoring, which occurred after further discussion regarding domains and tests for which consensus was not achieved in Round 1. The Eye Alignment Test (Scheiman, 2011) and Adult Developmental Eye Movement Test (A–DEM; Garzia, Richman, Nicholson, & Gaines, 1990; Sampedro, Richman, & Pardo, 2003) for saccades were selected after additional discussion even though they did not meet minimum weighted score criteria. The panel was split regarding which reading card to use to screen near acuity. Given both lack of consensus and the need to meet minimum weighted item score criteria, the panel decided to include the reading card on the back of the Chronister Pocket Acuity Chart (Gulden Ophthalmics, Elkins Park, PA; Scheiman, 2011), which received the highest score, and evaluate its utility at a later date. Because no screen was identified for photosensitivity, the panel decided to add a self-report question (to be drafted at a later date) to the College of Optometrists in Vision Development Quality of Life Outcomes Assessment (Daugherty, Frantz, Allison, & Gabriel, 2007).

Table 4 shows the resulting recommendations regarding the composition of a "better practice" occupational therapy TBI vision screen. Panel members emphasized the importance of observing functional performance and administering specific vision tests. The estimated time to administer this screen is 10–23 min, and the estimated cost of materials is $235 (both dimensions meeting the criteria earlier specified by the panel). Panel members voted and ultimately agreed on the sequence as listed.

Discussion

Many soldiers and veterans who sustain TBI are at risk for vision dysfunction; an estimated 50%–75% of veterans with TBI complain of vision symptoms (Bulson et al., 2012; Stelmack, Frith, Van Koevering, Rinne, & Stelmack, 2009) such as blurred vision, photosensitivity, and accommodative problems (Bulson et al., 2012). Similar TBI sequelae have been documented among civilians (Ciuffreda et al., 2007; Suchoff, Kapoor, Waxman, & Ference, 1999). The prevalence of these problems and their negative impact on functioning (Ciuffreda, Suchoff, Kapoor, Jackowski, & Wainapel, 2001; Suchoff, Kapoor, & Ciuffreda, 2001; Wainapel, 1995) underscore the need

Table 2. Screening Tests Considered by Panel Members Within 10 Domains and Mean Inclusion Scores After Round 1

Vision Domain	Screening Test Item Considered by Panel	Mean	Weighted Mean
Self-report	Vision Questionnaire (developed for internal use at the National Intrepid Center of Excellence; unpublished)	5.22	4.81
	College of Optometrists in Vision Development Quality of Life Outcomes Assessment (Daugherty, Frantz, Allison, & Gabriel, 2007)[a]	9.11	9.07
	Symptom Questionnaire: Acquired Brain Injury (Scheiman, 2011)	1.67	1.94
	Convergence Insufficiency Symptom Survey (Rouse et al., 2004, 2009)	3.11	3.41
	10-item neuro-ophthalmic supplement to the National Eye Institute Visual Function Questionnaire (Raphael et al., 2006)	2.67	2.78
Functional performance	Dynamic assessment of occupational performance (with attention to behaviors suggesting vision dysfunction)[a]	8.67	8.61
Vision acuity: distance	Chronister Pocket Acuity Chart (Gulden Ophthalmics, Elkins Park, PA; Scheiman, 2011)[a]	9.78	9.69
	Snellen chart (Stevens, 2007)	1.22	1.81
	LEA Symbols test (Good-Lite, Elgin, IL; Scheiman, 2011)	1.33	1.72
	Early Treatment of Diabetic Retinopathy Study chart (Precision Vision, LaSalle, IL; see Kaiser, 2009)	0.89	1.59
Vision acuity: reading	MNREAD Acuity Chart (Precision Vision, LaSalle, IL)	4.11	4.07
	Tumbling E Test (Precision Vision, LaSalle, IL; see Scheiman, 2011)	3.56	3.70
	Smith–Kettlewell Reading Test (Kent, 2013)	4.56	4.37
	Reading card (inclusion in screen without specifying test)[a]	8.44	8.13
Visual fields	Confrontation field testing: finger counting (Anderson, Shuey, & Wall, 2009)[a]	9.56	9.37
	Confrontation field testing: targets (Scheiman, 2011)	3.11	3.41
Saccades and pursuits	Northeastern State University College Optometry Oculomotor Test (Maples, Atchley, & Ficklin, 1992; Maples & Ficklin, 1988)[a]	8.44	7.30
	King–Devick saccades test (King–Devick Test, Oakbrook Terrace, IL; Galetta et al., 2011)	2.67	2.94
	Adult Developmental Eye Movement Test (Garzia, Richman, Nicholson, & Gaines, 1990; Sampedro, Richman, & Pardo, 2003)	7.22	6.65
Convergence	Near point of convergence testing (Scheiman et al., 2003)[a]	9.56	9.54
Alignment	Eye Alignment Test (Scheiman, 2011)	6.67	6.11
Binocular	Viewer-free random dot test, such as the Frisby Stereotest (Bernell Corporation, Mishawaka, IN; see Gillen, 2009)	1.11	1.57
	Binocular Vision Assessment computerized vision therapy assessment (HTS Inc., Gold Canyon, AZ)	6.89	6.26
	Randot Stereotest (Stereo Optical Co., Inc., Chicago; see Fricke & Siderov, 1997)	6.78	6.19
Accommodation	Amplitude of accommodation testing (Scheiman, 2011; Yothers, Wick, & Morse, 2002)[a]	9.56	9.37
Photosensitivity	Photosensitivity (general inclusion of painlike self-report scale)	8.11	7.07
General	VERA vision screening software (Visual Technology Applications, Philadelphia; Gallaway & Mitchell, 2010)	2.00	2.67
	Brain Injury Visual Assessment Battery for Adults (visABILITIES, Lenexa, KS)	0.56	1.20
	Dynavision (Dynavision, West Chester, OH)	0.33	0.72

[a]Recommended screening item.

for robust vision screening to ensure that adults with TBI receive needed medical and rehabilitative care.

Currently available vision screening protocols have limitations. Traditionally, vision screening has been reserved for the pediatric population because of the belief that undetected vision problems could interfere with academic performance or lead to amblyopia and loss of vision. Research on pediatric vision screens and the development of normative data has assumed greater priority because presumably, adults can self-identify vision-related problems and seek appropriate care. In addition, many existing vision screening protocols focus primarily on distance visual acuity and are not designed to screen for most prevalent TBI-related vision problems (i.e., binocular vision, accommodation, eye movements, and visual field disorders). Research is urgently needed to specify a reliable, valid, norm-referenced, and clinically feasible occupational therapy vision screen for adults with TBI. Until this best practice vision screen is available, occupational therapy practitioners are charged with using expertise and clinical judgment to implement, at minimum,

Table 3. Results of the Second Round of Scoring

Screening Test	Mean	Weighted Mean
Reading card–near acuity	2.78	3.19
Reading card on the back of the Chronister Pocket Acuity Chart	7.11	6.41
Northeastern State University College Optometry saccades	3.67	3.94
Adult Developmental Eye Movement Test saccades	7.11	6.41
Eye Alignment Test	8.44	7.80
Binocular Vision Assessment	3.22	3.48

Table 4. Screening Items, in Recommended Order of Administration

Recommended Screening Items[a]	Recommended Use of Corrective Lenses During Screening
Self-reported symptoms and performance: College of Optometrists in Vision Development Quality of Life Outcomes Assessment plus photosensitivity interview question	Test with corrective lenses (if appropriate)
Far acuity: Chronister Pocket Acuity Chart	
Reading: Chronister Pocket Acuity Chart reading card	
Accommodation: Accommodative amplitude testing	
Convergence: Near point of convergence	
Eye alignment and binocular vision: Eye Alignment Test	
Saccades: Developmental Eye Movement Test[b]	
Pursuits: Northeastern State University College Optometry Oculomotor Test	Test without corrective lenses
Visual fields: Confrontation field testing—finger counting	

[a]Observation of functional performance concurrent with or complementary to the tests. [b]The Developmental Eye Movement Test replaced the Adult Developmental Eye Movement Test after the consensus meeting.

"better practices" in TBI vision screening—the objective of this undertaking.

A panel of occupational therapy and optometry experts used a modified nominal group technique to specify the composition and sequence of an occupational therapy TBI vision screen that was aligned with predetermined criteria for rigor and clinical feasibility. The panel considered 29 optional tests or approaches. Reasons for exclusion included inappropriateness for servicemembers with mild TBI (the largest subgroup of servicemembers with TBI; Defense Veterans Brain Injury Center, 2013), inadequate specificity relative to an adult population, lack of portability, substantial time to administer, and high cost. This effort resulted in the specification of a "better practice" occupational therapy TBI vision screen comprising nine subtests that together examine self-reported problems, far–near acuity, reading, accommodation, convergence, eye alignment and binocular vision, saccades, pursuits, and visual fields (administered in the order listed). The panel recommended that these standardized tests complement clinicians' ongoing observations of patients' performance during visually demanding tasks (e.g., map reading, target location). A subgroup of panel members subsequently submitted a research proposal to validate the proposed vision screen on servicemembers with TBI. The proposal was not funded; a resubmission is under consideration.

The proposed sequence is commonly used in visual examinations. To establish a relationship between the practitioner and the patient and to guide the remainder of the examination, the process starts with a questionnaire assessing self-reported vision-related functioning. Visual acuity testing follows to rule out uncorrected refractive error (myopia, hyperopia, and astigmatism), which in a recent study was identified in 96% of TBI patients referred to a VHA clinic (Bulson et al., 2012). In addition to distance acuity, acuity for reading is screened before further vision or cognitive testing so that results are accurate and reliable. Problems with accommodation and convergence may invalidate any other tests of near vision, so this domain is examined early in the screening process. Assessment of binocular vision also occurs early in the screen because binocular vision problems and double vision have a negative impact on other testing. Eye movement screening follows, starting with the more challenging test, saccades, and ending with screening of pursuits. Visual field testing is last because visual field loss seems less common among servicemembers with TBI (Bulson et al., 2012).

One change was made to the recommended vision screening protocol after the consensus meeting. The panel originally recommended use of the Adult Developmental Eye Movement Test to screen saccades, but it was subsequently replaced with the Developmental Eye Movement Test (DEM), in part because the A–DEM was not commercially available. Concerns were also raised regarding the comparability of the A–DEM to the DEM, which has norms only on children up to age 13 yr (Garzia et al., 1990). Two important differences between the A–DEM and the DEM may threaten their comparability. The A–DEM requires the patient to read and state double-digit numbers, whereas the DEM involves single digits, which may have implications for time scores. Also, on the A–DEM, the order of the numbers on the vertical array card is not identical to those on the horizontal array card, whereas the DEM has identical number order in vertical and horizontal arrays (Powell, Fan, Kiltz, Bergman, & Richman, 2006). As suggested by Powell and colleagues (2006), these test differences may reflect measurement of different constructs. Furthermore, the A–DEM was normed on Spanish-speaking adults (Sampedro et al., 2003), which, along with potential differences in speaking rates, may limit the use of time scores for English-speaking adults (Powell et al., 2006).

Therefore, a post hoc panel subgroup concluded that the DEM was preferable to the A–DEM. The DEM appears to measure the construct of interest (impairment in saccades) and could defensibly be included in the screen on the basis of the assumption that under normal conditions, an adult would be expected to have the saccadic proficiency of a 13-yr-old (the upper tier of the DEM norms). Users of this test should be advised that it may underidentify impairment of saccades in adults (Powell, Birk, Cummings, & Ciol, 2005), although this risk appears to be minimal (Powell et al., 2006).

The modified nominal group technique minimized but did not eliminate potential bias in the consensus process. Panel planners may have inadvertently introduced bias in the selection of participants. However, the fact that it took two rounds and considerable discussion to achieve consensus regarding the composition of the TBI vision screen suggests that like-minded people were not intentionally selected for participation. In addition, participants may have had long-held experiences and perspectives that prevented them from fully considering all of the options for vision tests or the viewpoints of others on the panel, which may explain why the recommended screening protocol does not incorporate any tests that involve instrumentation or software.

Computerized vision screening programs such as the Binocular Vision Assessment (HTS Inc., Gold Canyon, AZ) and VERA vision screening software (Visual Technology Applications, Philadelphia) show promise for future consideration (Gallaway & Mitchell, 2010), but at present, neither has established norms for adults. Oculomotor functions (i.e., binocular vision, accommodation, and eye movements) were recently assessed with computerized oculomotor vision screening and by conventional methods in 20 military personnel with and 20 without mild TBI (Capó-Aponte, Tarbett, et al., 2012). The computer-based screening by non–eye care professionals showed excellent validity and repeatability for assessing near-related binocular vision problems and pursuit and saccadic eye movements. Although the sample size was very small, this study is an example of the work that will be necessary to develop effective vision screening for TBI-related vision disorders.

Implications for Occupational Therapy Practice

The work of this panel has the following implications for occupational therapy practice:

- Servicemembers and civilians with TBI who are referred to occupational therapy practitioners are likely to have visual dysfunction.
- Screening for vision impairments on all adults with TBI ensures that they are appropriately referred for full vision examination by specialists and that they receive necessary therapy and education to manage vision problems during functional activities.
- An occupational therapy TBI vision screen recommended by a consensus panel using the nominal group technique may represent a "better practice" option.
- Research is needed to develop a robust and clinically feasible occupational therapy vision screening protocol for adults with TBI; few options exist at present.

Conclusion

A significant need exists for research to develop vision screening protocols designed to identify TBI-related vision disorders in the adult population. Agreement will first be required on the areas to be screened and the tests and technologies that are most appropriate. Once these decisions are made, research will be necessary to develop normative data for adults and to plan and implement validation studies demonstrating appropriate specificity and sensitivity for these protocols.

As with children, the ideal scenario is for every person with TBI to routinely have a comprehensive vision examination as soon as possible after injury to rule out the presence of vision problems that could interfere with rehabilitation and recovery of independence. In most rehabilitation settings, this ideal is not often achieved, in part because eye care professionals are typically not part of the TBI rehabilitation team. Thus, occupational therapy practitioners have begun to recognize a need for an efficient, validated vision screening appropriate for adults after TBI that is designed to determine whether a client requires referral for a comprehensive vision examination and to inform clinical intervention. The vision screening protocol recommended by a consensus panel of experts using a nominal group technique is proposed as "better practice" until a validated option is available for clinicians. ▲

Acknowledgments

We appreciate the contributions of the following experts who participated in the consensus meeting: MAJ Jinjong Chung, OD, MHA; Meghan A. Crow, OTR/L; Jenny Owens, OTD, OTR/L; Erica Stern, PhD, OTR/L; Deborah Voydetich, OTR/L, SCLV; and Orli Weisser-Pike, OTD, OTR/L, CLVT, SCLV. Mary Radomski organized this project as part of her fellowship at the Army Office of the Surgeon General (OTSG), Rehabilitation & Reintegration Division. The support of her mentor at OTSG, LTC Sarah Goldman, PhD, OTR/L, was invaluable.

References

Anderson, A. J., Shuey, N. H., & Wall, M. (2009). Rapid confrontation screening for peripheral visual field defects and extinction. *Clinical and Experimental Optometry, 92,* 45–48. http://dx.doi.org/10.1111/j.1444-0938.2008.00280.x

Berger, S. (2013). Effectiveness of occupational therapy interventions for older adults living with low vision. *American Journal of Occupational Therapy, 67,* 263–265.http://dx.doi.org/10.5014/ajot.2013.007203

Bulson, R., Jun, W., & Hayes, J. (2012). Visual symptomatology and referral patterns for Operation Iraqi Freedom and Operation Enduring Freedom veterans with traumatic brain injury. *Journal of Rehabilitation Research and Development, 49,* 1075–1082. http://dx.doi.org/10.1682/JRRD.2011.02.0017

Capó-Aponte, J. E., Tarbett, A. K., Urosevich, T. G., Temme, L. A., Sanghera, N. K., & Kalich, M. E. (2012). Effectiveness of computerized oculomotor vision screening in a military population: Pilot study. *Journal of Rehabilitation Research and Development, 49,* 1377–1398. http://dx.doi.org/10.1682/JRRD.2011.07.0128

Capó-Aponte, J. E., Urosevich, T. G., Temme, L. A., Tarbett, A. K., & Sanghera, N. K. (2012). Visual dysfunctions and symptoms during the subacute stage of blast-induced mild traumatic brain injury. *Military Medicine, 177,* 804–813. http://dx.doi.org/10.7205/MILMED-D-12-00061

Cate, Y., & Richards, L. (2000). Relationship between performance on tests of basic visual functions and visual–perceptual processing in persons after brain injury. *American Journal of Occupational Therapy, 54,* 326–334. http://dx.doi.org/10.5014/ajot.54.3.326

Ciuffreda, K. J., Kapoor, N., Rutner, D., Suchoff, I. B., Han, M. E., & Craig, S. (2007). Occurrence of oculomotor dysfunctions in acquired brain injury: A retrospective analysis. *Optometry, 78,* 155–161. http://dx.doi.org/10.1016/j.optm.2006.11.011

Ciuffreda, K. J., Suchoff, I. B., Kapoor, N., Jackowski, M. M., & Wainapel, S. F. (2001). Normal visual function. In E. G. Gonzalez, S. J. Myers, J. F. Edelstein J. S. Lieberman, & J. A. Downey (Eds.), *Downey and Darling's physiological basis of rehabilitation medicine* (3rd ed., pp. 241–261). Boston: Butterworth-Heinemann.

Daugherty, K. M., Frantz, K. A., Allison, C. L., & Gabriel, H. M. (2007). Evaluating changes in quality of life after vision therapy using the COVD Quality of Life Outcomes Assessment. *Optometry and Vision Development, 38,* 75–81.

Davies, S., Romano, P. S., Schmidt, E. M., Schultz, E., Geppert, J. J., & McDonald, K. M. (2011). Assessment of a novel hybrid Delphi and nominal groups technique to evaluate quality indicators. *Health Services Research, 46,* 2005–2018. http://dx.doi.org/10.1111/j.1475-6773.2011.01297.x

Defense Veterans Brain Injury Center. (2013). *DoD numbers for traumatic brain injury: 2000–2013 (Q1 and Q2).* Retrieved from http://wwwdvbic.org/sites/default/files/uploads/2000-2013%20up%20to%20Q2-dod-tbi-worldwide-2000-2013-Q2-as-of-Q1-Q2-13_01-08-13RDS.pdf

Delbecq, A. L., & VandeVen, A. H. (1971). A group process model for problem identification and program planning. *Journal of Applied Behavioral Science, 7,* 466–491. http://dx.doi.org/10.1177/002188637100700404

Fricke, T. R., & Siderov, J. (1997). Stereopsis, stereotests, and their relation to vision screening and clinical practice. *Clinical and Experimental Optometry, 80,* 165–172. http://dx.doi.org/10.1111/j.1444-0938.1997.tb04876.x

Galetta, K. M., Brandes, L. E., Maki, K., Dziemianowicz, M. S., Laudano, E., Allen, M., . . . Balcer, L. J. (2011). The King–Devick test and sports-related concussion: Study of a rapid visual screening tool in a collegiate cohort. *Journal of the Neurological Sciences, 309,* 34–39. http://dx.doi.org/10.1016/j.jns.2011.07.039

Gallaway, M., & Mitchell, G. L. (2010). Validity of the VERA visual skills screening. *Optometry, 81,* 571–579. http://dx.doi.org/10.1016/j.optm.2010.07.024

Garzia, R. P., Richman, J. E., Nicholson, S. B., & Gaines, C. S. (1990). A new visual–verbal saccade test: The Development Eye Movement Test (DEM). *Journal of the American Optometric Association, 61,* 124–135.

Gillen, G. (2009). *Cognitive and perceptual rehabilitation: Optimizing function.* St. Louis, MO: Mosby.

Goodrich, G. L., Flyg, H. M., Kirby, J. E., Chang, C. Y., & Martinsen, G. L. (2013). Mechanisms of TBI and visual consequences in military and veteran populations. *Optometry and Vision Science, 90,* 105–112. http://dx.doi.org/10.1097/OPX.0b013e31827f15a1

Greenwald, B. D., Kapoor, N., & Singh, A. D. (2012). Visual impairments in the first year after traumatic brain injury. *Brain Injury, 26,* 1338–1359. http://dx.doi.org/10.3109/02699052.2012.706356

Kaiser, P. K. (2009). Prospective evaluation of visual acuity assessment: A comparison of Snellen versus ETDRS charts in clinical practice (an AOS thesis). *Transactions of the American Opthalmological Society, 107,* 311–324.

Kent, C. (2013). *Using low tech to assess low vision.* Retrieved from http://www.revophth.com/content/d/technology_update/c/40624/

Lew, H. L., Garvert, D. W., Pogoda, T. K., Hsu, P. T., Devine, J. M., White, D. K., . . . Goodrich, G. L. (2009). Auditory and visual impairments in patients with blast-related traumatic brain injury: Effect of dual sensory impairment on Functional Independence Measure. *Journal of Rehabilitation Research and Development, 46,* 819–826. http://dx.doi.org/10.1682/JRRD.2008.09.0129

Lew, H. L., Pogoda, T. K., Baker, E., Stolzmann, K. L., Meterko, M., Cifu, D. X., . . . Hendricks, A. M. (2011). Prevalence of dual sensory impairment and its association with traumatic brain injury and blast exposure in OEF/OIF veterans. *Journal of Head Trauma Rehabilitation, 26,* 489–496. http://dx.doi.org/10.1097/HTR.0b013e318204e54b

Maples, W. C., Atchley, J., & Ficklin, T. W. (1992). Northeastern State University College of Optometry's oculomotor norms. *Journal of Behavioral Optometry, 3,* 143–150.

Maples, W. C., & Ficklin, T. W. (1988). Inter-rater and test-rater reliability of pursuits and saccades. *Journal of the American Optometric Association, 59,* 549–552.

Powell, J. M., Birk, K., Cummings, E. H., & Ciol, M. A. (2005). The need for adult norms on the Developmental Eye Movement test. *Journal of Behavioral Optometry, 16,* 38–41.

Powell, J. M., Fan, M., Kiltz, P. J., Bergman, A. T., & Richman, J. (2006). A comparison of the Development Eye Movement Test (DEM) and the modified version of the Adult Developmental Eye Movement Test (A–DEM) with older adults. *Journal of Behavioral Optometry, 17,* 59–64.

Radomski, M. V., Davidson, L., Voydetich, D., & Erickson, M. W. (2009). Occupational therapy for service members with mild traumatic brain injury. *American Journal of Occupational Therapy, 63,* 646–655. http://dx.doi.org/10.5014/ajot.63.5.646

Raphael, B. A., Galetta, K. M., Jacobs, D. A., Markowitz, C. E., Liu, G. T., Nano-Schiavi, M. L., . . . Balcer, L. J. (2006). Validation and test characteristics of a 10-item neuro-ophthalmic supplement to the NEI–VFQ–25. *American Journal of Ophthalmology, 142,* 1026–1035. http://dx.doi.org/10.1016/j.ajo.2006.06.060

Rouse, M., Borsting, E., Mitchell, G. L., Cotter, S. A., Kulp, M., Scheiman, M., . . . Yamada, T.; Convergence Insufficiency Treatment Trial Investigator Group. (2009). Validity of the Convergence Insufficiency Symptom Survey: A confirmatory study. *Optometry and Vision Science, 86,* 357–363. http://dx.doi.org/10.1097/OPX.0b013e3181989252

Rouse, M. W., Borsting, E. J., Mitchell, G. L., Scheiman, M., Cotter, S. A., Cooper, J., . . . Wensveen, J.; Convergence Insufficiency Treatment Trial Group. (2004). Validity and reliability of the revised Convergence Insufficiency Symptom Survey in adults. *Ophthalmic and Physiological Optics, 24,* 384–390. http://dx.doi.org/10.1111/j.1475-1313.2004.00202.x

Sampedro, A. G., Richman, J. E., & Pardo, M. S. (2003). The Adult Developmental Eye Movement Test (A–DEM). *Journal of Behavioral Optometry, 14,* 101–105.

Sample, J. (1984). Nominal group technique: An alternative to brainstorming. *Journal of Extension, 22*(2). Retrieved from http://www.joe.org/joe/1984march/iw2.html

Scheiman, M. (2011). *Understanding and managing vision deficits: A guide for occupational therapists* (3rd ed.). Thorofare. NJ: Slack.

Scheiman, M., Gallaway, M., Frantz, K. A., Peters, R. J., Hatch, S., Cuff, M., & Mitchell, G. L. (2003). Nearpoint of convergence: Test procedure, target selection, and normative data. *Optometry and Vision Science, 80,* 214–225. http://dx.doi.org/10.1097/00006324-200303000-00011

Stelmack, J. A., Frith, T., Van Koevering, D., Rinne, S., & Stelmack, T. R. (2009). Visual function in patients followed at a Veterans Affairs polytrauma network site: An electronic medical record review. *Optometry, 80,* 419–424. http://dx.doi.org/10.1016/j.optm.2009.02.011

Stevens, S. (2007). Test distance vision using a Snellen chart. *Community Eye Health Journal, 20,* 52.

Suchoff, I. B., Kapoor, N., & Ciuffreda, K. J. (2001). An overview of acquired brain injury and optometric implications. In I. B. Suchoff, K. J. Ciuffreda, & N. Kapoor (Eds.), *Visual and vestibular consequences of acquired brain injury* (pp. 1–9). Santa Ana, CA: Optometric Extension Program.

Suchoff, I. B., Kapoor, N., Waxman, R., & Ference, W. (1999). The occurrence of ocular and visual dysfunctions in an acquired brain-injured patient sample. *Journal of the American Optometric Association, 70,* 301–308.

Veterans Health Administration. (2008). *Performance of traumatic brain injury specific ocular health and visual functioning examinations for polytrauma rehabilitation centers.* (VHA Directive No. 2008–065). Washington. DC: U.S. Department of Veterans Affairs.

Wainapel, S. F. (1995). Vision rehabilitation: An overlooked subject in physiatric training and practice (Commentary). *American Journal of Physical Medicine and Rehabilitation, 74,* 313–314. http://dx.doi.org/10.1097/00002060-199507000-00010

Weisser-Pike, O. (2014). Assessing abilities and capacities: Vision and visual processing. In M. V. Radomski & C. A. Trombly Latham (Eds.), *Occupational therapy for physical dysfunction* (7th ed, pp. 105–122). Baltimore: Lippincott Williams & Wilkins.

Yothers, T., Wick, B., & Morse, S. E. (2002). Clinical testing of accommodative facility: Part II. Development of an amplitude-scaled test. *Optometry, 73,* 91–102.