OCULOGICA

PUBLICATIONS

KEY TAKE-AWAYS

Click on journal logo to be directed to full article.

Metrics of concussion-related vision disorders among children and adolescents with persisting post-concussive symptoms using an objective eye tracking device

Master, C., Scheiman, M., Podolak, O., Grady, M., Howell, D (2025)

Assessing visual deficits is essential to reducing their impact on recovery and return to activities after concussion. Early detection of concussion-related visual dysfunction (CRVD) through a comprehensive exam by a binocular vision specialist can improve outcomes. A specialist trained to diagnose CRVD is not often available. The EyeBOX BOX score was significantly higher in individuals with CRVD (AUC = 0.7637). Each 1-point increase in the BOX score raised the odds of CRVD by 15%, highlighting its potential as a useful screening tool. The EyeBOX may thus be a useful measurement in identification of those with post-concussion CRVD, facilitating earlier referral, and better overall outcomes.

Eye tracking for classification of concussion in adults and pediatrics

Samadani U., Spinner R.J., Dynkowski G., Kirelik S., Schaaf T., Wall S.P., Huang P. (2022)

Eye tracking has the potential to serve as an objective “gold-standard” for detection of neurophysiologic disruption due to brain injury. A normal, uninjured population was NOT included in this study. Instead, only as "an intended use population" was included to meet an objective for an FDA label, which was that all subjects had experienced a blow to the head. This is an important distinction from other studies in the field. By including a normal population, the number of True Negatives would have increased along with specificity.

Objective infrared eye tracking aids in the identification of concussion-related vision disorders in adolescents with persistent post-concussive symptoms

Master, C. Rogers, T., Podolak, O., Howell, D., Grady, MF, Scheiman, M. (2022)

A multivariable model including all nine visio-vestibular examination (VVE) variables improved predictive ability to identify concussion-related vision disorders in adolescents with persistent post-concussion symptoms with an area under the ROC curve (AUC) = 0.73. The BOX score alone had an AUC = 0.67 ($p<0.01$). This implies that VVE and BOX Score measure different aspects of concussion. These results suggest that an objective eye tracking variable may be a valuable addition to the current concussion battery.

Eye tracking metric differences among uninjured adolescents and those with acute or persistent post-concussion symptoms

Jain, D., Arbogast, K.B., McDonald, C.C., Podolak, O.E., Margulies, S.S., Metzger, K.B., Howell, D.R., Scheiman, M.M., Master, C.L. (2022)

Objective eye tracking technology is capable of quickly identifying vision and pupillary disturbances after concussion, augmenting traditional clinical concussion assessments. The eye tracking metrics may enhance existing clinical practice for monitoring recovery in a heterogeneous adolescent concussion population.

Objective eye tracking metrics of vision and autonomic dysfunction distinguish adolescents with acute concussion and those with persistent post-concussion systems from uninjured controls

Jain, D., Arbogast, K.B., McDonald, C.C., Podolak, O.E., Margulies, S.S., Metzger, K.B., Howell, D.R., Scheiman, M.M., Master, C.L. (2022)

Objective eye tracking technology can identify vision and pupillary disturbances after concussion. The eye tracking metrics could be integrated into clinical practice to monitor recovery in a heterogeneous adolescent concussion population and may identify sex-specific differences in autonomic dysfunction.

The association between baseline eye tracking performance and concussion assessments in high school football players

Oldham, J.R., Master, C.L., Walker, G.A., Meehan, W.P. 3rd, Howell, D.R. (2021)

Eye tracking was not significantly associated with the commonly used clinical concussion assessments. These results suggest that an objective eye tracking variable may be a valuable addition to the current concussion battery.

Impaired eye tracking is associated with symptom severity but not dynamic postural control in adolescents following concussion

Oldham, J.R., Meehan W.P. 3rd, Howell, D.R. (2020)

The concussion group with abnormal eye tracking results had worse overall total symptom severity and higher BOX scores on each of the 5 symptom profiles than those with normal eye tracking results and with healthy controls.

Objective eye tracking deficits following concussion for youth seen in a sport medicine setting

Howell, D.R., Brillant, A.N., Storey, E.P., Podolak, O.E., Meehan, W.P. 3rd, Master, C.L. (2018)

Visual function is an important component in the post-concussion evaluation and identifying deficits soon after injury may allow for earlier specialist referral and intervention.

Eye tracking as a biomarker for concussion in children

Bin Zahid, A., Hubbard, M.E., Lockyer, J., Podolak, O., Dammavalam, V.M., Grady, M., Nance, M., Scheiman, M., Samadani, U., Master, C.L. (2018)

Eye tracking correlates with concussion symptoms and detected convergence and accommodative abnormalities associated with concussion in the pediatric population. It demonstrates utility as a rapid, objective, noninvasive aid in the diagnosis of concussion. Eye tracking reliably detected convergence and accommodative abnormalities as well as other types of oculomotor dysfunction associated with concussion in the pediatric population. These results demonstrate the utility of eye tracking as a rapid, objective, noninvasive aid in the diagnosis of concussion that does not require pre-injury data for interpretation.

Reliability of objective eye-tracking measures among healthy adolescent athletes

Howell, D.R., Brilliant, A.N., Master, C.L., Meehan, W.P. (2018)

Automated and quantitative eye movement and conjugacy metrics provide relatively stable measurements among a group of healthy youth athletes. Thus, their inclusion as visual tracking metrics may be complementary to other visual examination techniques when monitoring concussion recovery across time.

Elevated intracranial pressure and reversible eye-tracking changes detected while viewing a film clip

Kolecki, R., Dammavalam, V., Bin Zahid, A., Hubbard, M., Choudhry, O., Reyes, M., Han, B., Wang, T., Papas, P.V., Adam, A., North, E. Gilberston, D.T., Kondziolka, D., Huang, J.H., Huang, P.P., Samadani, U. (2017)

These results suggest that eye tracking may be used as a noninvasive, automatable means to quantitate the physiological impact of elevated intracranial pressure (ICP), which has clinical application for assessment of shunt malfunction, pseudotumor cerebri, concussion, and prevention of second-impact syndrome.

A new tool for monitoring brain function: eye tracking goes beyond assessing attention to measuring central nervous system physiology

Samadani, U. (2015)

Two manuscripts describe a novel algorithm for eye tracking that may be useful for concussion, other forms of traumatic brain injury (TBI), and other neuropathologies (Samadani et al., 2014; Samadani et al., 2015). Eye tracking assesses brain function rather than appearance or electrical activity and thus represents a relatively newer modality for assessment of central nervous system integrity. The difference between the two papers published by our group and nearly all prior eye tracking publications is that our new papers utilize non-spatially calibrated eye tracking. Rather than assessing what someone chooses to look at, the tracking measures how well the eyes can move.

Concussion

Will eye tracking change the way we diagnose and classify concussion and structural brain injury?

Samadani, U. (2015)

Eye tracking might ultimately be used to classify - or even define - concussion in traumatic neurologic injury that is not apparent on computed tomography (CT) scanning, resulting in intracranial mass effect, elevated intracranial pressure or disruption of neurologic pathways.

Journal of Neurotrauma

Eye tracking detects disconjugate eye movements associated with structural traumatic brain injury and concussion

Samadani, U., Ritlop, R., Reyes, M., Nehrbass, E., Li, M., Lamm, E., Schneider, J., Shimunov, D., Sava, M., Kolecki, R., Burris, R., Altomare, L., Mehmood, T., Smith, T., Huang, J.H., McStay, C., Todd, S.R., Qian, M., Kondziolka, D., Wall, S., Huang, P. (2015)

Establishment of eye tracking as an objective measure can enable testing of protective devices for concussion (e.g., helmets) as well as of therapeutics. It can potentially enable informed decision-making regarding return to baseline activity or sport play. Concussion may be the first of several neurological disorders for which eye tracking will be the preferred diagnostic.

Concussion

Detection of third and sixth cranial nerve palsies with a novel method for eye tracking while watching a short film clip

Samadani, U., Farooq, S., Ritlop, R., Warren, F., Reyes, M., Lamm, E., Alex, A., Nehrbrass, E., Kolecki, R., Jureller, M., Schneider, J., Chen, A., Shi, C., Mendhiratta, N., Huang, J.H., Qian, M., Kwak, R., Mikheev, A., Rusinek, H., George, A., Fergus, R., Kondziolka, D., Huang, P.P., Smith, T. (2015)

Results suggest that eye tracking may be used as a noninvasive, automatable means to quantitate the physiological impact of CN palsies and elevated intracranial pressure (ICP), which has clinical application for assessment of shunt malfunction, pseudotumor cerebri, concussion, and prevention of second-impact syndrome

Eye movement conjugacy while watching a video reveals greater vertical than horizontal disconjugacy in human subjects

Samadani, U. Ciddi, D., Chen, A., Lamm, E., Ritlop, R., Alex, A., Warren F., Huang, P., Smith T. (2014)

Normal control subjects have eye movements that are more conjugate when viewing a video playing in a small aperture versus on a larger screen, and in the horizontal versus vertical plane, as assessed by our algorithm. Since a disconjugate gaze may result from intracranial pathology the algorithm we have developed may be useful for automatable assessment and monitoring of patients with neurologic dysfunction.