Course Description:
Eye movement testing has become increasingly utilized in clinical evaluation of various neurological conditions. This course will discuss technology in visual function and eye movement tracking, review the evidence of this technology and discuss the management of neurological conditions in primary care optometry using eye tracking.

Course Objectives:
At the completion of this lecture, participants will be able to:
- Describe visual function and eye movement tracking technology
- Describe the evidence based science of eye tracking
- Describe the management strategies for neurological conditions in primary care optometry

Course Outline:
1. Introduction
   a. Eye tracking technology
      i. Historical eye tracking technology
         1. Visagraph
            a. Goggle/computer set-up
            b. Oculomotor activity determined through infra-red sensors
      ii. New technologies
         1. Tobii Eye tracker
            a. Non-invasive, unobtrusive
            b. head movements subtracted from gaze direction data
            c. measuring true eye movements
            d. uses robust infrared technology
            e. accurately and precisely measure saccades among many other oculometrics to allow for quantification of the dynamics of eye movement data
            f. Tracking features and oculometrics described:
               i. Fixations
                  1. average fixation time
                  2. average fixation size
                  3. fixation count, total fixation time
                  4. fluctuation in fixation time length
               ii. Saccades
                  1. average saccadic length
                  2. total saccadic time
                  3. saccadic amplitude
               iii. Blinks
                 1. blink rate
                 2. blink duration
                 3. inter-blink interval
               iv. Pupillary dynamics
                  1. pupil diameter
                  2. fluctuation in pupil size
                  3. pupillary stress ratio
   2. King-Devick test review of literature & applications
      a. Concussion
         1. Requires baseline, new test, objective, sideline test, <1 minute to administer, trained administrator (non-medical)
         2. Testing eye movements: concussion anatomy overview
1. DLPFC, FEF, PEF, Visual cortex, Caudate nucleus, GP, STN, SNr, SC, ON
2. Approximately 55% of the brain's circuits are devoted to vision and eye movements, abnormalities in these areas correlate with long-term outcomes of concussion (Heitger et al., 2002; Heitger et al., 2010)
3. K-D concussion protocol: Baseline & Post-injury testing
4. Validated studies & evidence based research
   a. Boxers & MMA fighters Study: (n=39) (Galetta et al., 2011)
      i. Learning effects
      ii. Post-fight K-D scores correlated with post-fight Military Acute Concussion Evaluation (MACE) scores
      iii. Worsening of K-D score by >5 sec noted only in subjects with head trauma
   b. Collegiate Cohort Prospective Study: (n=219) (Galetta et al., 2011)
      i. Learning effects
      ii. Worsening of K-D score by 5.9 sec (avg) in concussed athletes
      iii. Exhaustion trial of basketball team (n=18) after 2 hour scrimmage showed average improvement of K-D time, K-D test robust to fatigue.
   c. New Zealand Amateur Rugby Pilot study: (n=50) (King et al., 2012)
      i. Post-game K-D testing revealed 2 incidental concussions neither witnessed nor reported during the game
   d. New Zealand Amateur Rugby Study: (n=37) (King et al., 2013)
      i. 5 witnessed concussions, 17 un-witnessed concussions
      ii. By incorporating the K-D test as part of the post-match assessment of players concussive injuries were identified that may have previously gone unnoticed or unmonitored.
   e. On-Going research:
      i. Professional hockey: SCAT2 and K-D
      ii. Sports Parents study
      iii. Wheaton College
      iv. Youth Hockey
   b. Parkinson's (Lin et al, 2013)
      i. Visual function testing
      1. Visual acuity, contrast sensitivity, vision specific quality of life
      ii. Structural vs. Functional testing
      1. Contrast sensitivity visual acuity
   c. Multiple sclerosis (Most et al, 2011; Rosenberg et al, 2013, Balcer et al, 2013)
      i. Oculomotor function metrics
      ii. Visual function testing
      1. Visual acuity, contrast sensitivity, vision specific quality of life
      iii. Structural vs. Functional testing
      1. Optical Coherence Tomography
      2. Contrast sensitivity visual acuities
   d. Hypoxia (Stepanek et al, 2013)
3. New eye tracking technology & the science (Stepanek et al, 2013)
   a. Hypoxia studies
      i. Review of hypoxia incapacitation
      ii. The King-Devick test and the Tobii Eye Tracker have been utilized in the study of changes in neurological function in the setting of hypoxia through the
measurement of eye movement dynamics and oculometrics with Mayo Clinic software. After just 3 minutes of exposure to hypoxic conditions (8% O2) researchers found statistically significant increases in multiple oculometrics when compared to baseline (Average fixation time, average fixation size, fluctation in fixations, total saccadic time, blink rate and fluctuation in pupil size).

b. Concussion recovery
   i. Objective measures to monitor healing over time
   ii. Eye movement, saccadic function as a metric for recovery (Tjarks et al, 2013)
   iii. Role of oculomotor integrate training with vestibular therapy in rehabilitation

c. Additional applications
   i. oculomotor assessments related to reading fluency/ability
   ii. reading remediation progress monitoring

4. Conclusion
   a. How to implement research and science into clinical practice
      i. Concussion
      ii. Multiple sclerosis
      iii. Parkinson's disease
      iv. Hypoxia
References:


27. Terao Y, Fukada H, Yugeta A. Initiation and inhibitory control of saccades with the progression of Parkinson's disease-changes in three major drives converging on the superior colliculus. Neuropsychologia. 2011;49(7):1794-806. PMID: 21420990


