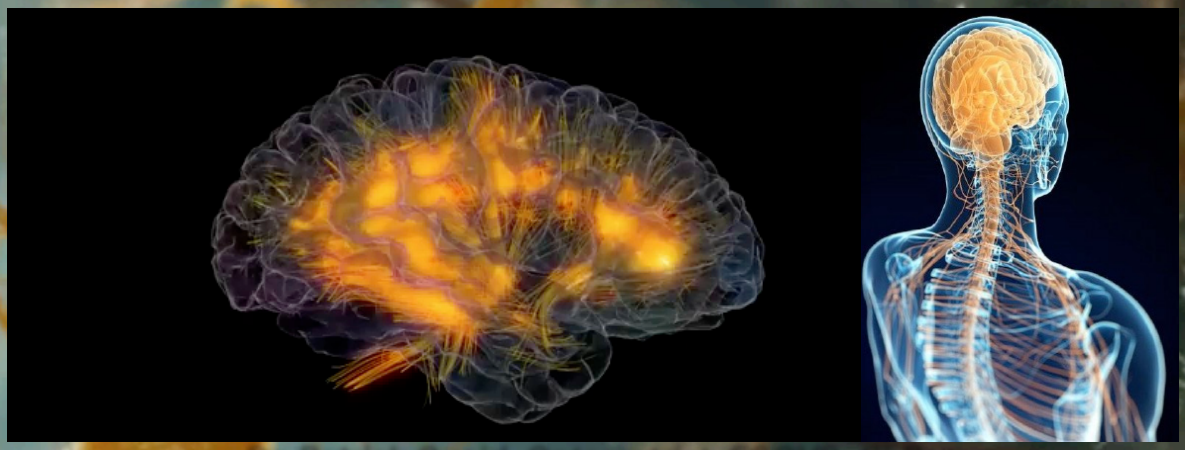
Diagnosis before Prognosis:

Going beyond visual acuity in visual rehabilitation



Dr. Patrick Quaid, Optometrist, FCOVD, PhD

President & CEO, VUE³ Vision Therapy & Rehabilitation Clinics (Guelph & Toronto)

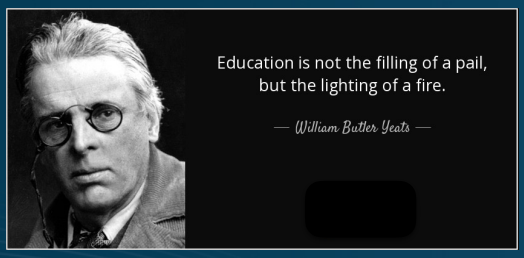
Adjunct Professor, University of Waterloo School of Optometry & Vision Science

Board of Directors, College of Optometrists in Vision Development (COVD International)

Chair of Registration & Executive Member, Ontario College of Optometrists (Regulatory Board, Canada)

VUE³ Cubed VT Network

Patrick Quaid, Optometrist, FCOVD, PhD



Told I would be lucky to finish high-school.....twice!

- PhD & Post-Doc at University of Waterloo School of Optometry & Vision Science
- Canadian Institute of Health Research (CIHR) Post-Doctorate Research Fellow
- University of Waterloo President's Award for Research Excellence (2005)
- Several publications in high impact ophthalmology / optometry journals
- CEO of VUE-Cubed Vision Rehabilitation Network (www.vuetherapy.va)
- Consultant Optometrist to Sports Medicine (David L. MacIntosh Sports Med)
- Delivered over 500 lectures to optometry, ophthalmology and allied professionals
- Author of book chapter on mTBI and vision with Neuro-ophthalmology (Hopkins)
- Adjunct Professor at University of Waterloo School of Optometry & Vision Science

My ultimate goal: What is the RIGHT *approach* in the RIGHT *sequence*?

What if we are ALL right? How do we move forward TOGETHER?

My original PhD / post-doc research: Illusions

Short and Sweet

i-PERCEPTION

Crowding and the Furrow Illusion

i-Perception
2018 Vol. 9(5), 1–4

DOI: 10.1177/2041669518801029
journals.sagepub.com/home/ipe
SAGE

McGurk Effect: Vision wins when vision and auditory collide!

Invest Ophthalmol Vis Sci. 2014 Apr 24;55(5):3158-64. doi: 10.1167/iovs.14-14140.

Audiovisual perception in adults with amblyopia: a study using the McGurk effect.

Narinesingh C[1], Wan M[2], Goltz HC[3], Chandrakumar M[1], Wong AM[1].

Author information

Abstract

PURPOSE: The effects on multisensory integration have rarely been examined in amblyopia. The McGurk effect is a well-established audiovisual illusion that is manifested when an auditory phoneme is presented concurrently with an incongruent visual phoneme. Visually healthy viewers will hear a phoneme that does not match the actual auditory stimulus, having been perceptually influenced by the visual phoneme. This study examines audiovisual integration in adults with amblyopia.

METHODS: Twenty-two subjects with amblyopia and 25 visually healthy controls participated. Participants viewed videos of combinations of visual and auditory phonemes, and were asked to report what they heard. Some videos had congruent video and audio (control), whereas others had incongruent video and audio (McGurk). The McGurk effect is strongest when the visual phoneme dominates over the audio phoneme, resulting in low auditory accuracy on the task.

RESULTS: Adults with amblyopia demonstrated a weaker McGurk effect than visually healthy controls (P = 0.01). The difference was greatest when viewing monocularly with the amblyopic eye, and it was also evident when viewing binocularly or monocularly with the fellow eye. No correlations were found between the strength of the McGurk effect and either visual acuity or stereoacuity in subjects with amblyopia. Subjects with amblyopia and controls showed a similar response pattern to different speakers and syllables, and subjects with amblyopia consistently demonstrated a weaker effect than controls.

CONCLUSIONS: Abnormal visual experience early in life can have negative consequences for audiovisual integration that persists into adulthood in people with amblyopia.

So what about vision and vestibular function?

How do Visual & Auditory information interact?

Neuron, Vol. 48, 489–496, November 3, 2005, Copyright ©2005 by Elsevier Inc. DOI 10.1016/j.neuron.2005.10.020

Why Seeing Is Believing: Merging Auditory and Visual Worlds

Review

Ilana B. Witten* and Eric I. Knudsen
Department of Neurobiology
Stanford University School of Medicine
Stanford, California 94305

Vision may dominate our perception of space not because of any inherent physiological advantage of visual over other sensory connections in the brain, because visual information tends to be more reliable than other sources of spatial information, and the central nervous system integrates information in a statistically optimal fashion. This review discusses recent experiments on audiovisual integration that support this hypothesis. We consider candidate neural codes that would enable optimal integration and the implications of optimal integration for perception and plasticity.

Introduction

Vision dominates our perception of space. When our localization of a stimulus based on nonvisual information is ambiguous or conflicts with visual localization of the same stimulus, our nonvisual percept of location is sometimes drawn to the visually identified location, a phenomenon

in space perception that occurs in the presence of an auditory-visual discrepancy. Other kinds of experiments demonstrate that vision can also instruct short-term plastic changes in the processing of auditory spatial information, an effect referred to as the ventriloquism aftereffect (Canon, 1970; Radeau and Bertelson, 1974; Recanzone, 1998; Woods and Recanzone, 2004). In

"..visual information tends to be more reliable than other sources.....when our non-visual sources are ambiguous.."

Current Biology Vol 20 No 1
R22

Multisensory Integration: Vision Boosts Information through Suppression in Auditory Cortex

organization of the neocortex seems to more accurately reflect the nature of real world events — they rarely, if ever, consist of a unimodal sensory signal.

Signals fr
sensory a
any relev
show that
cortex, b

"vision enhances information coming from auditory cortex....."

Asif A. Ghaz

Quick note on the eyes and the ears....tensor tympani

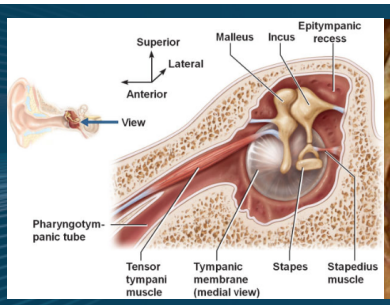
PNAS

The eardrums move when the eyes move: A multisensory effect on the mechanics of hearing

Kurtis G. Gruters[a,b,c,1], David L. K. Murphy[a,b,c,1], Cole D. Jenson[a,b,c], David W. Smith[d], Christopher A. Shera[e,f], and Jennifer M. Groh[a,b,c,2]

[a]Department of Psychology and Neuroscience, Duke University, Durham, NC 27708; [b]Department of Neurobiology, Duke University, Durham, NC 27708; [c]Duke Institute for Brain Sciences, Duke University, Durham, NC 27708; [d]Program in Behavioral and Cognitive Neuroscience, Department of Psychology, University of Florida, Gainesville, FL 32611; [e]Caruso Department of Otolaryngology, University of Southern California, Los Angeles, CA 90033; and [f]Department of Physics and Astronomy, University of Southern California, Los Angeles, CA 90033

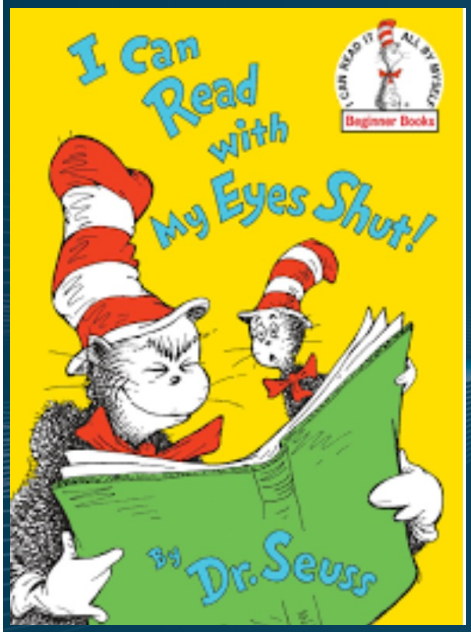
Edited by Peter L. Strick, University of Pittsburgh, Pittsburgh, PA, and approved December 8, 2017 (received for review October 19, 2017)



"Ears get ready….the eyes are about to move"

"...the eardrum moves in conjunction with eye movements...the eardrum motion was oscillatory and began as early as 10ms BEFORE saccadic onset in humans or monkeys....(this interaction) may aid the brain in evaluating the relationship between visual and auditory stimulus locations as the eyes move"

So……"the weirdest thing ever said to me"



"Vision has nothing to do with the ability to read"

Did you know...you need 17 different visual skills to successfully read, write and play sports???

1. Eye Movement Control
2. Simultaneous focus at far
3. Sustaining focus at far
4. Simultaneous focus at near
5. Sustaining focus at near
6. Simulatenous alignment at far
7. Sustaining alignment at far
8. Simultaneous Alignment at near
9. Sustaining alignment at near
10. Central Vision (Visual Acuity)
11. Peripheral Vision
12. Depth Awareness
13. Color Perception
14. Cross Visual-Motor
15. Fine Visual Motor
16. Visual Perception
17. Visual Ingegration

Why we have to completely change what we THINK vision is….

Question: What do you understand from the term "20/20"?

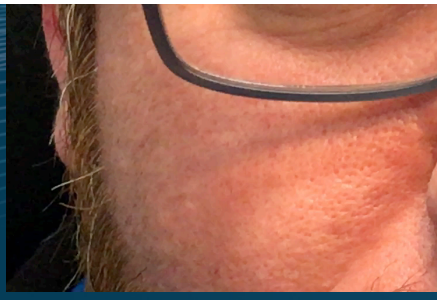
Graefes Arch Clin Exp Ophthalmol (2013) 251:169–187
DOI 10.1007/s00417-012-2135-0

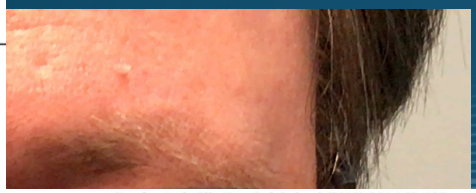
MEDICAL OPHTHALMOLOGY

Association between reading speed, cycloplegic refractive error, and oculomotor function in reading disabled children versus controls

Patrick Quaid · Trefford Simpson

Received: 23 May 2012 / Revised: 15 July 2012 / Accepted: 3 August 2012 / Published

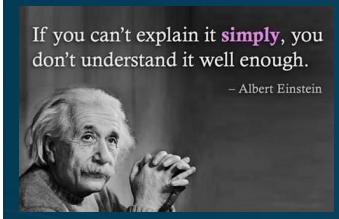




Clinical test performed	Mean (SD) IEP (n=50)	Mean (SD) control (n=50)	Significance level
WPM below age normal	54.92 (32.87) wpm	8.62 (8.93) wpm	p<0.001
# of extra eye movements[a]	90.24 (62.52)	11.74 (12.14)	p<0.001
Questionnaire (0–60 score)	26.82 (13.91)	5.38 (3.58)	p<0.001
12BO / 3BI vergence facility	7.31 (3.37) cpm	14.48 (2.03) cpm	p<0.001
Spherical Rx (average Rx)	+1.37 (1.92) DS	−0.66 (1.62) DS	p<0.001
Astigmatic Rx	−0.82 (0.68) DC	−0.78 (0.59) DC	p=0.69
MAF (+/−2DS)	8.24 (3.58) cpm	12.81 (1.57) cpm	p<0.001
BAF (+/−2DS)	9.14 (3.44) cpm	13.52 (1.61) cpm	p<0.001
Amplitudes of accommodation	10.44 (2.13) D	12.86 (1.31) D	p<0.05
Base out break (near)	15.88 (6.95) PD	25.58 (5.67) PD	p<0.001
Base out recovery (near)	12.56 (6.21) PD	21.05 (4.41) PD	p<0.001
Base in break (near)	9.21 (4.37) PD	13.28 (2.87) PD	p<0.001
Base in recovery (near)	7.02 (4.07) PD	11.21 (2.59) PD	p<0.001
Stereopsis (seconds of arc)	65.20 (41.36)	32.40 (12.04)	p<0.001
Near point of convergence	10.76 (4.03) cm	7.48 (2.27) cm	p<0.001

Doctors have missed a fundamental fact: "20/20" tells you nothing about eye movements, yet we move the eyes a lot with reading and locomotion through our environment!

My model for reading...VWFA is the "visual library"



Frontal lobe "pick me...pick me"

EF, WM

J Neurosci. 2017 May 24;37(21):5288-5297. doi: 10.1523/JNEUROSCI.0138-17.2017. Epub 2017 Apr 27.

Privileged Functional Connectivity between the Visual Word Form Area and the Language System.

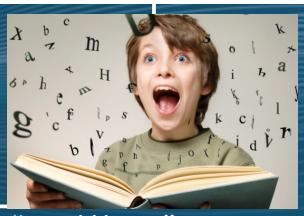
Stevens WD[1], Kravitz DJ[2], Peng CS[2], Tessler MH[2], Martin A[2].

Proper visual function

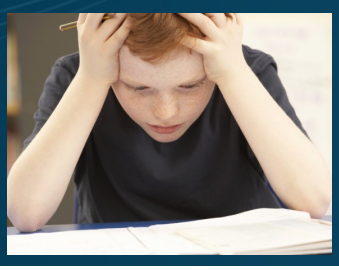
STM

"VM HWY"

LTM



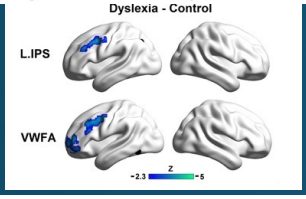
"visual library" Area VWFA



Aud

ORIGINAL RESEARCH ARTICLE
Front. Hum. Neurosci., 10 September 2015 | http://dx.doi.org/10.3389/fnhum.2015.00495

Altered connectivity of the dorsal and ventral visual regions in dyslexic children: a resting-state fMRI study



Quick word on "dyslexia" & ADHD
Let's be a little more specific!

ATTENTION-DEFICIT/HYPERACTIVITY DISORDER
Alternative Diagnoses

Symptoms	ADHD (DSM-IV)*	Learning-Related Visual Problems (Kavner)	Normal Child Under 7 (Gesell)
Inattention ***(At least 6 necessary)*****:**			
Often fails to give close attention to details or makes careless mistakes	X	X	
Often has difficulty sustaining attention in tasks or play activities	X	X	X
Often does not listen when spoken to directly	X	X	
Often does not follow through on instructions or fails to finish work	X	X	X
Often has difficulty organizing tasks and activities	X	X	X
Often avoids, dislikes or is reluctant to engage in tasks requiring sustained mental effort	X	X	X
Often loses things	X	X	X
Often distracted by extraneous stimuli	X	X	X
Often forgetful in daily activities	X	X	
Hyperactivity and Impulsivity ***(At least 6 necessary)*****:**			
Often fidgets with hands or feet or squirms in seat	X	X	X
Often has difficulty remaining seated when required to do so	X	X	X
Often runs or climbs excessively	X		X
Often has difficulty playing quietly	X		
Often "on the go"	X		X
Often talks excessively	X	X	
Often blurts out answers to questions before they have been completed	X	X	
Often has difficulty awaiting turn	X	X	X
Often interrupts or intrudes on others	X	X	X

NOTE: 6 or more symptoms must be present for more than 6 months in 2 or more environments. If the child is reading, it is the same environment no matter where the child is.

First off, does the child struggle dyseidetic or dysphonetic skills?

Dyslexia Diagnosis

When diagnosing dyslexia, the DSM-V clearly states:

"*The individual's difficulties must not be better explained by developmental, neurological, sensory (vision or hearing), or motor disorders... "*

How common are BV disorders overall?

- Convergence insufficiency: 4% general population (15.9% in ADHD population)
- Amblyopia: 2-3%
- Strabismus: 2-3%
- Accommodative Dysfunction: 6%

Learning impaired: conservatively 7 in 10

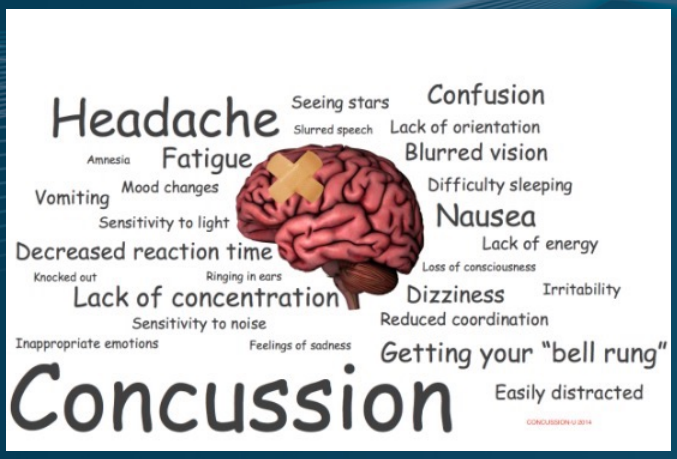
General population: 1 in 10

Concussion: Almost universal!

Symptoms by percentage (n=215, Lovell et al., 2004)

High School & College aged subjects within 3 days of concussion

- Incidence: 650/100,000 (under-reported)
- 15% remain symptomatic (PCS), 3x higher risk suicide
- 16% visual pre-existing vision issues (Quaid et al, 2017)
- 1.7m / yr (USA) with 35% being <16 y.o.
- Estimated as a $16.7B / yr issue

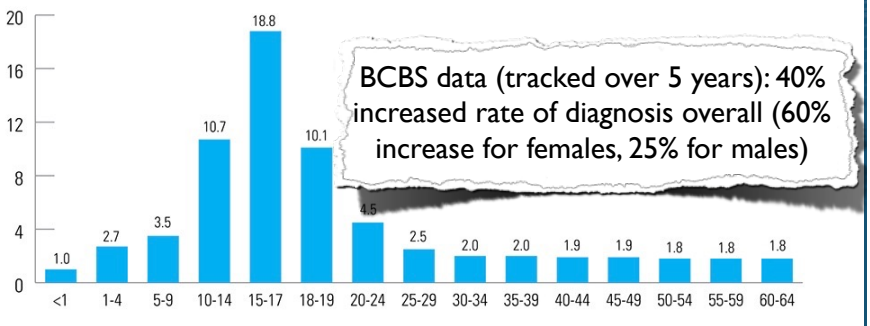


- Headaches (71%)
- Feeling "slowed down" (58%)
- Difficulty concentrating (57%)
- Dizziness (55%)
- "Fogginess" (53%)
- Fatigue (50%)
- Blurred vision / double vision (49%)
- Light sensitivity (47%)
- Memory dysfunction (43%)
- Balance dysfunction (43%)

General incidence and what insurance companies are finding.....they track data REAL WELL!

Activity	Number of emergency room visits
Bicycles	23,405
Football	20,293
Basketball	11,506
Playground	10,414
Soccer	7,667
Baseball	7,433
All-Terrain Vehicle	5,220
Hockey	4,111
Skateboarding	4,408
Swimming/Diving	3,846
Horseback Riding	2,648

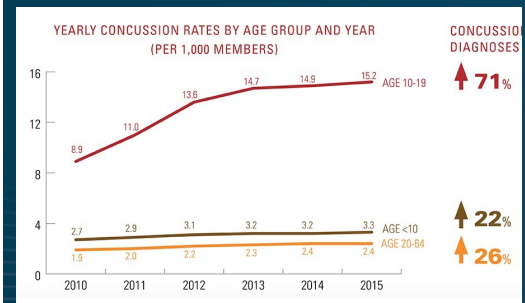
concussions presenting to ER rooms in the USA in 2007 for children ages 5-18 years old by activity (Valasek & McCambridge, 2012)

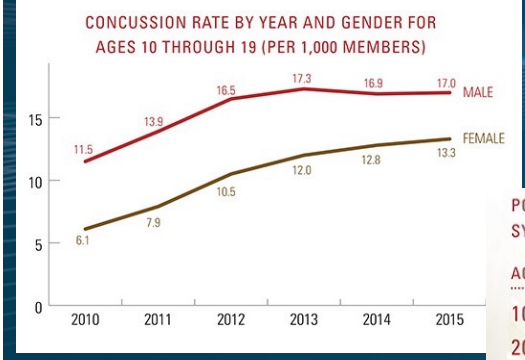


BCBS data (tracked over 5 years): 40% increased rate of diagnosis overall (60% increase for females, 25% for males)

When analyzing patients of all ages, concussion diagnoses increased 40 percent from 3.0 to 4.2 diagnoses per 1,000 members between 2010 and 2015. Female concussion diagnoses increased 60 percent from 2.5 to 4.0 diagnoses per 1,000 members, compared to 25 percent (3.6 to 4.5 diagnoses per 1,000 members) for males. Males continued to be diagnosed with 26 percent more concussions than females (4.3 per 1,000 members for males versus 3.4 for females) during the six-year study period.

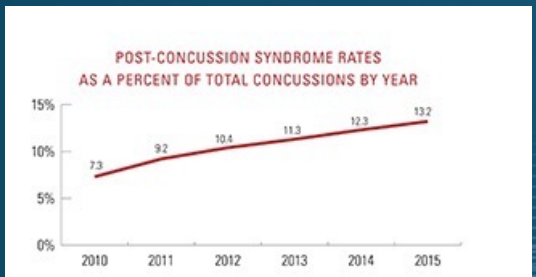
More interesting data from insurers....about which patients do not recover as well

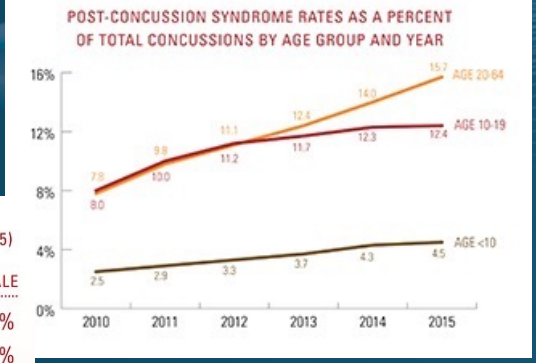




POST-CONCUSSION SYNDROME BY GENDER (2015)

AGE GROUP	MALE	FEMALE
10-19	50.0%	50.0%
20-64	38.7%	61.3%





Overall PCS rates up from 7.3% to 13.2% (81% increase) from 2010 to 2015, with most of the increase coming from females.

Older age group (20-64) have experienced the largest increase in non-resolving PCS patients, more of which tend to be female (matches what we see clinically).

Some other tragic literature that you may not be aware of...

CMAJ. 2016 Apr 19;188(7):497-504. doi: 10.1503/cmaj.150790. Epub 2016 Feb 8.

Risk of suicide after a concussion.

Fralick M[1], Thiruchelvam D[1], Tien HC[1], Redelmeier DA[2].

⊕ Author information

Abstract

BACKGROUND: Head injuries have been associated with subsequent suicide among military personnel, but outcomes after a concussion in the community are uncertain. We assessed the long-term risk of suicide after concussions occurring on weekends or weekdays in the community.

METHODS: We performed a longitudinal cohort analysis of adults with diagnosis of a concussion in Ontario, Canada, from Apr. 1, 1992, to Mar. 31, 2012 (a 20-yr period), excluding severe cases that resulted in hospital admission. The primary outcome was the long-term risk of suicide after a weekend or weekday concussion.

RESULTS: We identified 235,110 patients with a concussion. Their mean age was 41 years, 52% were men, and most (86%) lived in an urban location. A total of 667 subsequent suicides occurred over a median follow-up of 9.3 years, equivalent to 31 deaths per 100,000 patients annually or 3 times the population norm. Weekend concussions were associated with a one-third further increased risk of suicide compared with weekday concussions (relative risk 1.36, 95% confidence interval 1.14-1.64). The increased risk applied regardless of patients' demographic characteristics, was independent of past psychiatric conditions, became accentuated with time and exceeded the risk among military personnel. Half of these patients had visited a physician in the last week of life.

INTERPRETATION: Adults with a diagnosis of concussion had an increased long-term risk of suicide, particularly after concussions on weekends. Greater attention to the long-term care of patients after a concussion in the community might save lives because deaths from suicide can be prevented.

What are the main interventions for concussion currently?

- Rest (2 weeks to 6 months depending on what you read!)
- "Nothing can be done" (nonsense)
- VRT (Vestibular Rehabilitation Therapy)
- Physiotherapy for neck / back
- CBT (Cognitive Behavioral Therapy, infancy)
- Medications (headaches, depression, anxiety)
- Hormone work (very few doing)

Visual system virtually off the radar....despite <u>40% of the brain</u> being primarily visual machinery!!

Data in children (and pre-existing stats!) 2016 Study (n=100, ages 11-17)

Article

Vision Diagnoses Are Common After Concussion in Adolescents

Clinical Pediatrics
2016, Vol. 55(3) 260–267

College of Optometrists in Vision Development

Vision Development & Rehabilitation

Journal of the College of Optometrists in Vision Development

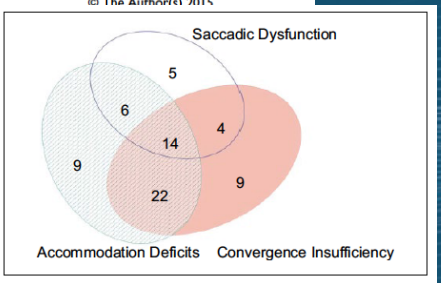
VDR, 2017; 3(2), 75-88

Prevalence of oculomotor dysfunction in healthy athletes: implications for concussion in sport

Shaylea D. Badovinac, BSc[1]

[3] Faculty of Kinesiology and Physical Education, University of Toronto, Ontario, Canada

[4] Neuroscience Research Program, St. Michael's Hospital, Ontario, Canada



"On average, approximately 18% of varsity athletes had significant visual issues at **<u>BASELINE</u>**"

"In all, 46% of patients had more than one vision diagnosis...69% had one or more vision issues present"

Likelihood of oculomotor dysfunction in concussion

BRAIN INJURY

http://informahealthcare.com/bij
ISSN: 0269-9052 (print), 1362-301X (electronic)

Brain Inj, Early Online: 1–11
© 2014 Informa UK Ltd. DOI: 10.3109/0269052.2014.888771

informa healthcare

Screening for lifetime concussion in athletes: Importance of oculomotor measures

Dmitri V. Poltavski[1], & David Biberdorf[2]

[1]Department of Psychology, University of North Dakota, Grand Forks, ND, USA and [2]Valley Vision Clinic, Grand Forks, ND, USA

Abstract

Hypothesis/objective: The purpose of the present study was to determine the utility of oculomotor-based evaluation protocols in screening for lifetime concussion incidence in elite hockey players.

Methods: Forty-two Division I collegiate male and female hockey players were evaluated using the guidelines of an overall oculomotor-based diagnostic clinical test protocol for the mTBI population. The sensitivity of the collected measures to lifetime concussion was then compared with the corres[illegible] often used with[illegible]

Results: This mo[illegible] equal to or grea[illegible] on part A of an[illegible] more likely to h[illegible] NPFD and ADHD[illegible] IMPACT baseli[illegible] concussion hist[illegible]

Conclusion: The[illegible] previous concussion(s) in an athlete. This model may allow athletic personnel to address in a timely manner the risks associated with repeat concussions and to develop individualized concussion management protocols.

Keywords

Concussion, hockey, ImPACT, NPFD, oculomotor measures, Visagraph

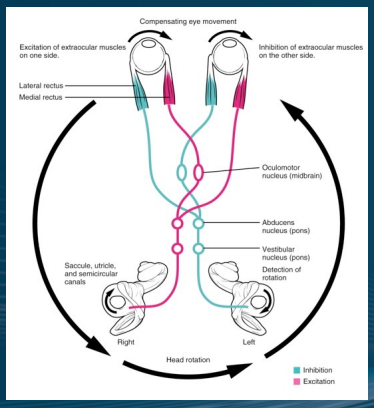
History

Received 21 October 2013
Revised 24 January 2014

"presence of oculomotor dysfunction...on average 10.72x more likely to have previously suffered a concussion..."

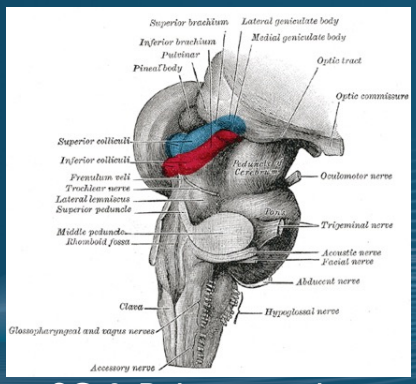
How exactly does VISION fit into concussion?

4 months post-birth

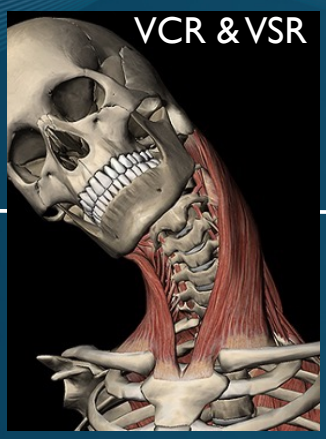


Vision

VOR



SC & Pulvinar pathway (under-researched!)



Vestibular

48 days GESTATION

Proprioception
(SCM function)

Neck: 3.5 months post-birth

Cerebellum: How does visual input factor in?

SJOVS, July 2012, Vol. 5, No. 1 - Review (in English) 1

The Oculomotor System's Ability to Adapt to Structural Changes Caused by the Process of Senescence: A Review

Jan Richard Bruenech[1, *], Inga-Britt Kjellevold Haugen[1], Ulla Bak[2], Marianne Maagaard[2] and Frans VanderWerf[3]

[1]Biomedical Research Unit, Faculty of Health Sciences, Buskerud University College, Kongsberg, Norway
[2]Danish College of Optometry and Visual Science, Randers, Denmark
[3]Department of Neuroscience, Erasmus Medical Center, the Netherlands

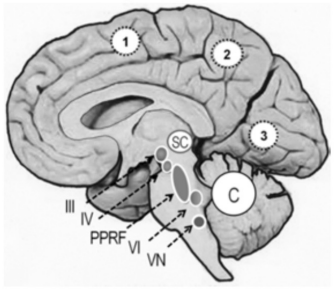


Figure 1. Sagittal section of a human brain. The principal components of the oculomotor system are outlined. Dashed circles indicate a location on the lateral aspect of each hemisphere (1: FEF/frontal eye field, 2: PEF/parietal eye field, 3: Extrastriate visual areas MT and MST/middle temporal and medial superior temporal). C: cerebellum, SC: superior colliculus, III-IV-V: ocular motor nerve nuclei, PPRF: parapontine reticular formation, VN: vestibular nucleus.

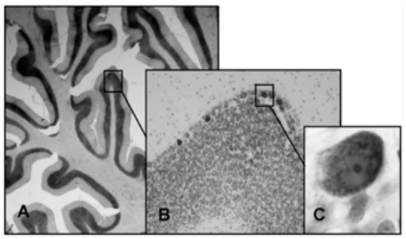
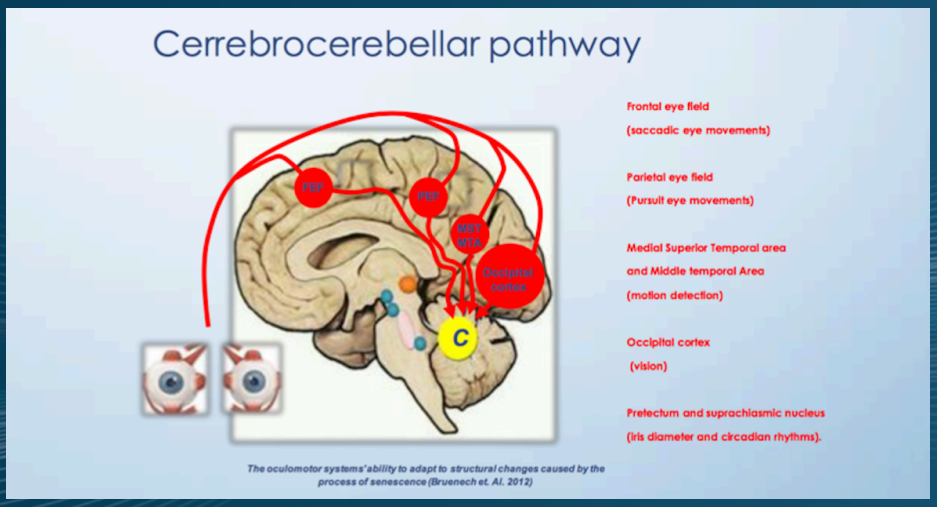


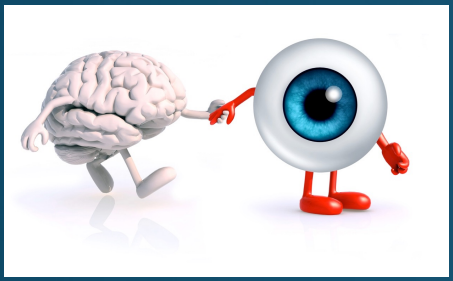
Figure 2. Micrographs of the cerebellum (Rhesus monkey). A) The cerebellar hemispheres displaying the lobular organization. B) The cortical layers of the cerebellum; the outer molecular layer, the central layer of Purkinje cells and an inner granular layer. C) Purkinje cell.

"Purkinje cells, which are the main efferent cells of the cerebellum, are found in the cortical region of all three cerebellar components (see Figure 1 and 2). These cells essentially project back to the structures from which they receive neural input. Visually related information, proprioception and vestibular input are cross-referenced through neural interactions between these three areas forming the basis for maintaining equilibrium, balance and fine motor control….this neural integration is vital for fluent and accurate eye movements".

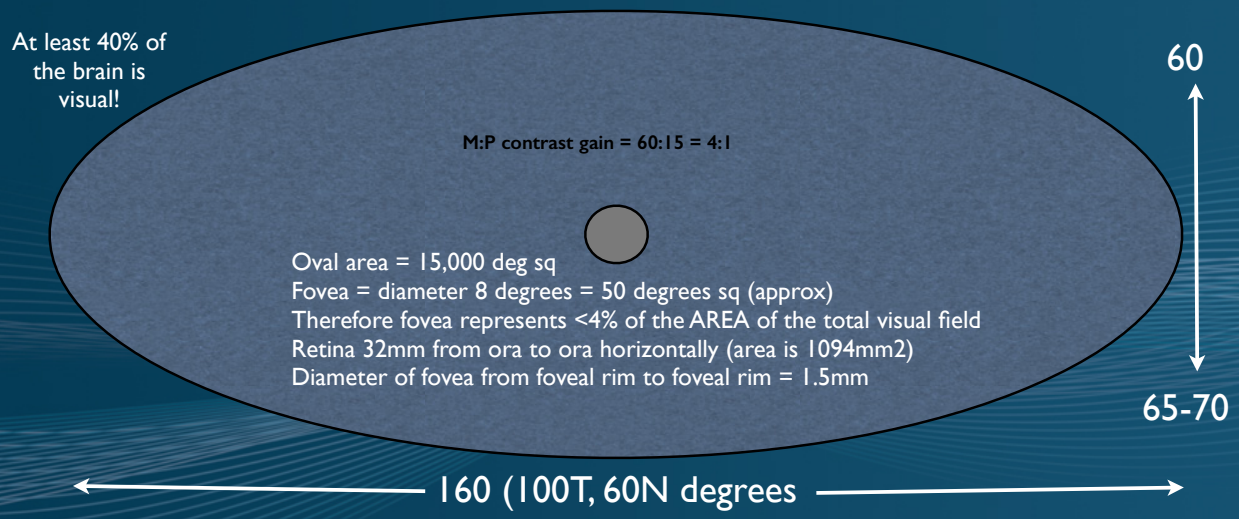
Richard Jan Bruenech, PhD (Norway)
UNDISPUTED expert in human anatomy!



Dr. Bruenech in Montreal 2017: "The visual system is unique in that it has a 1:1 connection in the cerebellum, something that is unmatched by either vestibular or proprioceptive input to the cerebellum. 1:1 connectivity in the cerebellum is as close to anatomical perfection as possible, there is literally no degradation in signal"

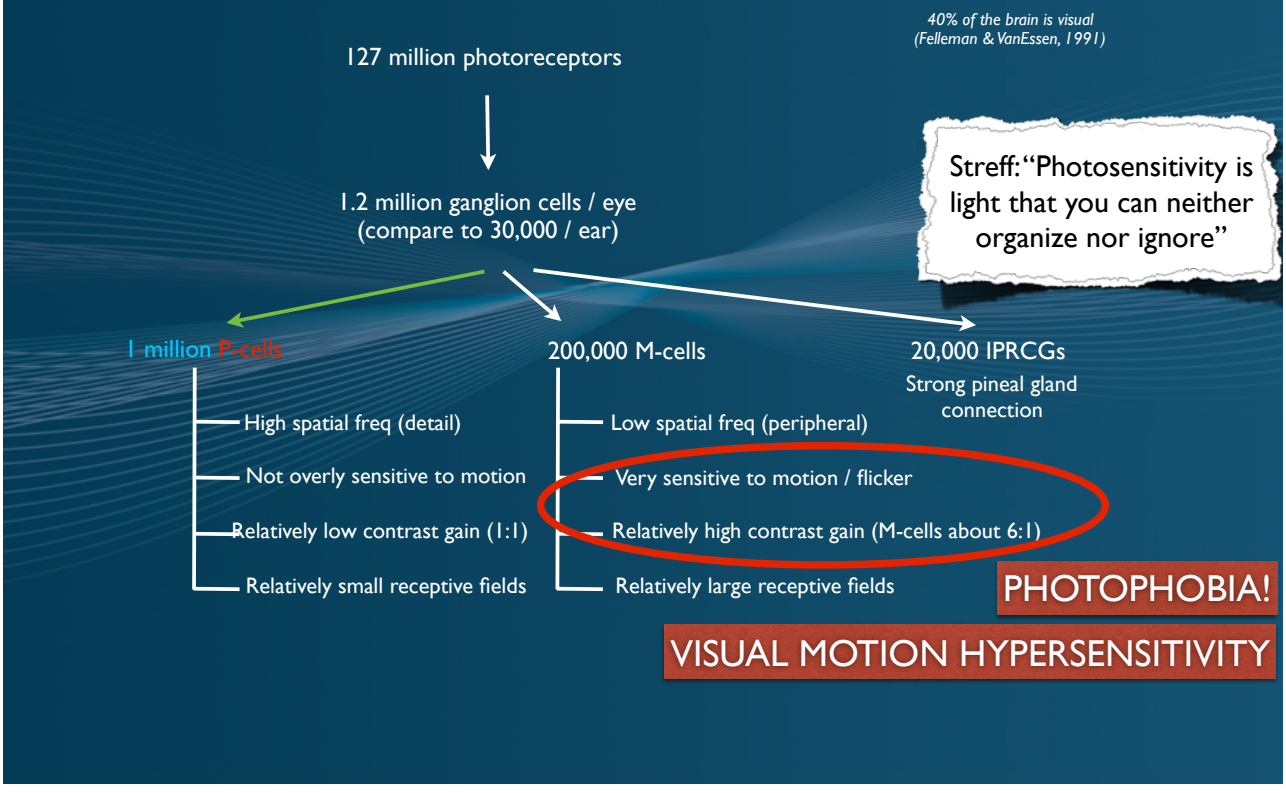


Saccadic integrity a reflection of PA integrity?



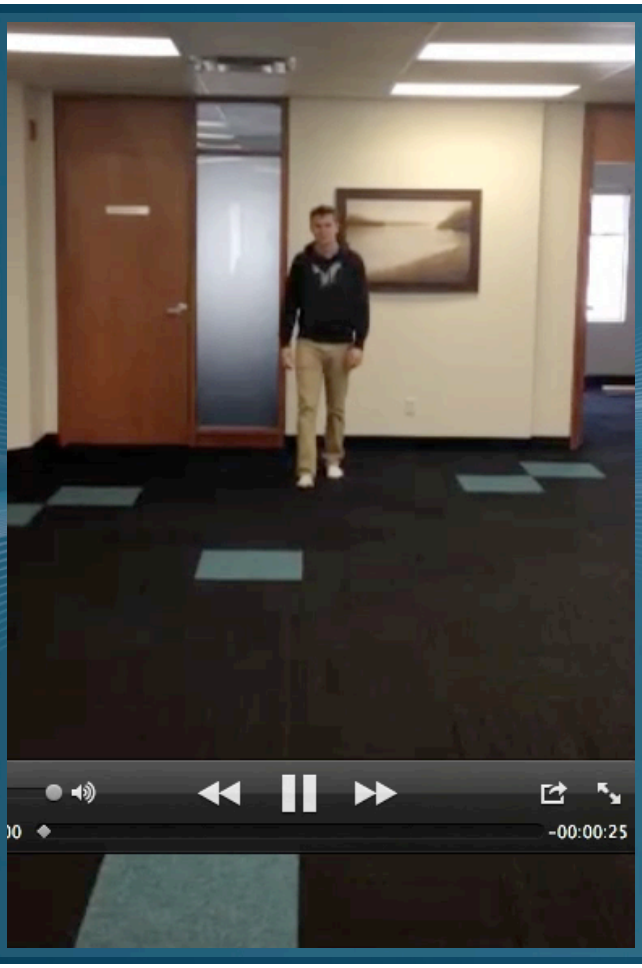
- 127 million photoreceptors at retinal level (120 million rods, 7 million cones)
- 1.22million retinal ganglions cells (1m P-cells, 200,000 M-cells, 20,000 IPRCs)
- 35:1 P:M at fovea, drops to 5:1 @ 15 degrees eccentricity (7-fold increase 15 deg)
- M-system less redundancy (i.e. 50k cells "short-wiring" more of issue in M-system)

Lets take a look at M-cells versus P-cells...



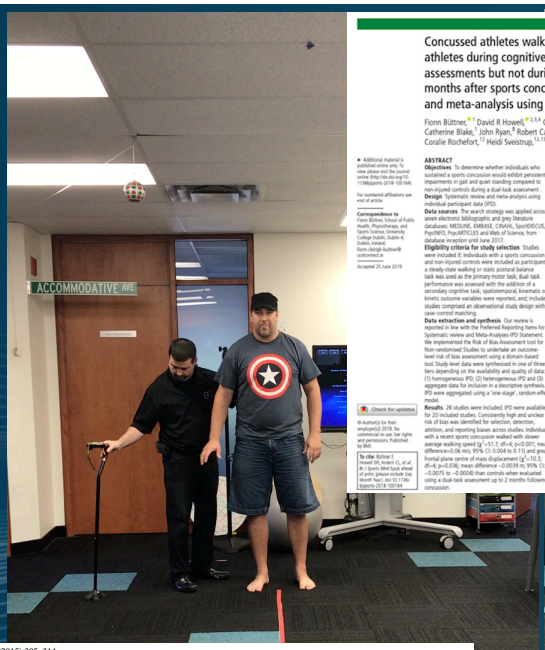
How influential is peripheral vision on balance?

Short answer....VERY! When vision collides with other sense...usually VISION WINS....but when dysfunctional vision wreaks havoc!



After in-office vision therapy....prisms no longer required!

Note: Saw "20/20" at all times!



Review

Concussed athletes walk slower than non-concussed athletes during cognitive-motor dual-task assessments but not during single-task assessments 2 months after sports concussion: a systematic review and meta-analysis using individual participant data

Fionn Büttner,[*1] David R Howell,[*2,3,4] Clare L Ardern,[*5,6] Cailbhe Doherty,[*1,7] Catherine Blake,[1] John Ryan,[8] Robert Catena,[9] Li-Shan Chou,[10] Peter Fino,[11] Coralie Rochefort,[12] Heidi Sveistrup,[12,13] Tonya Parker,[14] Eamonn Delahunt[*1,15]

ABSTRACT

Objectives To determine whether individuals who sustained a sports concussion would exhibit persistent impairments in gait and quiet standing compared to non-injured controls during a dual-task assessment.

Design Systematic review and meta-analysis using individual participant data (IPD).

Data sources The search strategy was applied across seven electronic bibliographic and grey literature databases: MEDLINE, EMBASE, CINAHL, SportDISCUS, PsycINFO, PsycARTICLES and Web of Science, from database inception until June 2017.

Eligibility criteria for study selection Studies were included if: individuals with a sports concussion and non-injured controls were included as participants; a steady-state walking or static postural balance task was used as the primary motor task; dual-task performance was assessed with the addition of a secondary cognitive task; spatiotemporal, kinematic or kinetic outcome variables were reported, and; included studies comprised an observational study design with case–control matching.

Data extraction and synthesis Our review is reported in line with the Preferred Reporting Items for Systematic review and Meta-Analyses–IPD Statement. We implemented the Risk of Bias Assessment tool for Non-randomised Studies to undertake an outcome-level risk of bias assessment using a domain-based tool. Study-level data were synthesised in one of three tiers depending on the availability and quality of data: (1) homogeneous IPD, (2) heterogeneous IPD and (3) aggregate data for inclusion in a descriptive synthesis. IPD were aggregated using a 'one-stage', random-effects model.

Results 26 studies were included; IPD were available for 20 included studies. Consistently high and unclear risk of bias was identified for selection, detection, attrition, and reporting biases across studies. Individuals with a recent sports concussion walked with slower average walking speed (χ^2_4=17.7, df=4, p=0.001; mean difference=0.06 m/s; 95% CI: 0.004 to 0.11) and greater frontal plane centre of mass displacement (χ^2_4=10.3, df=4; p=0.036; mean difference −0.0039 m; 95% CI: −0.0075 to −0.0004) than controls when evaluated using a dual-task assessment up to 2 months following concussion.

Summary/conclusions Our IPD evidence synthesis identifies that, when evaluated using a dual-task assessment, individuals who had incurred a sports concussion exhibited impairments in gait that persisted beyond reported standard clinical recovery timelines of 7–10 days. Dual-task assessment (with motion capture) may be a useful clinical assessment to evaluate recovery after sports concussion.

Protocol pre-registration This systematic review was prospectively registered in PROSPERO CRD42017064861.

INTRODUCTION

Sports concussion is an international sports medicine priority. Typically, diagnosis of sports concussion is informed by athlete self-reported symptoms, computerised cognitive testing, and clinician-assessed static postural balance performance.[1–3] The discriminative capacity of these assessments, however, diminishes dramatically with increasing time following injury.[4–6] The fifth Concussion in Sport Consensus Statement identifies innovative assessment techniques to evaluate the time-course of concussion-induced impairments as a research priority.[7]

A cognitive-motor dual-task is one where an individual performs a physical task (such as walking or quiet stance) while simultaneously performing a cognitive task (eg, subtracting numbers backwards). Cognitive-motor dual-task evaluations can detect latent gait impairments following sports concussion that extend beyond the reported recovery timelines for clinical symptoms, cognitive impairments, and static postural balance impairments.[8–10] Everyday movement tasks such as walking and quiet standing are completed regularly with little-to-no conscious effort, and participant performance does not tend to improve on these tasks with practice.[11] Therefore, walking and quiet standing are ideal tasks with which to simultaneously present a cognitive task to assess dual-task performance.

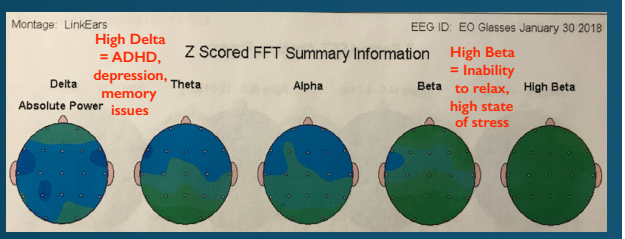
Previous systematic reviews have investigated the psychometric properties of dual-task assessments,[12] described the constituents of dual-task protocols[13] and quantified the dual-task deficit

NeuroRehabilitation 37 (2015) 305–314
DOI:10.3233/NRE-151263
IOS Press

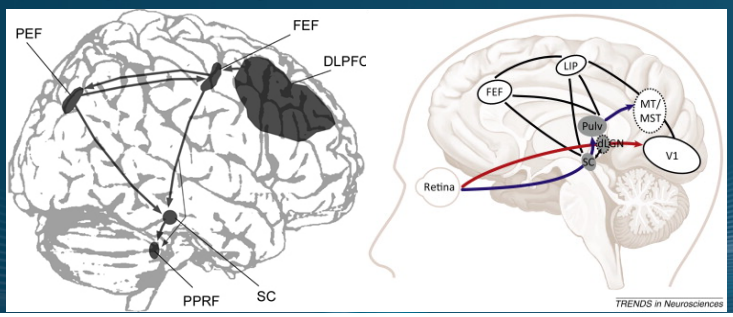
Risk of fall (RoF) intervention by affecting visual egocenter through gait analysis and yoked prisms

William V. Padula[a,c,*], Prem Subramanian[b], April Spurling[a] and Jonathan Jenness[a]
[a]*Padula Institute of Vision Rehabilitation, Guilford, CT, USA*
[b]*Department of Ophthalmology, University of Colorado School of Medicine, Aurora, CO, USA*
[c]*Department of Health Policy and Management, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA*

Live qEEG with a psychology team recordings....watch the data



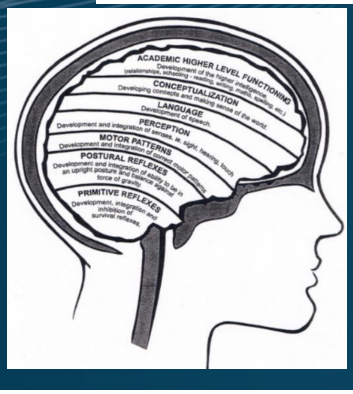
The Dorsolateral Prefrontal Cortex (DLPFC): Anatomical overlap significant between saccadic eye movements and working memory...and of course area MT implicated



J Neurol Sci. 2013 May 15;328(1-2):28-31. doi: 10.1016/j.jns.2013.02.008. Epub 2013 Mar 15.

Saccades and memory: baseline associations of the King-Devick and SCAT2 SAC tests in professional ice hockey players.

Galetta MS[1], Galetta KM, McCrossin J, Wilson JA, Moster S, Galetta SL, Balcer LJ, Dorshimer GW, Master CL.



"The DLPFC is the highest cortical area that is involved in motor planning organization and regulation.....it is one of the most recently evolved parts of the human brain.....it undergoes a prolonged period of maturation which lasts until adulthood".

What else can we use the peripheral system for?

40% of the brain is visual!

60

65-70

160 (100T, 60N degrees

A supposedly "constant esotrope" fuses? Huh?

Which system do you think we tapped into? the 94% of the visual field.....or the 6% of the acuity field?

VOR reflex....needs to be 98% accurate to avoid Sxs!

Am J Otolaryngol. 2014 Sep-Oct;35(5):572-6. doi: 10.1016/j.amjoto.2014.06.003. Epub 2014 Jun 21.

The correlation between the vestibulo-ocular reflex and multi-focal ocular correction: implications for vestibular compensation.

Michaelides E[1], Schutt CA[2].

Author information

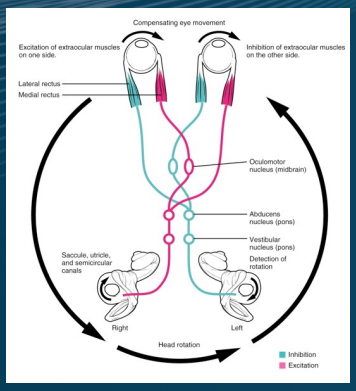
Abstract

PURPOSE: An accurate vestibulo-ocular reflex is important for gaze stability, and is adaptable through modification, based on stable and repeated vestibular and visual feedback. The optical power of eye glasses changes the ocular rotation needed to view an object due to the prismatic effect. Depending on the diopter of a lens, eyes have to rotate through fewer or more degrees to correct for refractive change. We aim to determine how multifocal lenses, such as progressives, affect needed ocular rotation and ocular gain based on location of the lens in which an object is viewed. Differing ocular gains within the same field of vision will create non-stable visual feedback possibly delaying vestibular recovery.

METHODS AND MATERIALS: Needed ocular rotation, and ocular gain to view an object 30° lateral to midline were calculated across different points in the vertical axis of a representative progressive lens.

RESULTS: In a progressive lens with superior correction of +1 D and inferior correction of +5.5 D, needed ocular rotation to view an object 30° lateral to midline would differ by 4.015°, with difference in ocular gain of 0.1336, indicating a 13.027% change in ocular gain, based on superior verse inferior viewing.

CONCLUSIONS: Progressive lenses have variable areas of VOR gain. This lack of consistent vestibulo-visual feedback may lead to prolonged compensation time in patients with vestibular injury.



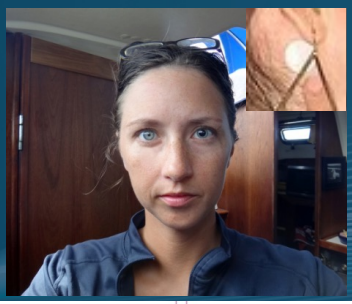
Note: How text is reported to appear in mTBI Distortion of central / peripheral integration?

Where is the "distortion", yup - in the PERIPHERY! Patient still sees "20/20" yet tracking and eye movements are a mess. This is why we need to think about vision from a different perspective. After all, the mind is like a parachute, only of use when OPEN (Frank Zappa)

As an aside....I think we explained motion sickness and also why scopolamine works!

What is more likely happening: VOR "gain" is fluctuating less as the accommodative system is more quiescent (i.e. the 500lb gorilla is sedated!).

Vision



Muscarinic receptor antagonists

- **Hyoscine (scopolamine)**
- **Orally, injection, patches**
- **Used as transdermal patches for prevention of motion sickness (applied behind the external ear before an insult).**
- **Acts centrally by reduce impulses from vestibular nuclei**

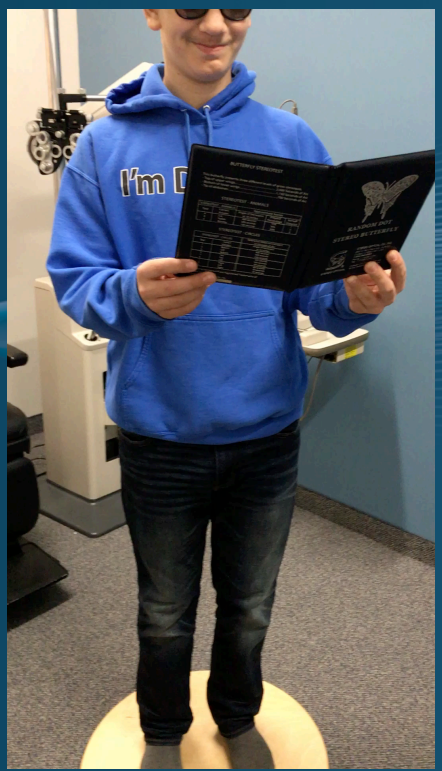
Vestibular

Proprioception
(SCM function)

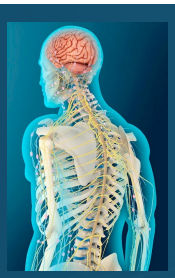
Remember the 3 legged stool analogy?

Well, it is a 2-way street….you need the other legs also!

"Bigger muscles can teach smaller muscles how to move / stabilize more effectively" - WC Maples



I needed to learn more...I needed to get outside the "eyecare bubble"!



- Hormone function and concussion (MD, OB/GYN background), how important?
- How exactly the neck and back is involved in concussion (neuro-muscular angle)?
- How can a TMJ dentist majorly help my patient to SLEEP (DDS, TMJ only)?
- How a COLLABORATIVE neuro-ophthalmologist can be invaluable (MD, PhD)
- How a Doctor of Audiology (AIB certified) is an invaluable member of the team?
- Importance of a neuro-psychologist...how exactly can they help?
- Incidence 650/100,000, approx 15% remaining symptomatic at 1-yr - WHY?
- Why do some PCS patients respond (very) differently to the SAME rehab applied?

So…how do we put all this together to form a proper team for rehab?

Sleep issues

Aggression

Memory

Balance

Headaches

Photophobia

Tracking issues

Mental "fogginess"

Anxiety

Speech issues

Neck pain

Tinnitus & auditory localization

Hormone dysfunction

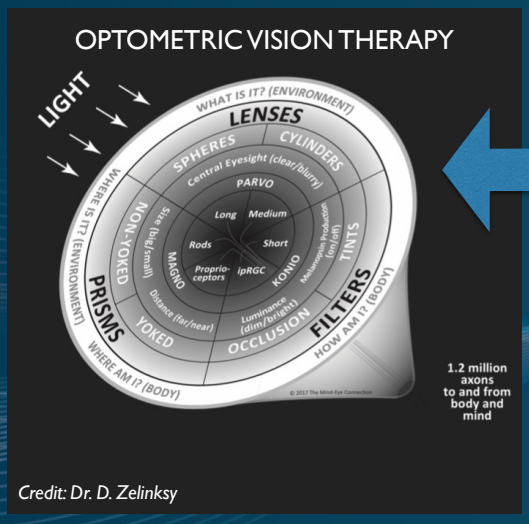
Depression

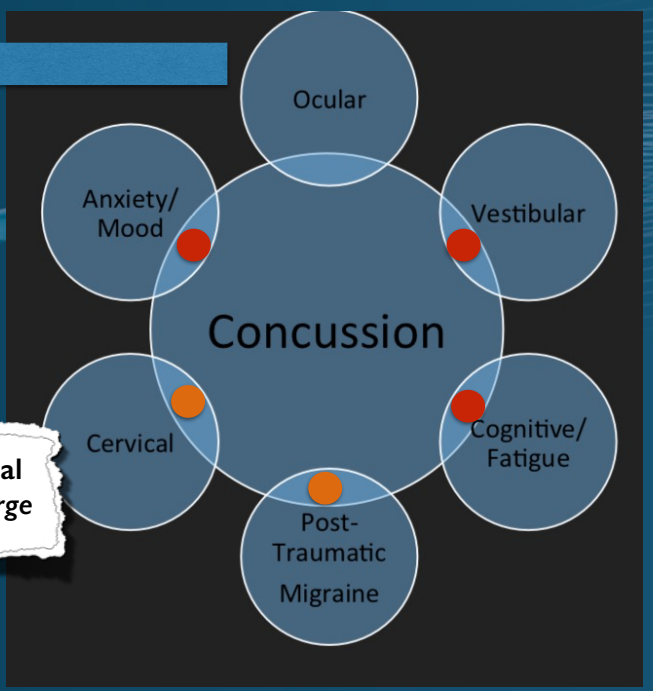
Bruxism

Let's look at my "Sandbox" of colleagues:

- Neuro-Optometry
- TMJ DDS
- NeuroPsychology
- Neuromuscular / Cervicogenic function (PT/OT/DC)
- Neurology / ENT
- mTBI hormone specialist
- Nutritionist
- AIB Audiologist & Speech Pathology

We have to be aware of the 6 subtypes





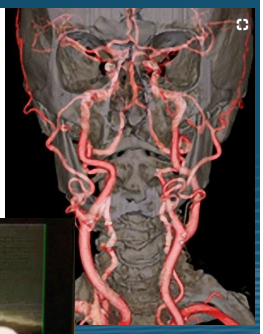
"Migraine patients have an abnormal velocity storage mechanism" *Dr. Berge*

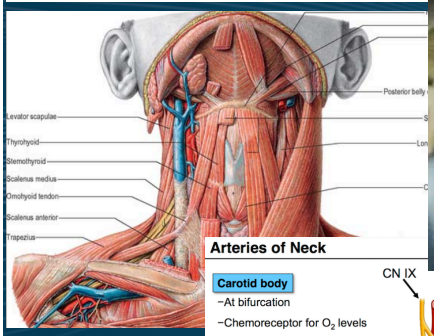
Mention of low perfusion....blood flow key!

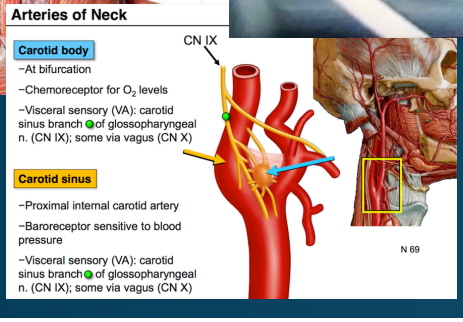
Glaucoma *Investigative Ophthalmology & Vision Science, 2013*

Relationship between Diastolic Perfusion Pressure and Progressive Optic Neuropathy as Determined by Heidelberg Retinal Tomography Topographic Change Analysis

Patrick Quaid,[1,2] Trefford Simpson,[3]

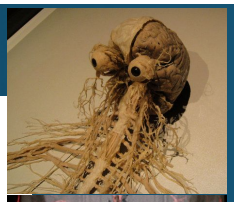






Brain weighs 2% of body weight and yet consumes 25-35% of the body's oxygen and over 70% of the body's glucose supply. Blood flow REALLY important to the brain as a whole!

Blood flow is implicated in NTG / dementia



Glaucoma

Relationship between Diastolic Perfusion Pressure and Progressive Optic Neuropathy as Determined by Heidelberg Retinal Tomography Topographic Change Analysis

Patrick Quaid,[1,2] Trefford Simpson,[3] and Thomas Freddo[3]

Purpose. To determine through retrospective file analysis which clinical factors best predict glaucomatous optic neuropathy as evaluated by Heidelberg retinal tomography (HRT II) imaging.

Methods. One hundred twenty-two records from patients referred for HRT imaging at the University of Waterloo Ocular Heath Clinic met inclusion criteria for this study and were reviewed. Topographic change analysis (TCA) data generated by HRT were examined in addition to the following clinical information: diastolic blood pressure, right arm sitting, intraocular pressure, and central corneal thickness. All HRT scans included were required to have 20 µm or better standard deviation (SD) on acquisition and deemed "very good" quality or "excellent" by HRT software. Based on previously defined published HRT TCA change criteria, each patient was allocated to one of the following groups: stable, borderline, or progressive.

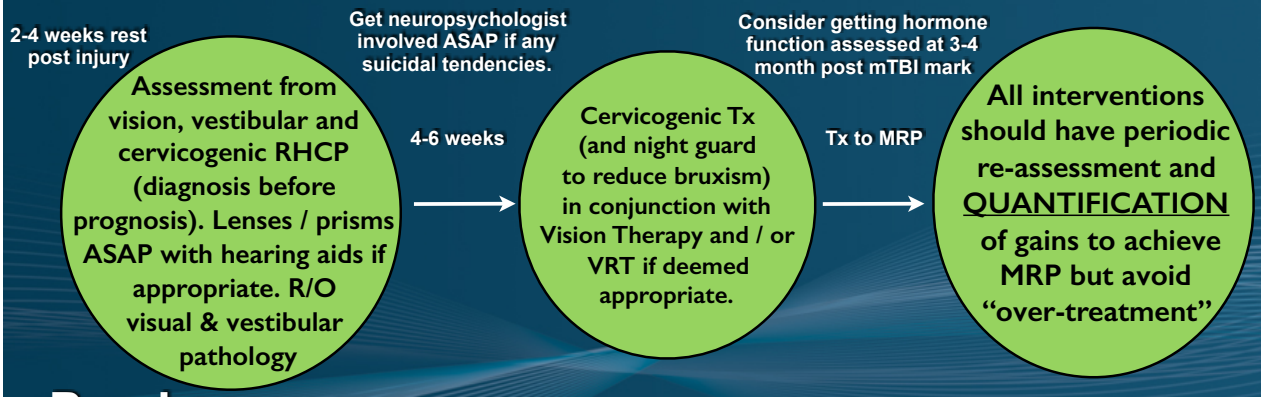
Results. Diastolic perfusion pressure (DPP) was found to be significantly lower in the borderline and progressive groups compared with the stable group ($P < 0.001$). DPP was also lower significantly lower in the progressive group compared with the borderline group ($P < 0.001$).

Conclusions. Low DPP appears to be a reasonable predictor of progressive optic neuropathy as determined using scans of <20 µm SD on the HRT TCA platform. DPP of 56 mm Hg or lower appears to be a clinically useful threshold to identify patients at increased risk of progressive optic neuropathy. (*Invest Ophthalmol Vis Sci.* 2013;54:000-000) DOI:10.1167/iovs.12-11177

"...low DPP appears to be a good predictor of progressive optic neuropathy as determined on HRT TCA....DPP of 56mmHg or lower appears to be a strong clinical indictor for higher risk of progression" (IOP & CCT far less so).

Remember: Brain weighs 2% of body weight and yet consumes 25% of the body's oxygen and over 70% of the body's glucose supply. Blood flow REALLY important in concussion!

General sequence and pearls.....



Pearls:

- Migraine Pxs can be curve balls (abnormal vestibular velocity storage mechanism)
- Px with Hx of severe motion sickness / MDDS tendencies may not respond as well
- Px with connective tissue disorders (i.e. EDS) or low DPP likely poorer recovery.
- Tx to MRP (Maximum Rehab Potential), give QUANTITATIVE DATA, data driven!
- Pre-existing IEP / LD issues may mean a longer Tx plan with lower MRP prognosis.

VOMS testing….finally, vision is on the radar!

Published in final edited form as:
Am J Sports Med. 2014 October ; 42(10): 2479–2486. doi:10.1177/0363546514543775.

A Brief Vestibular/Ocular Motor Screening (VOMS) Assessment to Evaluate Concussions:

Preliminary Findings

Anne Mucha, DPT[*], **Michael W. Collins, PhD**[†], **R.J. Elbin, PhD**[‡], **Joseph M. Furman, MD, PhD**[§], **Cara Troutman-Enseki, DPT**[*], **Ryan M. DeWolf, MS, ATC**[†], **Greg Marchetti, PhD**[||], and **Anthony P. Kontos, PhD**[†,¶]
Investigation performed at the University of Pittsburgh, Pittsburgh, Pennsylvania, USA

Abstract

Background—Vestibular and ocular motor impairments and symptoms have been documented in patients
assess and
Purpose—
clinical scr
related con
Study De
Methods—Sixty-four patients, aged 13.7 ± 2.5 years and seen approximately 5.5 ± 4.0 days after a sport-related concussion, and 78 controls were administered the Vestibular/Ocular Motor Screening (VOMS) assessment, which included 5 domains: (1) smooth pursuit, (2) horizontal and vertical saccades, (3) near point of convergence (NPC) distance, (4) horizontal vestibular ocular reflex (VOR), and (5) visual motion sensitivity (VMS). Participants were also administered the Post-Concussion Symptom Scale (PCSS).

"..five visual domains (smooth pursuits, horizontal and vertical saccades, NPC, horizontal VOR and **visual motion sensitivity**"

We now also have imaging data!

Optom Vis Sci. 2018 Jun;95(6):505-514. doi: 10.1097/OPX.0000000000001221.

Post-therapy Functional Magnetic Resonance Imaging in Adults with Symptomatic Convergence Insufficiency.

Widmer DE[1], Oechslin TS[1], Limbachia C[2], Kulp MT, Toole AJ[1], Kashou NH[2], Fogt N[1].

Author information

Abstract

SIGNIFICANCE: Prior studies have demonstrated the effectiveness of vergence-accommodative therapy in the treatment of convergence insufficiency (CI). These results show the changes in brain activation following therapy through the use of functional magnetic resonance imaging (fMRI).

PURPOSE: The purpose of this study was to investigate changes in brain activation following office-based vergence-accommodative therapy versus placebo therapy for CI using the blood oxygenation level-dependent signal from fMRI.

METHODS: Adults (n = 7, aged 18 to 30 years) with symptomatic CI were randomized to 12 weeks of vergence-accommodative therapy (n = 4) or placebo therapy (n = 3). Vergence eye movements were performed during baseline and outcome fMRI scans.

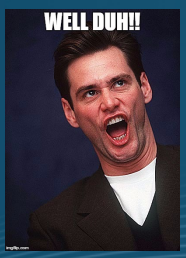
RESULTS: Before therapy, activation (z score ≥ 2.3) was observed in the occipital lobe and areas of the brain devoted to attention, with the largest areas of activation found in the occipital lobe. After vergence-accommodative therapy, activation in the occipital lobe decreased in spatial extent but increased in the level of activation in the posterior, inferior portion of the occipital lobe. A new area of activation appeared in the regions of the lingual gyrus, which was not seen after placebo therapy. A significant decrease in activation was also observed in areas of the brain devoted to attention after vergence-accommodative therapy and to a lesser extent after placebo therapy.

CONCLUSIONS: Observed activation pre-therapy consistent with top-down processing suggests that convergence requires conscious effort in symptomatic CI. Decreased ac… in clinical signs such as fusional verge… response in the occipital areas followi… vergence may be enhanced following…

"The significant change in blood-oxygen level dependant response in the occipital areas following rehabilitative vision therapy…. suggests that both depth and vergence may be enhanced.."

An aside: Best way to treat concussion in sports = try to prevent it!

OPTOMETRY & VISUAL PERFORMANCE



Article ▸ **An Exploratory Study of the Potential Effects of Vision Training on Concussion Incidence in Football**

Joseph F. Clark, PhD, ATC, Department of Neurology & Rehabilitation Medicine, University of Cincinnati, Cincinnati, Ohio

Pat Graman, MA, ATC, Department of Education, University of Cincinnati, Cincinnati, Ohio

James K. Ellis, OD, Department of Sports Medicine, University of Cincinnati, Cincinnati, Ohio

Robert E. Mangine, MEd, PT, ATC, Associate Athletic Director of Sports Medicine, University of Cincinnati, National Director of Clinical Sp…

Joseph T. Rauch, DPT, SCS, ATC, Departm… University of Cincinnati, Cincinnati, Ohio

Ben Bixenmann, MD, Department of Ne…

Kimberly A. Hasselfeld, MS, Department … University of Cincinnati, Cincinnati, Ohio

Jon G. Divine, MD, Department of Ortho… University of Cincinnati, Cincinnati, Ohio

Angelo J. Colosimo, MD, Departments o… University of Cincinnati, Cincinnati, Ohio

Gregory D. Myer, PhD, FACSM, Division c… Center, Department of Pediatrics and Or… Medicine Sports Health & Performance I… The Micheli Center for Sports Injury Prev…

Sample size (total) = 365 (2015 publication) (about 50/50 between VT and non-VT)

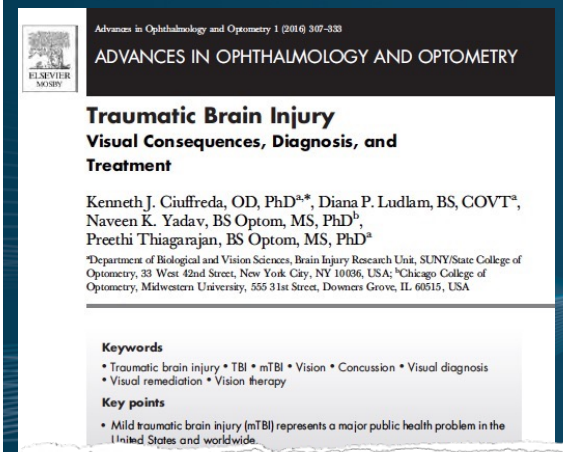
Results: During the 2006-2013 pre- and regular football seasons, there were 41 sustained concussion events reported. The overall concussion incidence rate for the entire cohort was 5.1 cases per 100 player seasons. When the data were evaluated relative to vision trained versus referent untrained player seasons, a statistically significant lower rate of concussion was noted in player season in the vision training cohort (1.4 concussions per 100 player seasons) compared to players who did not receive the vision training (9.2 concussions per 100 player seasons; p<0.001). The decrease in injury frequency in competitive seasons with vision training was also associated with a concomitant decrease in missed play time.

Discussion: The current data indicates an association of a decreased incidence of concussion among football players during the competitive seasons where vision training was performed as part of the … We suggest that better field awareness … y awareness to avoid concussion- … rranted to confirm the effects noted …

… football, injury, injury prevention,

"During the 2006-2013 seasons...41 sustained concussions. Average for whole group was 5.1 /100 per "player seasons". However, in VT group only 1.4/100 cases reported as opposed to 9.2/100 per "player seasons" in the non-VT group....the decrease in injury frequency in the VT group was associated with a decrease in missed play time.."

Rehabilitative VT is gaining research ground...rapidly!



Advances in Ophthalmology and Optometry 1 (2016) 307–333

ADVANCES IN OPHTHALMOLOGY AND OPTOMETRY

Traumatic Brain Injury
Visual Consequences, Diagnosis, and Treatment

Kenneth J. Ciuffreda, OD, PhD[a,*], Diana P. Ludlam, BS, COVT[a], Naveen K. Yadav, BS Optom, MS, PhD[b], Preethi Thiagarajan, BS Optom, MS, PhD[a]

[a]Department of Biological and Vision Sciences, Brain Injury Research Unit, SUNY/State College of Optometry, 33 West 42nd Street, New York City, NY 10036, USA; [b]Chicago College of Optometry, Midwestern University, 555 31st Street, Downers Grove, IL 60515, USA

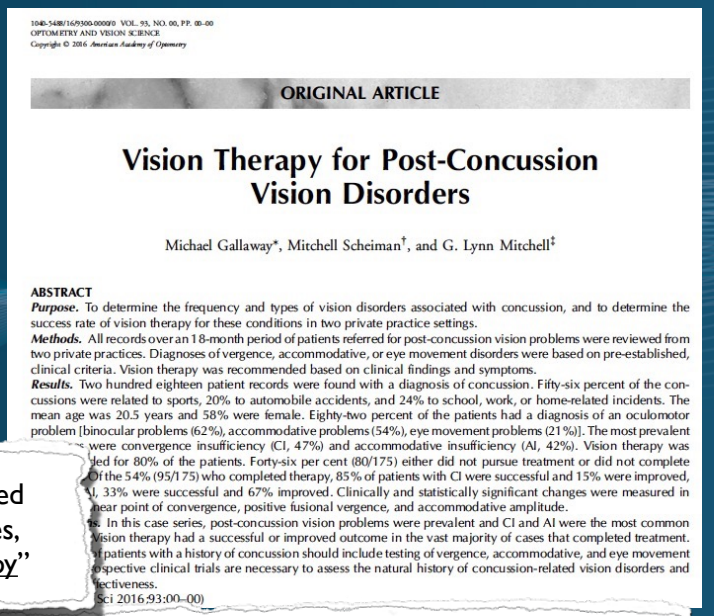
Keywords

• Traumatic brain injury • TBI • mTBI • Vision • Concussion • Visual diagnosis • Visual remediation • Vision therapy

Key points

• Mild traumatic brain injury (mTBI) represents a major public health problem in the United States and worldwide.

"These visual problems...can be remedied by a range of visual interventions: lenses, prisms, occluders, tints and vision therapy"



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OPTOMETRY AND VISION SCIENCE

ORIGINAL ARTICLE

Vision Therapy for Post-Concussion Vision Disorders

Michael Gallaway*, Mitchell Scheiman†, and G. Lynn Mitchell‡

ABSTRACT

Purpose. To determine the frequency and types of vision disorders associated with concussion, and to determine the success rate of vision therapy for these conditions in two private practice settings.

Methods. All records over an 18-month period of patients referred for post-concussion vision problems were reviewed from two private practices. Diagnoses of vergence, accommodative, or eye movement disorders were based on pre-established, clinical criteria. Vision therapy was recommended based on clinical findings and symptoms.

Results. Two hundred eighteen patient records were found with a diagnosis of concussion. Fifty-six percent of the concussions were related to sports, 20% to automobile accidents, and 24% to school, work, or home-related incidents. The mean age was 20.5 years and 58% were female. Eighty-two percent of the patients had a diagnosis of an oculomotor problem [binocular problems (62%), accommodative problems (54%), eye movement problems (21%)]. The most prevalent were convergence insufficiency (CI, 47%) and accommodative insufficiency (AI, 42%). Vision therapy was ded for 80% of the patients. Forty-six per cent (80/175) either did not pursue treatment or did not complete Of the 54% (95/175) who completed therapy, 85% of patients with CI were successful and 15% were improved, I, 33% were successful and 67% improved. Clinically and statistically significant changes were measured in ear point of convergence, positive fusional vergence, and accommodative amplitude.

s. In this case series, post-concussion vision problems were prevalent and CI and AI were the most common Vision therapy had a successful or improved outcome in the vast majority of cases that completed treatment. patients with a history of concussion should include testing of vergence, accommodative, and eye movement spective clinical trials are necessary to assess the natural history of concussion-related vision disorders and fectiveness.

Sci 2016;93:00–00)

"CI and AI were the most common diagnoses....vision therapy had a successful outcome in the vast majority of cases that completed treatment protocol"

Rehabilitative VT also works overall for reading and concussion

NeuroRehabilitation. 2014;34(1):129-46. doi: 10.3233/NRE-131025.

Oculomotor neurorehabilitation for reading in mild traumatic brain injury (mTBI): an integrative approach.

Thiagarajan P[1], Ciuffreda KJ[1], Capo-Aponte JE[2], Ludlam DP[1], Kapoor N[3].

⊕ Author information

Abstract

BACKGROUND: Considering the extensive neural network of the oculomotor subsystems, traumatic brain injury (TBI) could affect oculomotor control and related reading dysfunction.

OBJECTIVE: To evaluate comprehensively the effect of oculomotor-based vision rehabilitation (OBVR) in individuals with mTBI.

METHODS: Twelve subjects with mTBI participated in a cross-over, interventional study involving oculomotor training (OMT) and sham training (ST). Each training was performed for 6 weeks, 2 sessions a week. During each training session, all three oculomotor subsystems (vergence/accommodation/version) were trained in a randomized order across sessions. All laboratory and clinical parameters were determined before and after OMT and ST. In addition, nearvision-related symptoms using the Convergence Insufficiency Symptom Survey (CISS) scale and subjective visual attention using the Visual Search and Attention Test (VSAT) were assessed.

RESULTS: Following the OMT, over 80% of the abnormal parameters significantly improved. Reading rate, along with the amplitudes of vergence and accommodation, improved markedly. Saccadic eye movements demonstrated enhanced rhythmicity and accuracy. The improved reading-related oculomotor behavior was reflected in reduced symptoms and increased visual attention. None of the parameters changed with ST.

CONCLUSIONS: OBVR had a strong positive effect on oculomotor control, reading rate, and overall reading ability. This oculomotor learning effect suggests considerable residual neuroplasticity following mTBI.

"Oculomotor based visual rehabilitation (OBVR) had a strong positive effect on oculomotor control, reading rate and overall reading ability. This oculomotor learning effect suggests considerable residual neuroplasticity following mTBI"....

Allied Health Professionals are taking note!

BRAIN INJURY

http://informahealthcare.com/bij
ISSN: 0269-9052 (print), 1362-301X (electronic)

Brain Inj, 2015; 29(6): 688–700
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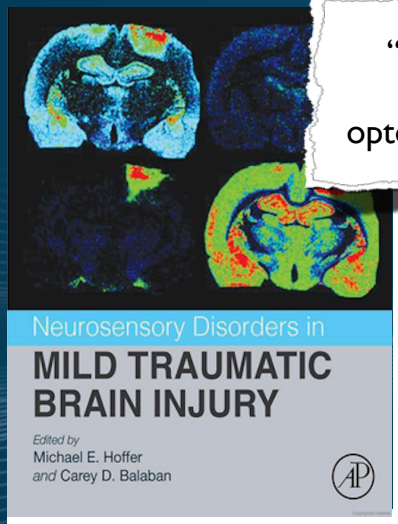
informa healthcare

Table II. Continued

Recommendation	Grade*
10. *Persistent vision and vestibular (balance/dizziness) dysfunction*	
Vestibular (balance/dizziness) dysfunction	
10.1. Evaluation should include a thorough neurologic examination that emphasizes vision, vestibular, balance and co-ordination and hearing [23]. See Table 10.1 for specific exam details.	C
10.2. If symptoms of benign positional vertigo are present, the Dix-Hallpike Manoeuvre (see Appendix 10.1) should be used for assessment [55].	A
10.3. A canalith repositioning manoeuvre (Appendix 10.1) should be used to treat benign positional vertigo if the Dix-Hallpike Manoeuvre is positive [55].	A
10.4. For persons with functional balance impairments and screening positive on a balance measure, consideration for further balance assessment and treatment by a qualified healthcare professional may be warranted pending clinical course.†	C
10.5. Vestibular rehabilitation therapy is recommended for unilateral peripheral vestibular dysfunction [55].	A
10.6. When the patient identifies a problem with hearing the following steps should be followed [23]:	C
1. Perform an otol	
2. Review medicat	
3. Refer to audiol	
10.7. When the patie	
1. Define triggers	
2. Assess medicat	
3. Perform orophai	
4. Assess vision a	
Persistent vision dys	
10.8. Take an appro motion sensiti symptoms and their related vision dysfunction.†	
10.9. Perform tests of visual acuity, extra-ocular motility, vergence, visual fields, pupils and fundoscopy. See Appendix 10.2 for an explanation of screening techniques.†	C
10.10. Other functional vision changes should be given consideration for referral to a qualified optometrist specializing in neuro-optometric rehabilitation for vision therapy [56].	B

"Other functional vision changes should be given consideration for referral to a qualified optometrist specializing in neuro-optometric rehabilitation for vision therapy"

Published in Jan 2019 (MD PhD and Optometry PhD) THIS IS ESSENTIALLY A CONSENSUS BOOK!



"...vision problems can impede the OVERALL rehabilitative plan and for the most part, the optometric community has embraced this arena...."

Vision Disorders in Mild Traumatic Brain Injury

Eric Singman, MD, PhD[1] and Patrick Quaid, Optometrist, MCOptom, FCOVD, PhD[2,3,4]

[1]Milton & Muriel Shurr Division Chief, General Eye Services Clinic of the Wilmer Eye Institute, Johns Hopkins Hospital, Baltimore, MD, United States [2]Vue-Cubed Vision Therapy Network, Guelph and North York, ON, Canada [3]Adjunct Faculty, School of Optometry and Vision Science, University of Waterloo, Waterloo, ON, Canada [4]Consultant Optometrist, David L. MacIntosh Sports Medicine Clinic and Faculty of Kinesiology, University of Toronto, Toronto, ON, Canada

Conclusion

Visual dysfunction after mTBI is pervasive and long lasting, albeit often amenable to treatment. It is the responsibility of the medical community to educate providers, offering better means of detection and avenues of therapy. Perhaps it is time to recognize that the term "mild TBI" is oxymoronic, considering the fact that the impact on quality of life is so great.

"I am not an OD / I do not do VT"
You still have a duty to *detect and refer*!
Do not treat in the ABSENCE of a formal DIAGNOSIS
(should be common sense, no different than for a retinal issue!)

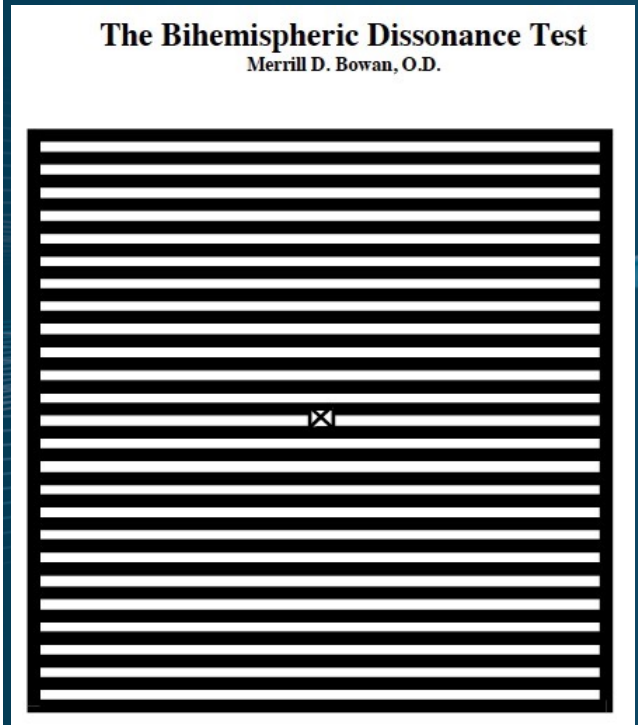
At the very least do three high yield screening tests

1. NPC testing (watch symptomatology during testing, not just about the number)!

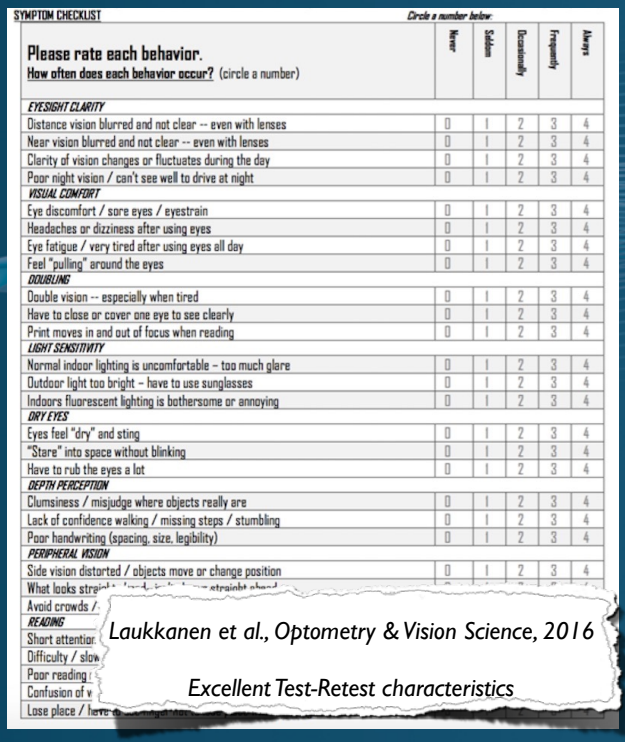
2. BDT testing (grating sensitivity) - see next slide, reaction will be instant.

3. BIVSS (Brain Injury Vision Symptom Survey, validated via publications for mTBI)

BDT test (5 second test!)



BIVSS Questionnaire
(Brain Injury Vision Symptom Survey)
Any score 32 or higher warrants a through oculomotor work-up



SYMPTOM CHECKLIST — *Circle a number below*

Please rate each behavior. How often does each behavior occur? (circle a number)	Never	Seldom	Occasionally	Frequently	Always
EYESIGHT CLARITY					
Distance vision blurred and not clear -- even with lenses	0	1	2	3	4
Near vision blurred and not clear -- even with lenses	0	1	2	3	4
Clarity of vision changes or fluctuates during the day	0	1	2	3	4
Poor night vision / can't see well to drive at night	0	1	2	3	4
VISUAL COMFORT					
Eye discomfort / sore eyes / eyestrain	0	1	2	3	4
Headaches or dizziness after using eyes	0	1	2	3	4
Eye fatigue / very tired after using eyes all day	0	1	2	3	4
Feel "pulling" around the eyes	0	1	2	3	4
DOUBLING					
Double vision -- especially when tired	0	1	2	3	4
Have to close or cover one eye to see clearly	0	1	2	3	4
Print moves in and out of focus when reading	0	1	2	3	4
LIGHT SENSITIVITY					
Normal indoor lighting is uncomfortable – too much glare	0	1	2	3	4
Outdoor light too bright – have to use sunglasses	0	1	2	3	4
Indoors fluorescent lighting is bothersome or annoying	0	1	2	3	4
DRY EYES					
Eyes feel "dry" and sting	0	1	2	3	4
"Stare" into space without blinking	0	1	2	3	4
Have to rub the eyes a lot	0	1	2	3	4
DEPTH PERCEPTION					
Clumsiness / misjudge where objects really are	0	1	2	3	4
Lack of confidence walking / missing steps / stumbling	0	1	2	3	4
Poor handwriting (spacing, size, legibility)	0	1	2	3	4
PERIPHERAL VISION					
Side vision distorted / objects move or change position	0	1	2	3	4
What looks straight ... straight ahead					
Avoid crowds /					
READING					
Short attention					
Difficulty / slow					
Poor reading					
Confusion of v					
Lose place / have					

Laukkanen et al., Optometry & Vision Science, 2016

Excellent Test-Retest characteristics

VTODs have several metrics (both oculomotor and visual processing based) with normative data that VT ODs can use for assessment and progression determination in rehab….we have very powerful tools!

OCULOMOTOR DATA (*remains a concern)

Testing	Baseline- August 1/17	Current	Goal (at least)
Symptom score CITT Study	34/60	20/60*	<15/60
Accommodative Facility OD (+/-2DS)	2cpm (issue with -)	8cpm	12cpm
Accommodative Facility OS (+/-2DS)	3cpm (issues with -)	8cpm	12cpm
Stereo (Depth Perception)	140" (3/10)	60" (8/10)	40" (10/10) with global
Vergence Facility (12BO/3BI at 40cm)	6cpm	10cpm	15cpm
Visual Acuity OD	20/50	20/20	20/20
Visual Acuity OS	20/40	20/20	20/20
Near Point of Convergence (NPC)	25cm	10cm	<7cm
Vergence Amplitude (positive at near)	-/8/6	-/20/18	-/25/20

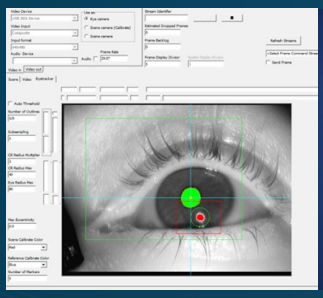
VISUAL PROCESSING (percentiles, * still concern)

Testing (DTVP-A)	Baseline	Current	Goal (at least)
Copying	5th	60th	37th-50th
Figure Ground	50th	91st	37th-50th
Vis- Motor Search	9th	*15th	37th-50th
Visual Closure	50th	63rd	37th-50th
Vis- Motor Speed	50th	63rd	37th-50th
Form Constancy	25th	91st	37th-50th
Visual Memory	8th	37rd	37th-50th
DEM. Vertical tracking / saccades	1st	35th	37th-50th
DEM. Horizontal tracking / saccades	<1st	20th	37th-50th
TOSWRF-2 reading efficiency	5th	50th	37th-50th

Percentile guide
<25th= impaired, 25th - 36th = mildly impaired, 37th - 50th = low average, ≥50th = normal

Think of the advantage from a medico-legal standpoint. We can not only "prove" injury but can also just as importantly show progress (or not) in rehabilitation!

On the horizon: Pupil reflexes and free space eye tracking



Remember: Detection is the EASY part, TREATMENT is the challenging part - get an "A-Team" in your corner and ensure there is a VTOD involved!

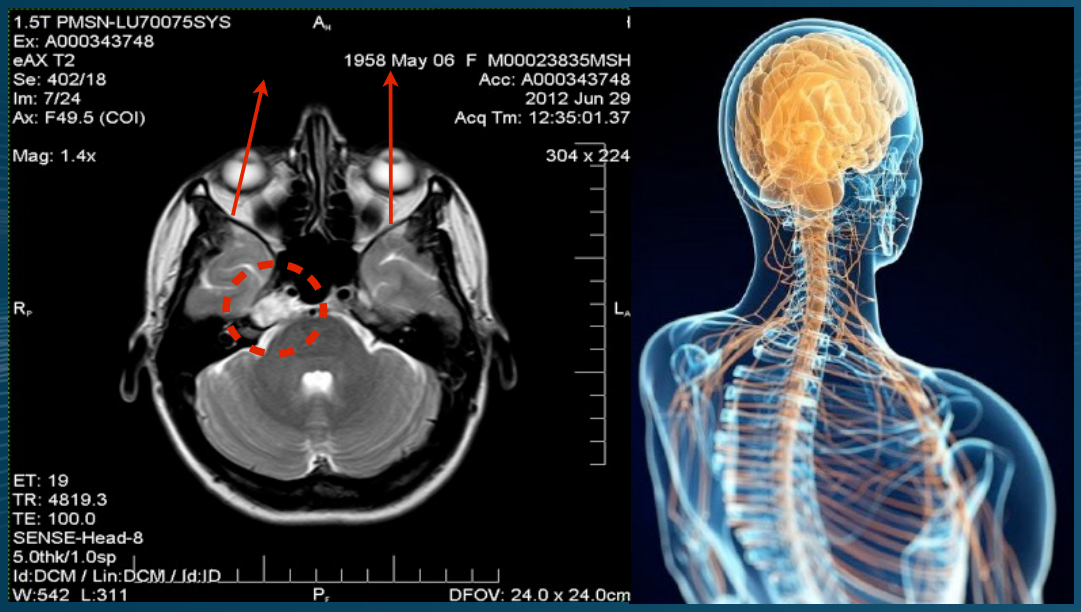
- Useful to a point, but can be VERY high cost and what does the data MEAN?
- Garbage in = Garbage out (how accurate exactly - what is gold standard)?
- Measurement meaningless without CONTEXT (other findings. normative data?)
- Should never be used in the absence of a FULL visual examination!

If we can have a truly objective test of impairment we can eliminate the "doubt" that often insurers have with these cases (i.e. are they REALLY injured etc) but be careful that you are also not trying to "build a spaceship to cross the road"!

A quick word on PATHOLOGY...some basic neuro-rules

Remember these to keep you "out of trouble"

(i) VF / careful ONH exam (ii) Pupils (iii) Eso-deviation at distance



ODs have to be mindful of these rules - another reason to have the VT OD overseeing the visual angle!

Some other tragic literature that you may not be aware of...

CMAJ. 2016 Apr 19;188(7):497-504. doi: 10.1503/cmaj.150790. Epub 2016 Feb 8.

Risk of suicide after a concussion.

Fralick M[1], Thiruchelvam D[1], Tien HC[1], Redelmeier DA[2].

⊕ **Author information**

Abstract

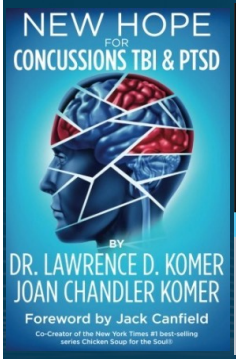
BACKGROUND: Head injuries have been associated with subsequent suicide among military personnel, but outcomes after a concussion in the community are uncertain. We assessed the long-term risk of suicide after concussions occurring on weekends or weekdays in the community.

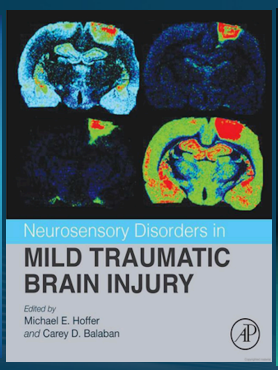
METHODS: We performed a longitudinal cohort analysis of adults with diagnosis of a concussion in Ontario, Canada, from Apr. 1, 1992, to Mar. 31, 2012 (a 20-yr period), excluding severe cases that resulted in hospital admission. The primary outcome was the long-term risk of suicide after a weekend or weekday concussion.

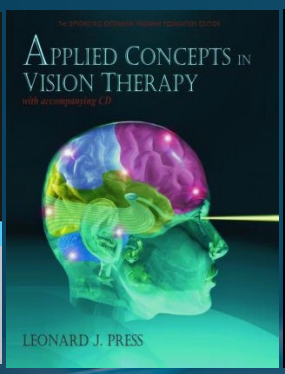
RESULTS: We identified 235,110 patients with a concussion. Their mean age was 41 years, 52% were men, and most (86%) lived in an urban location. A total of 667 subsequent suicides occurred over a median follow-up of 9.3 years, equivalent to 31 deaths per 100,000 patients annually or 3 times the population norm. Weekend concussions were associated with a one-third further increased risk of suicide compared with weekday concussions (relative risk 1.36, 95% confidence interval 1.14-1.64). The increased risk applied regardless of patients' demographic characteristics, was independent of past psychiatric conditions, became accentuated with time and exceeded the risk among military personnel. Half of these patients had visited a physician in the last week of life.

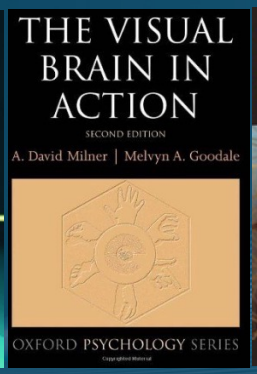
INTERPRETATION: Adults with a diagnosis of concussion had an increased long-term risk of suicide, particularly after concussions on weekends. Greater attention to the long-term care of patients after a concussion in the community might save lives because deaths from suicide can be prevented.

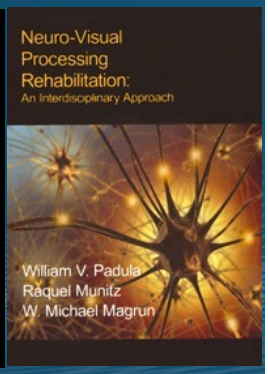
Recommended reading

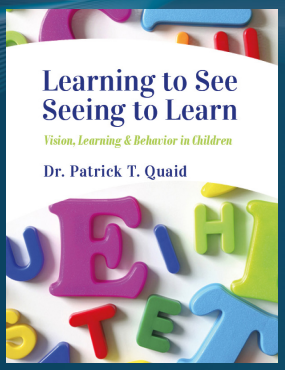








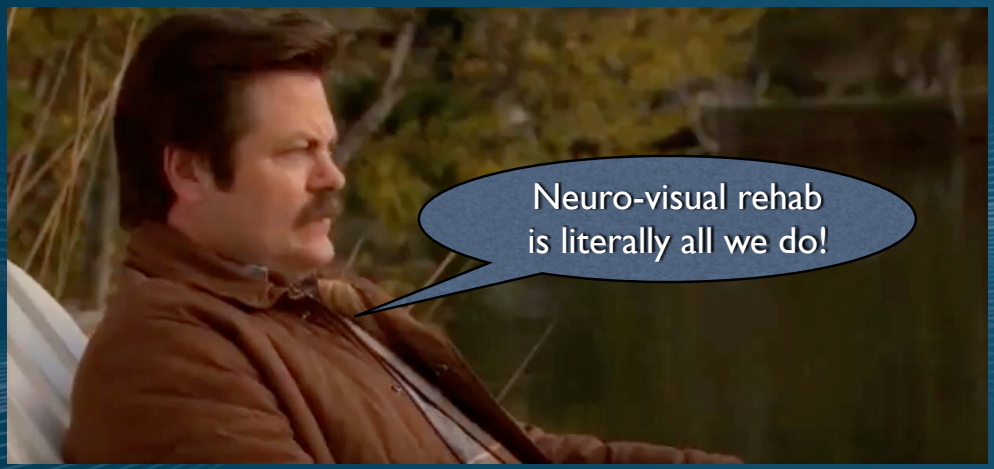




Coming Sept 2019

My DIRECT e-mail: *drpq@vuetherapy.ca*

What have I ultimately learned from my colleagues?



"The difference between an average healthcare professional and an excellent one is that the excellent one knows when to get others involved" Dr. Eric Singman MD PhD

TRANSLATED = LEAVE THE EGOS AT THE DOOR!
At the end of the day, the patient does not care about our *titles*, only whether we can *help them*!