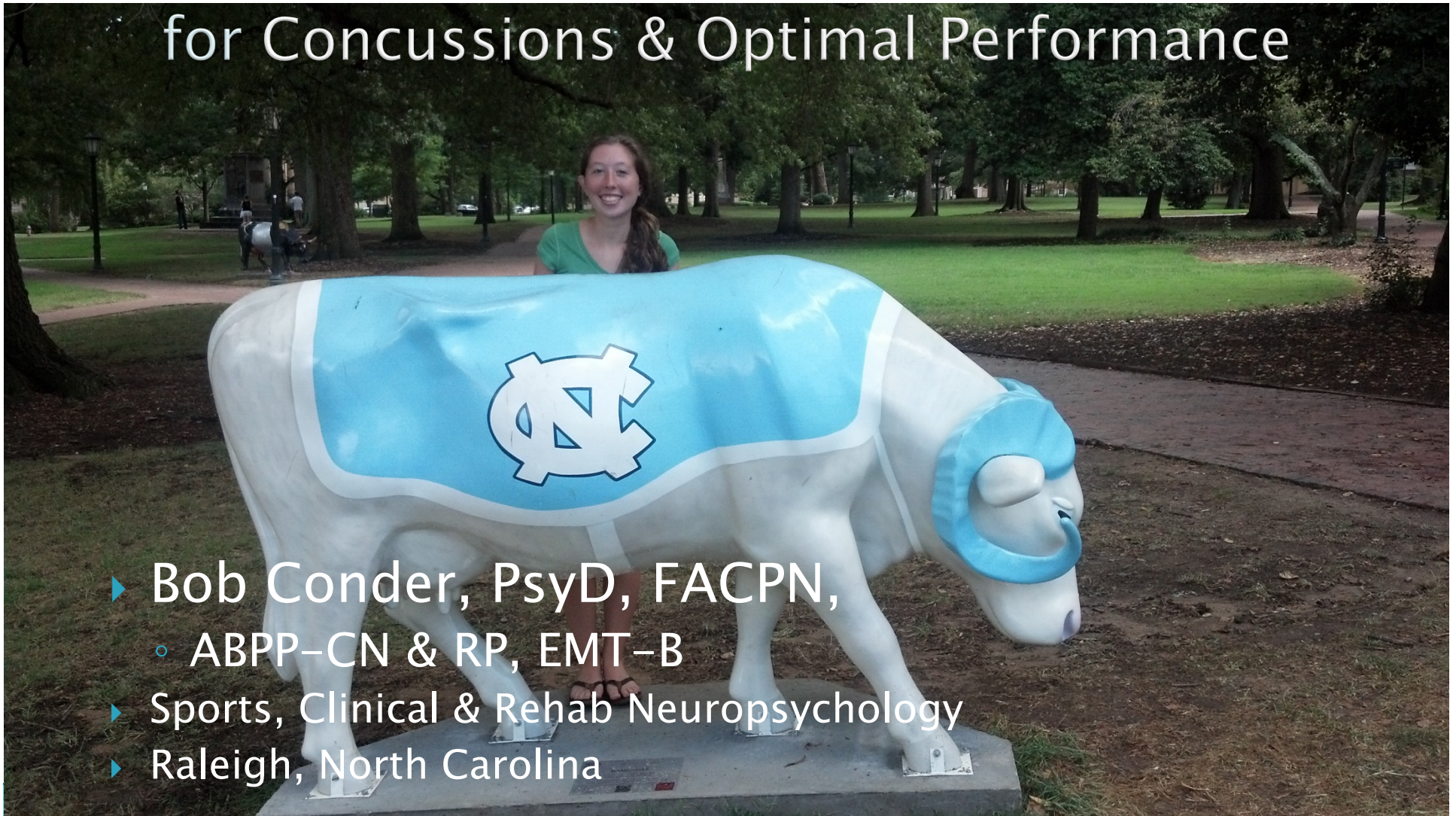


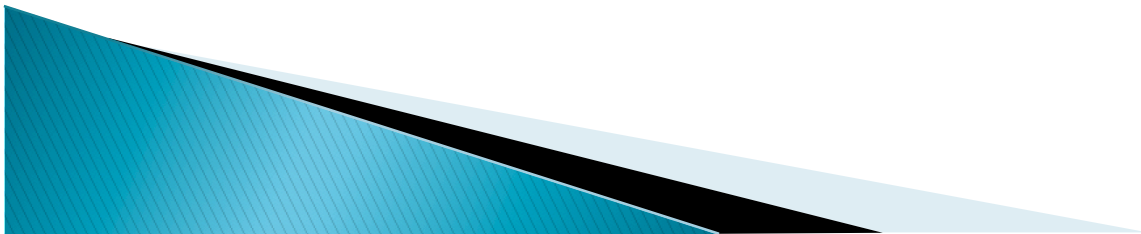
Biofeedback & Neurofeedback Interventions for Concussions & Optimal Performance



- ▶ Bob Conder, PsyD, FACPN,
 - ABPP-CN & RP, EMT-B
- ▶ Sports, Clinical & Rehab Neuropsychology
- ▶ Raleigh, North Carolina

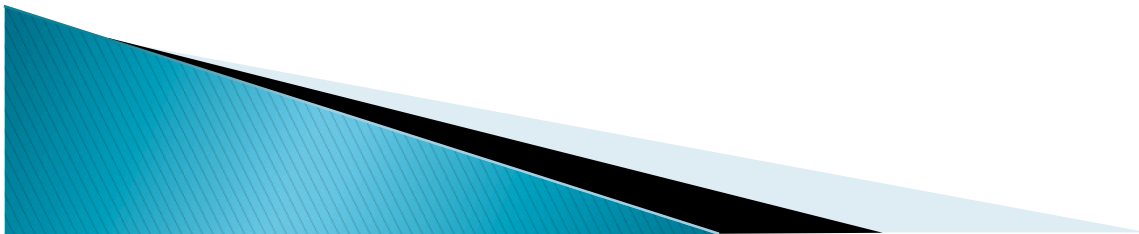
Conflict of Interest

- ▶ No financial conflicts of interest to declare
- ▶ Got free shipping once from Thot Tech
- ▶ Beta tested for Muse– free headset
- ▶ All I'm selling are ideas...



APA Mandated Disclaimer

- ▶ *"Materials that are included in this course may include interventions and modalities that are beyond the authorized practice of mental health professionals. As a licensed professional, you are responsible for reviewing the scope of practice, including activities that are defined in law as beyond the boundaries of practice in accordance with and in compliance with your professions standards."*



Carolina Hurricanes NHL

Stanley Cup 2006



North Carolina State University



St. David's Concussion Education, Prevention & Management Program



Coach Dean Smith & Concussions 1994

THE UNIVERSITY OF NORTH CAROLINA

Basketball Office
P.O. Box 2118
Chapel Hill, NC 27515
or
Smith Center - Bowles Drive
Chapel Hill, NC 27514
Telephone (919) 962-1154

Dean E. Smith
Head Basketball Coach

Assistant:
Bill Guthridge
Phil Ford, Jr.
Dave Harroun

April 13, 1994

Robert L. Conder, PsyD, ABPN
Clinical Neuropsychologist
Diplomate, Neuropsychology
Carolina Neuropsychological Service, Inc.
4001 Barrett Drive, Suite A
Raleigh, NC 27609

Dear Bob:

Thanks so much for your well-written letter regarding the seriousness of a concussion brain injury.

I have turned your letter over to Hank Nichols, the editor of the basketball rules, and he shares my concern as well as yours. I am confident we should have some new interpretation that may prevent this type of serious accident on the basketball court.

You were nice to take the time to write the letter and also to express your continued interest in Carolina basketball.

Warmest regards.

Cordially,

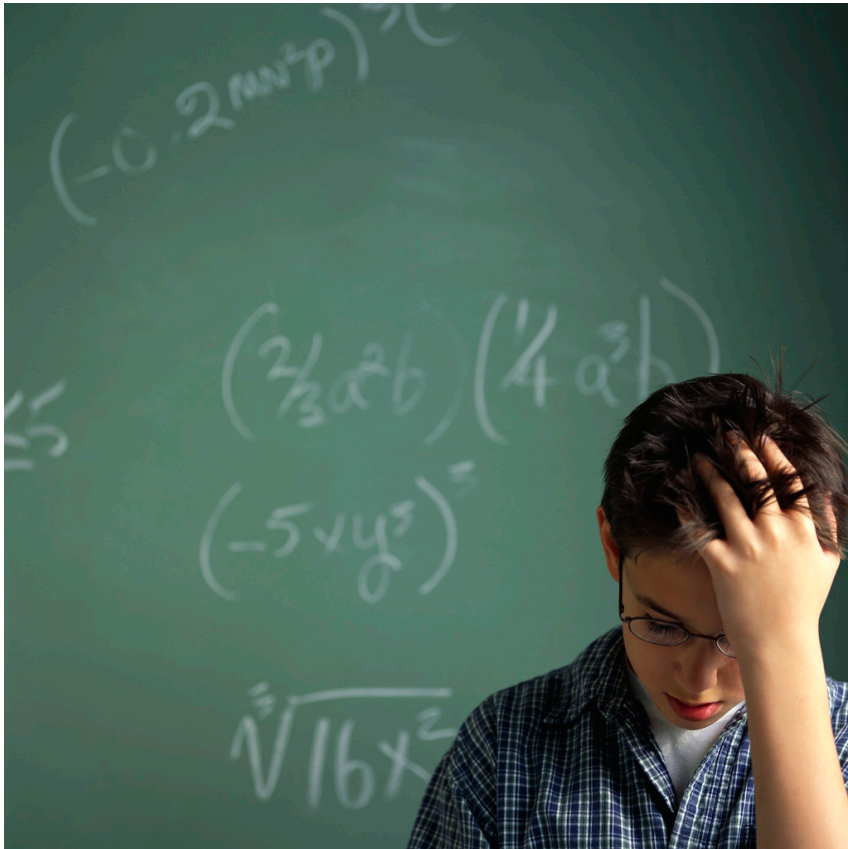


Dean E. Smith

DES/rk

*'72 graduate!
a young man
in your work -
DS*

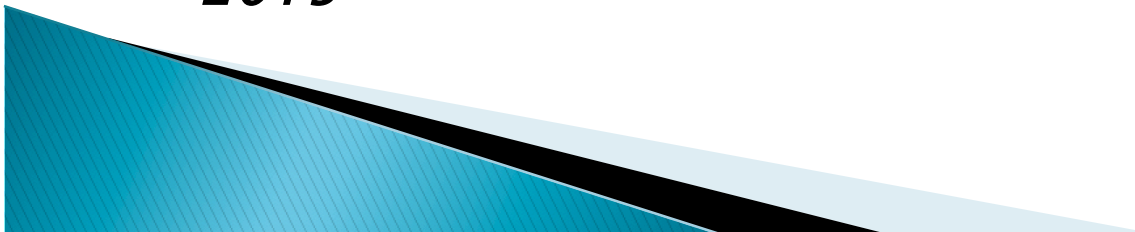
Pediatric Implications of TBI & Concussion



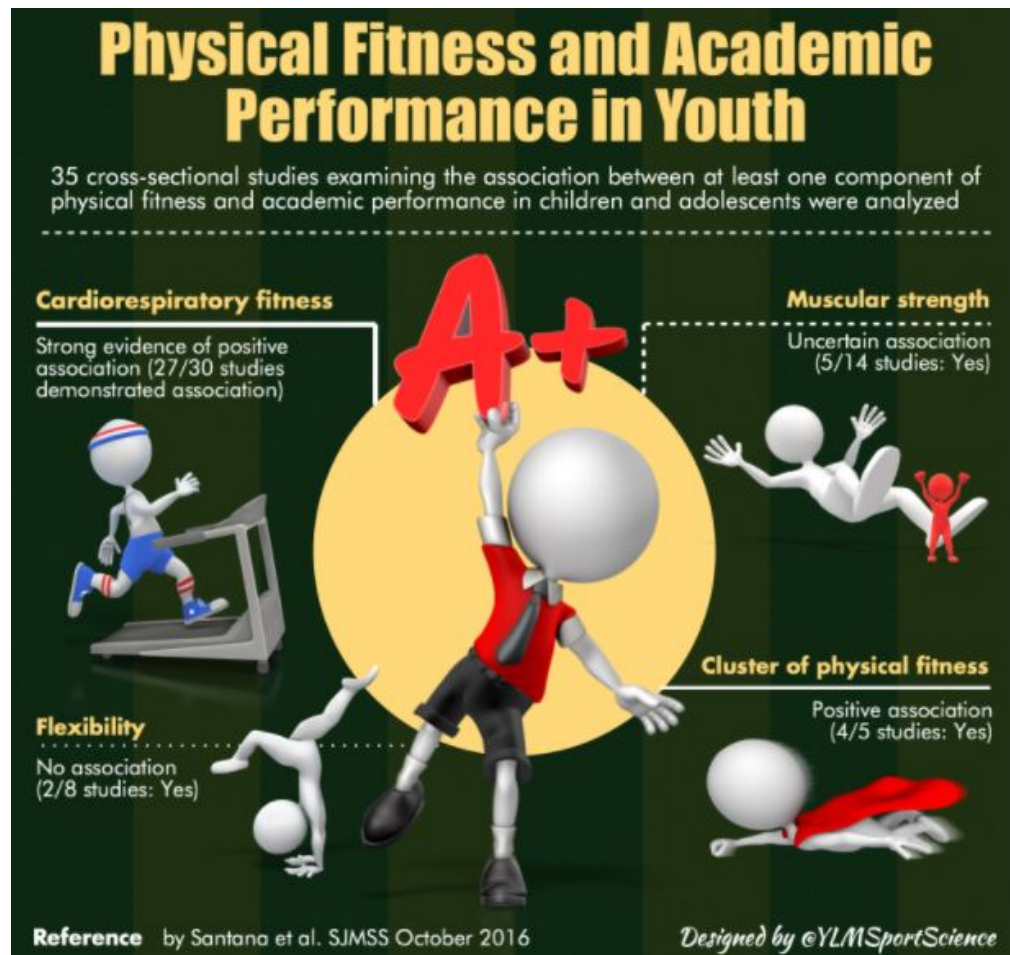
Sports Related Pediatric Traumatic Brain Injury: Scope of the Problem

CDC

- ▶ • Est 45 Million children & adolescents participate in organized & recreational sports
- ▶ • Est 1.6–3.8 million youth Sport & Recreation Concussions
- ▶ • Est 300K Organized Sports Concussions
- ▶ •
- ▶ • Sports provide positive physical, intellectual & social development
- ▶ •
- ▶ • Current push-back against kids playing contact sports, driven by fear & anxiety,
- ▶ •
- ▶ • **EDD vs. ADD** – Exercise Deficiency Disorder leading to Chronic Health Conditions, Depression and Isolation
- ▶ • ***66% > 20-Overweight; 34% Obese; 25% Kids 2-19 OW 2015***



Physical & Academic Performance



Sports Related Pediatric Traumatic Brain Injury 2012

- ▶ 10–14 yr old boys & girls have the highest rates of Sports related TBI ER visits
- ▶ Among the 10–14 yr old group with TBIs, their sports and/or recreational activities are:
Bicycling, football, playground activities, basketball & riding ATVs
- ▶ Among the 5–18 yr old group with TBIs, their sports and/or recreational activities are:
Bicycling, football, basketball, playground activities & soccer



TBI Frequency at ED by Sport

Activity	TBIs		All visits for sports and recreation--related injuries		% of all visits for injuries that were TBIs
	No.*	95% CI (±)	No.*	95% CI (±)	
Bicycling	26,212	(6,809)	323,571	(48,566)	8.1
Football	25,376	(4,845)	351,562	(47,448)	7.2
Playground	16,706	(5,198)	210,979	(37,050)	7.9
Basketball	13,987	(3,077)	375,601	(47,607)	3.7
Soccer	10,436	(3,736)	135,988	(39,167)	7.7
Baseball	9,634	(2,401)	121,309	(22,175)	7.9
All-terrain vehicle riding	6,337	(3,481)	59,533	(14,061)	10.6
Skateboarding	6,004	(2,455)	101,577	(31,907)	5.9
Swimming	4,557	(1,699)	62,745	(14,500)	7.3
Hockey [†]	4,427	(2,749)	45,450	(24,405)	9.7
Miscellaneous ball games [§]	4,065	(1,477)	66,543	(15,306)	6.1
Horseback riding	3,638	(1,266)	23,842	(5,169)	15.3
Moped/Dirt bike riding [¶]	3,370	(978)	39,363	(9,209)	8.6
Scooter riding	3,336	(779)	54,561	(11,784)	6.1
Gymnastics ^{**}	3,319	(948)	71,248	(13,881)	4.7
Combative sports ^{††}	2,981	(786)	50,639	(10,941)	5.9
Softball	2,735	(756)	49,345	(10,002)	5.5
Exercising	2,406	(825)	77,069	(11,731)	3.1
Tobogganing/Sledding	2,377	(948)	23,306	(8,383)	10.2
Trampolining	2,323	(823)	86,584	(17,540)	2.7

Youth Sport Participation Changes

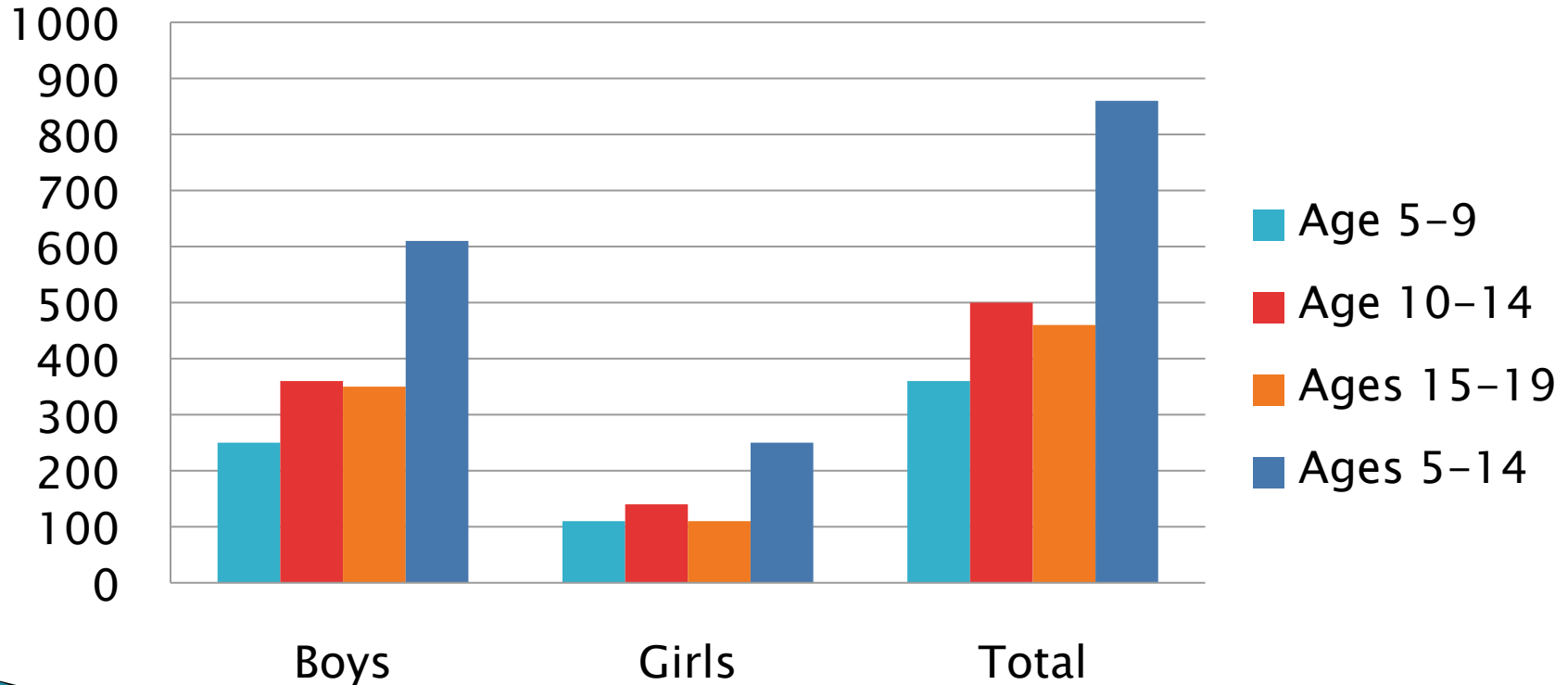
Sport	2009 (,000)	2014 (,000)	6-17 yr. olds % Change
Baseball	7,012	6,711	-4.30%
Basketball	10,404	9,694	-6.80%
Field hockey	438	370	-15.50%
Football (tackle)	3,962	3,254	-17.90%
Football (touch)	3,005	2,032	-32.40%
Gymnastics	2,510	2,809	11.90%
Ice hockey	517	743	43.70%
Lacrosse	624	804	28.80%
Rugby	150	301	100.70%
Soccer (indoor)	2,456	2,172	-11.60%
Soccer (outdoor)	8,360	7,656	-8.40%
Softball (fast-pitch)	988	1,004	1.60%
Softball (slow-pitch)	1,827	1,622	-11.20%
Track and field	2,697	2,417	-10.40%
Volleyball (court)	3,420	2,680	-21.60%
Volleyball (sand/beach)	532	652	22.60%
Wrestling	1,385	805	-41.90%

Source: 2015 SIFA Trends in U.S. Team Sports Report



Sports Related Pediatric Traumatic Brain Injury 2012

Number of Sports-Related TBIs per 100,000 children



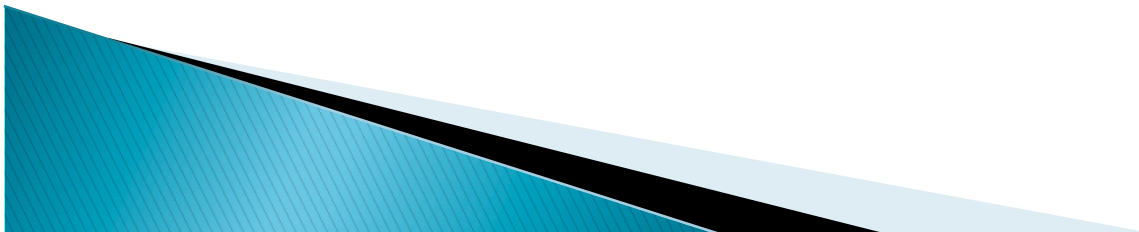
History of Concussions

- ▶ **Historic:** Head injuries since became species
- ▶ **Ancient:** earliest reports from Ancient Egypt (Military) and Ancient Greece, where sports were integral to society
- ▶ **Modern:** Medical supervision of organized Boxing for Dementia Pugilistica
- ▶ **Recent:** SLAM approach to sports concussions by Jeff Barth, PhD, at UVA
- ▶ **Recent:** National Hockey League Concussion Management program, also by Ruben Echemendia, PhD (Penn State model)

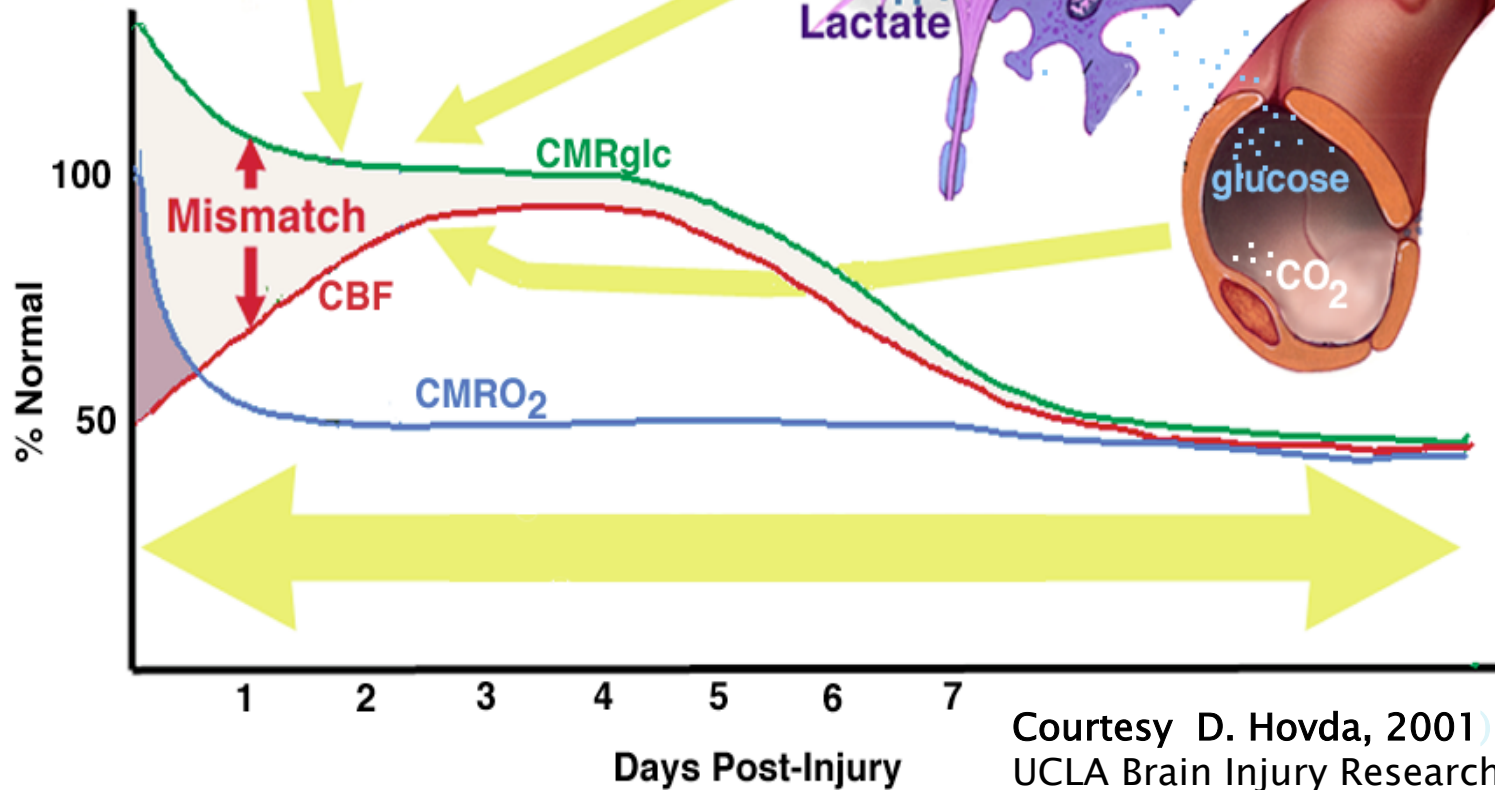
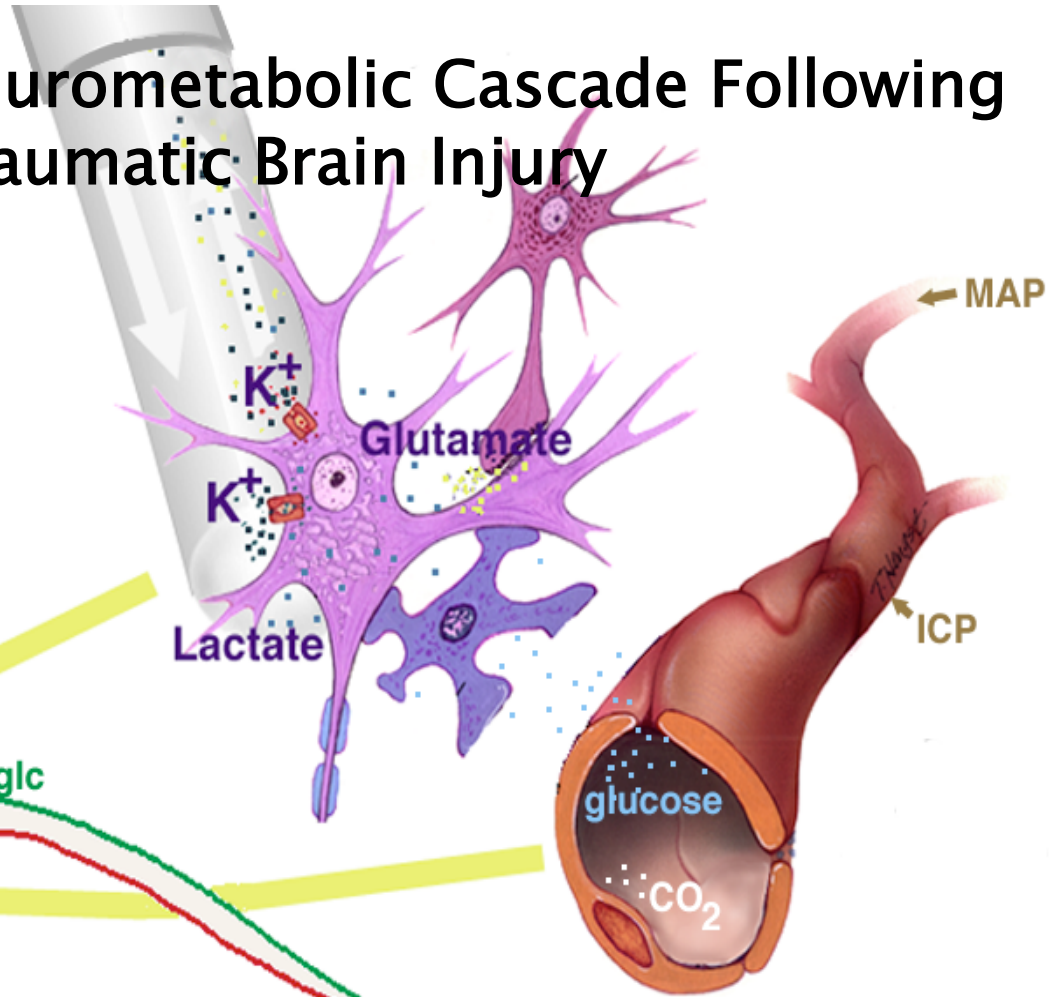
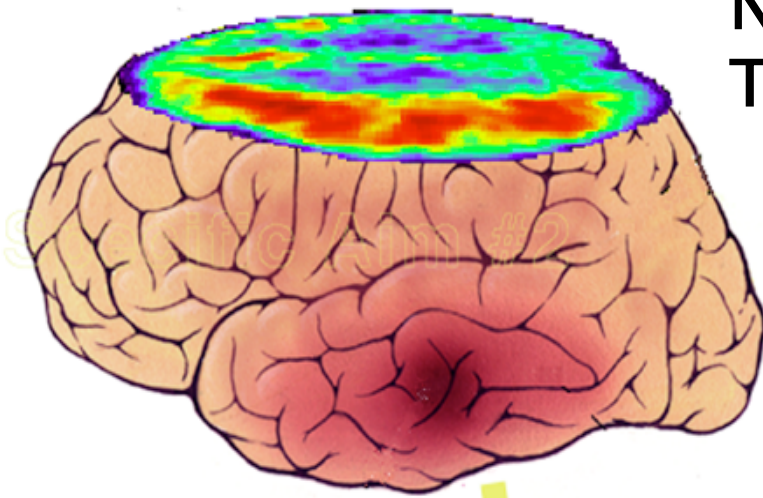


Concussion Definition: Berlin International Sports Concussion Conference Nov 2016

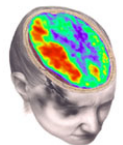
- A Concussion is a traumatic brain injury (TBI)
- Caused by a direct blow to the head, face, neck or elsewhere on the body with an “impulsive” force transmitted to the head, eg, shaking
- Results in rapid onset of short-lived impairment of neurologic function that resolves spontaneously. However, in some cases s/s may evolve over a number of minutes to hours
- **Neuropathological changes may occur, but initial presentation is functional rather than structural injury.** As such, no abnormality seen on standard neuroimaging.



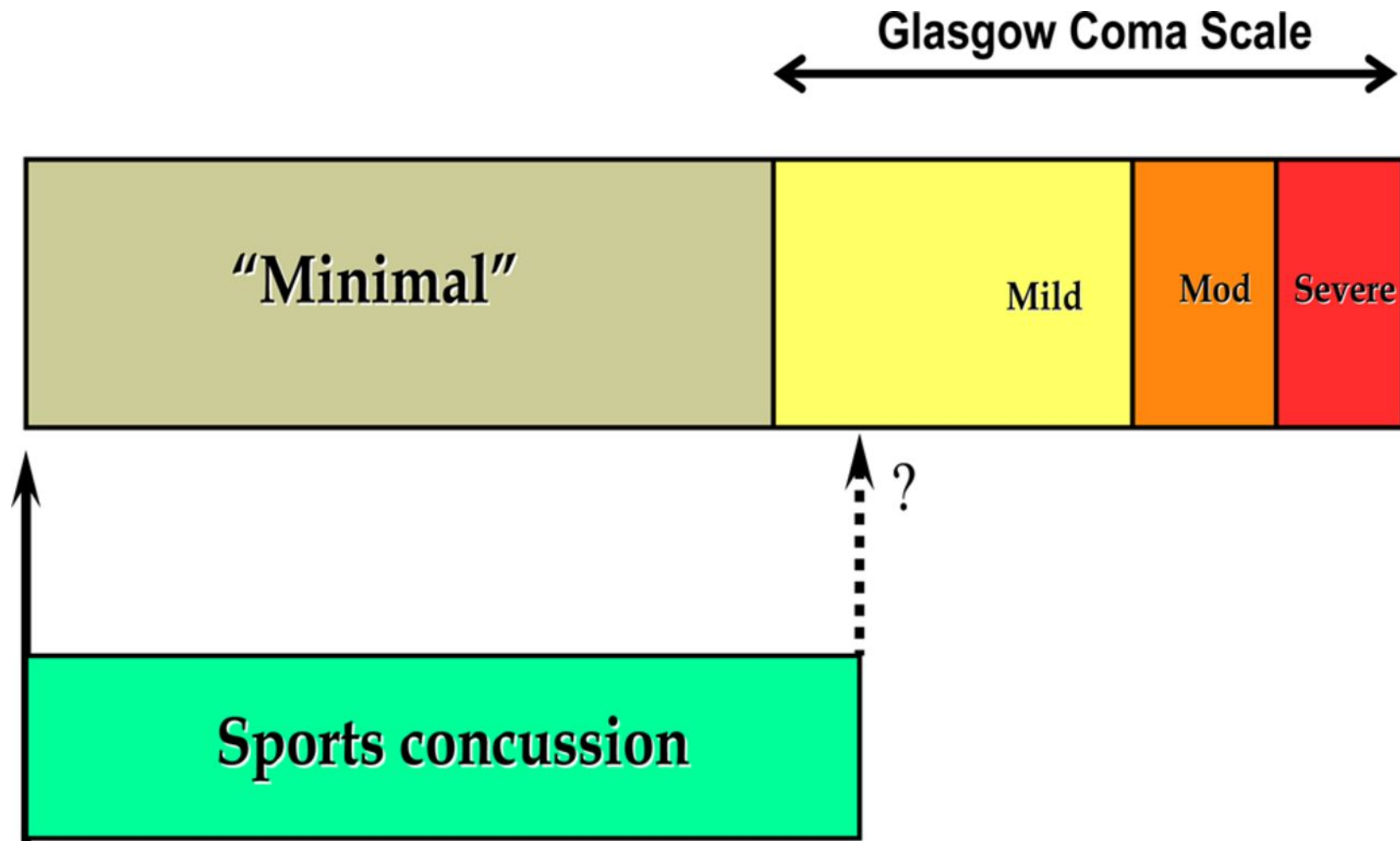
Neurometabolic Cascade Following Traumatic Brain Injury



Courtesy D. Hovda, 2001
UCLA Brain Injury Research Center



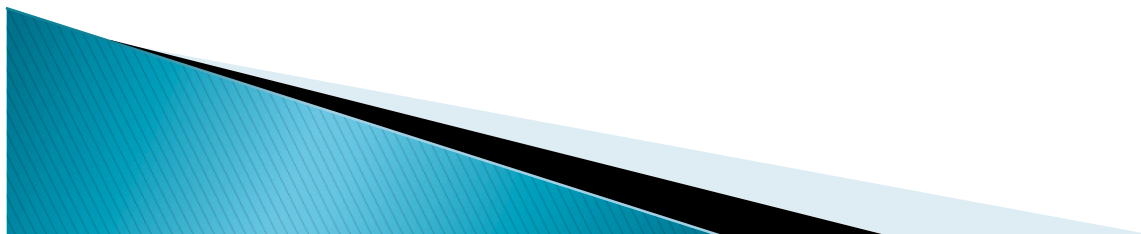
Conceptual understanding of sports concussion.



McCrory P et al. Br J Sports Med 2013;47:268-271

VA/DOD Classification of TBI Severity
 (if criteria met in > 1 category of severity, assign the
 higher level of severity)–AACN

Criteria	Mild	Moderate	Severe
Structural Imaging	Normal	Normal or Abnormal	Normal or abnormal
Loss of Consciousness	0–30 min	>30 min and <24 hours	>24 hours
Alteration of consciousness/ mental state	Up to 24 hours	>24 hrs; severity based on other criteria	>24 hrs; severity based on other criteria
Posttraumatic Amnesia (PTA)	0 – 1 day	>1 and <7 days	>7 days
GCS (best available score in first 24 hrs)	13–15	9–12	<7



Concussion–Not Just the Brain

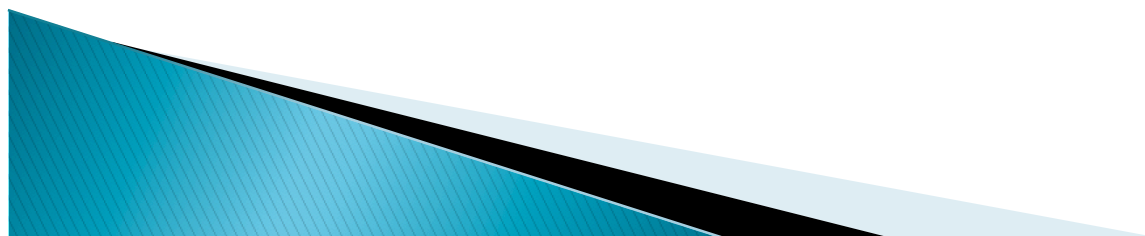
cf Erin Bigler 2007

- ▶ Head
- ▶ Eye
- ▶ Inner Ear (vestibular)
- ▶ Spine
- ▶ Hollow Organs
- ▶ Solid Organs
- ▶ Muscles
- ▶ Joints



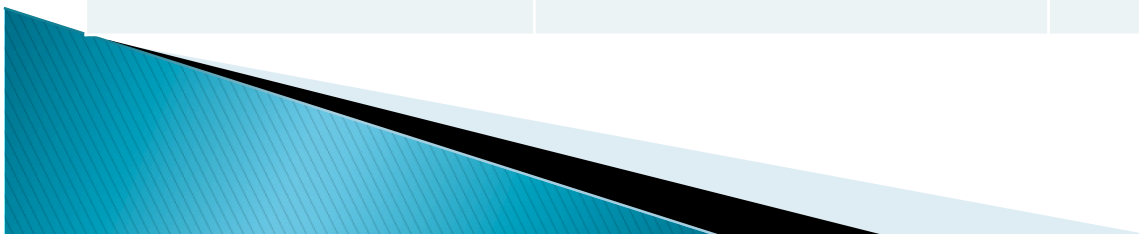
Aspects of a Concussion

- ▶ 1) **Neurochemical**: mismatch in glucose metabolism and oxygenation; causes disruption in CNS integrity
- ▶ 2) **Vestibular**: dizziness, somatosensory problems, vertigo, resulting in balance problems
- ▶ 3) **Oculomotor**: Convergence dysfunction; poor visual scanning & tracking, visual disturbance
- ▶ 4) **Neuro-electric**: Slowing & Coherence
- ▶ 5) **Neurocognitive**: Concentration & Memory with compromise to attn, STM, processing speed
- ▶ 6) **Psychological**: Depression, Anxiety, Anger, Self Esteem as athlete, Social Group Identity



Concussion: Signs & Symptoms

PHYSICAL	COGNITIVE	EMOTIONAL	SLEEP
Headache	Feeling mentally “foggy”	Irritability or Lability	Drowsiness
Nausea/Vomiting	Feeling slowed down	Sadness	Sleeping more than usual
Balance problems	Difficulty concentrating	More emotional	Sleeping less than usual
Visual problems	Difficulty remembering	Nervousness	Difficulty falling asleep
Fatigue	Forgetful of recent information		
Sensitivity to light	Confused about recent events		
Sensitivity to noise	Answers questions slowly		
Dizziness	Repeats questions		



Clinical Diagnosis for Concussion

- ▶ Blow to the head or transfer of forces
- ▶ Stunned, Dinged, Bell Rung, Woozy
- ▶ Leading to:
- ▶ Headaches
- ▶ Nausea
- ▶ Photophobia
- ▶ Phonophobia
- ▶ Vomiting
- ▶ Increasing Confusion
- ▶ Deteriorating Consciousness
- ▶ Severe Headache
- ▶ Behavior Change
- ▶ Lower Extremity Weakness & Balance
- ▶ Double Vision

Usual Symptoms

RED FLAGS

Proposed Recovery Course

Nelson & McCrea

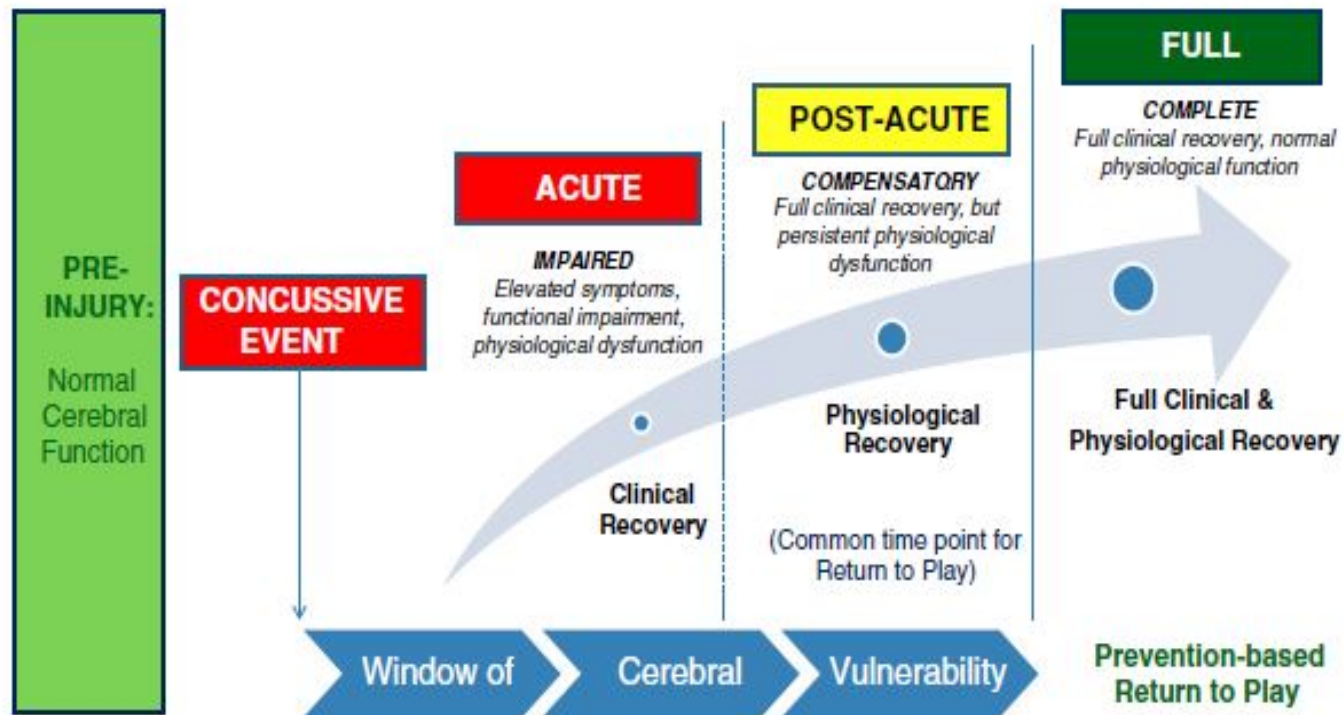


Fig. 2 Proposed integrated model of clinical and physiological recovery after concussion

Positive Findings post-SRC

Perhaps Physiologic vulnerability > Clinical

- ❑ Balance Dysfunction: 3 Hours to days?
- ❑ Neuropsych Tests: SAC 3 days -> Yrs
- ❑ Quantitative EEG: 8-45+ days - > Yrs
- ❑ Traditional CT/MRI: Negative in mTBI + Chiari
- ❑ ERP: 1 YR +, especially P3b
- ❑ PET -> 1-2 Wks
- ❑ MEG - ? \$10K/Hr
- ❑ fMRI -> 13 H hypo 7 wks hyperactive R Attn Ntwks
- ❑ DTI: Corpus Callosum MD Athletic Season & reduced verbal learning & memory



PCS is not a unitary syndrome

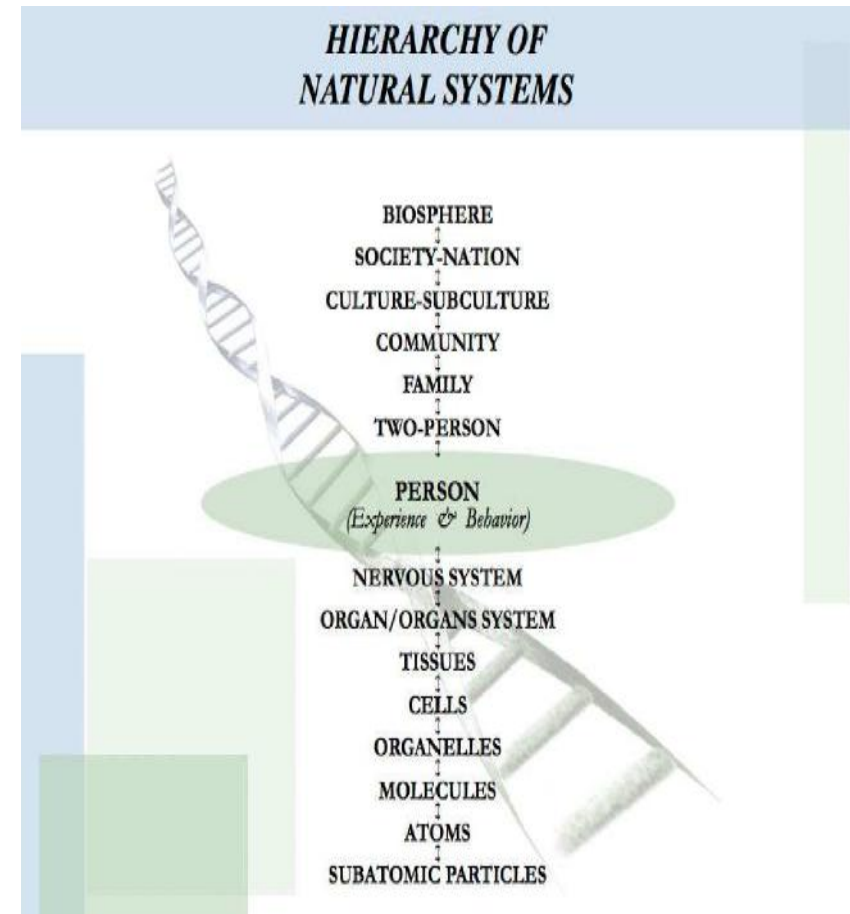
	Frequency of PCS by Dx	Odds Ratio Risk PCS by Dx	Odds Ratio Headache	Odds Ratio Dizziness
mTBI	27%	2.47	2.31	2.14
PTSD	39%	4.26	2.45	2.41
Generalized Anxiety Disorder (GAD)	41%	4.76	1.88	2.47
Depression	55%	8.39	1.96	2.05
Depression and mTBI	74%	19.76	5.85	7.10
PTSD and mTBI	75%	20.45	6.16	6.00
GAD and mTBI	80%	27.26	7.04	8.77
Somatization	91%	64.74	19.70	37.28

(Donnell et al, 2012 *TCN*, 26, 1092–1101)

Prolonged Recovery Considerations

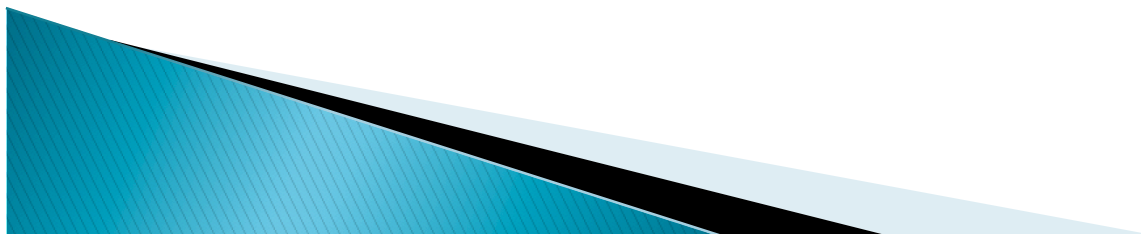
Maybe it's not (purely) the concussion!!!

- ▶ Need to do a thorough **BioPsychoSocial Eval**:
- ✓ Premorbid medical & psych factors: child & family
- ✓ Maladaptive personality characteristics, eg, lack of flexibility & resilience, **anxiety**, depression, rigidity, negativity, expectations, catastrophizing, eg, Neuroticism per NEO
- ✓ Poor pain coping abilities
- ✓ Family dynamics, eg, parents divorcing
- ✓ Possibility of secondary gain, especially non-sports

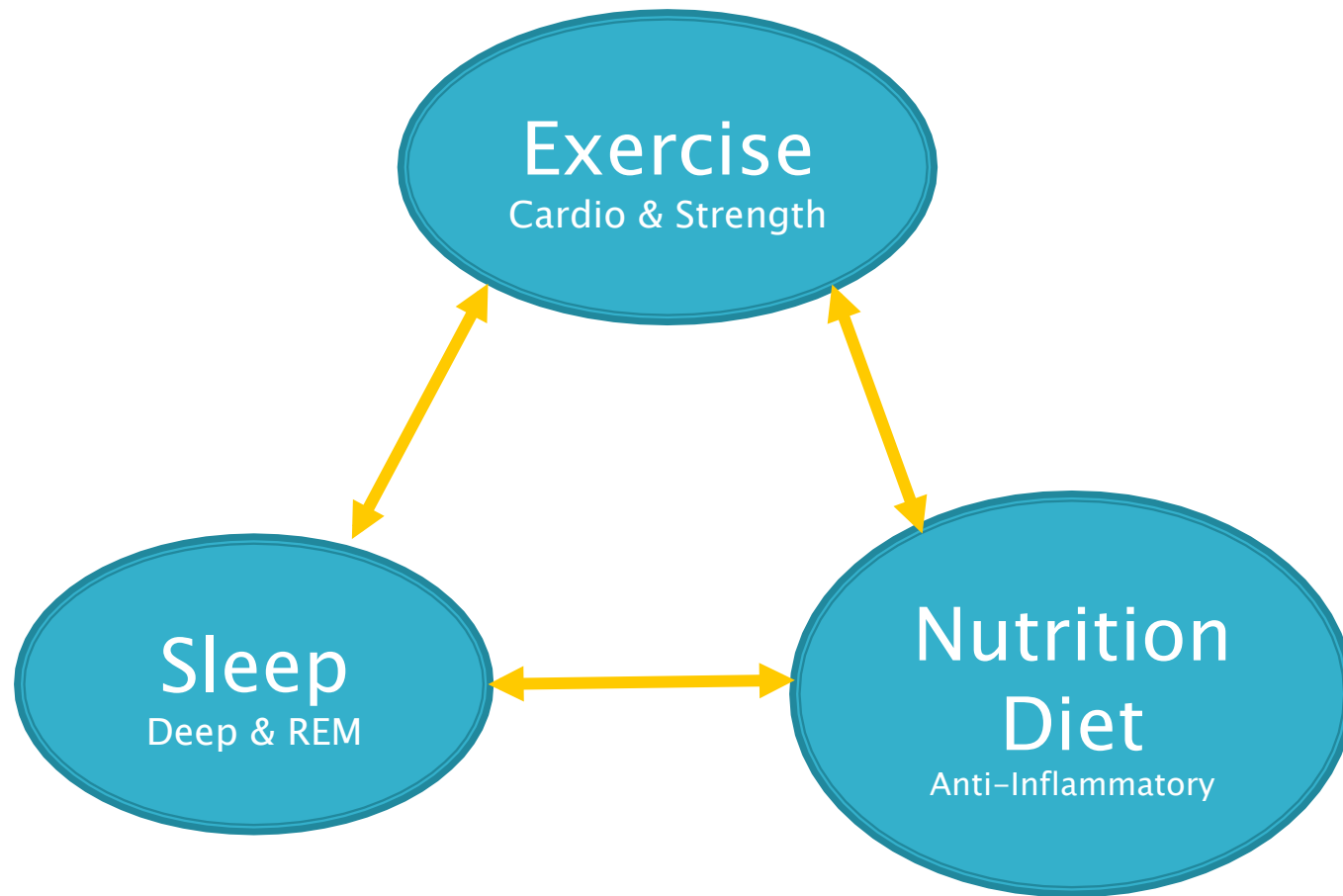


Resilience of Human Brain vs Vulnerability

- ▶ Brain can withstand inertial forces & deformation
- ▶ In skull, consistency of cold Tofu (unbaked)
- ▶ No Specific G-force,
- ▶ 60 to 140 Gs (90)
- ▶ Has self-repairing qualities



Holy Trinity for good health and aging



Exercise, per CDC [/www.cdc.gov/physicalactivity/](http://www.cdc.gov/physicalactivity/)

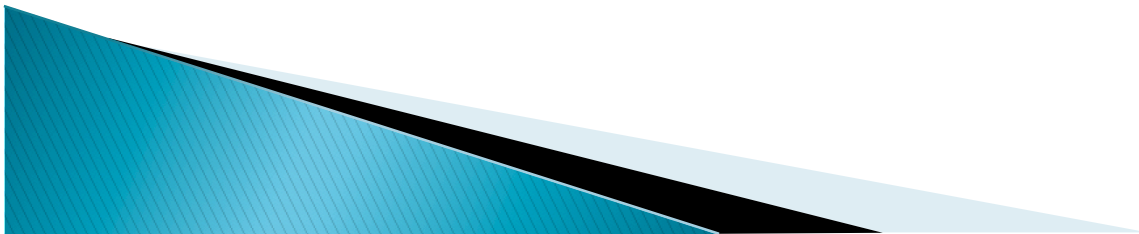
- ▶ Adults: 150 minutes of Moderate (50–75% MHR) or 75 minutes of vigorous (75–85% or more MHR) cardiovascular exercise per week
- ▶ Older Adults: 300 minutes of Moderate or 150 minutes of vigorous cardiovascular exercise per week
- ▶ Strength Training: twice a week or more (free weights or machines) for major muscle groups
- ▶ Any exercise is good, any quantity is good
- ▶ 10,000 steps a day keeps Alzheimer's away



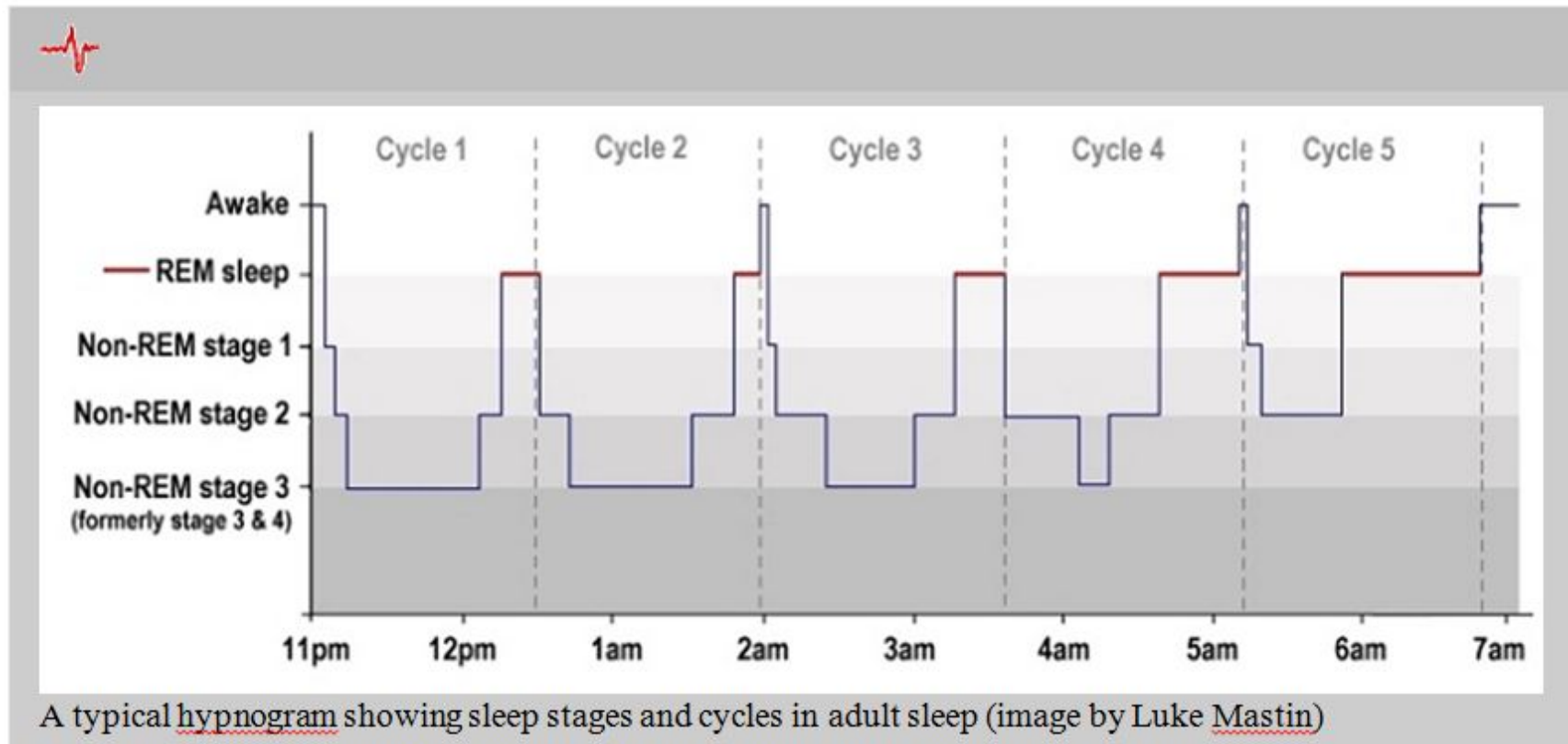
Sleep Recommendations

www.cdc.gov/sleep/about_sleep/how_much_sleep.html

- ▶ Child: 9–12 Hours
- ▶ Teen: 8–10
- ▶ Adult: 7 or more; Elder: 7–8
- ▶ Non-REM: Stage 1: 5%; Stage 2: 45%; Stage 3: 25% (Deep)
- ▶ REM: 25%
- ▶ Deep Sleep restores Body
- ▶ REM sleep restores Mind (memory consolidation)

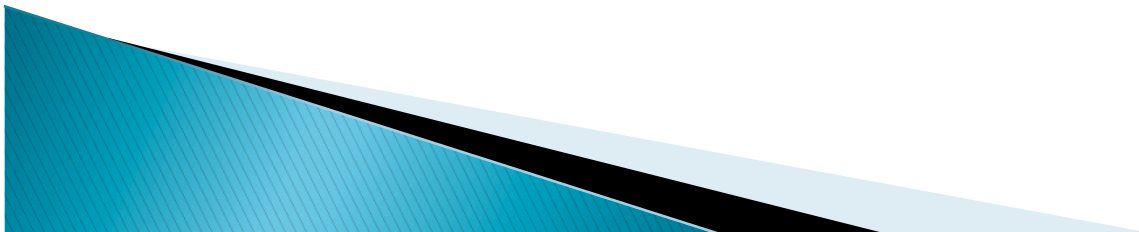


Hypnogram – Idealized



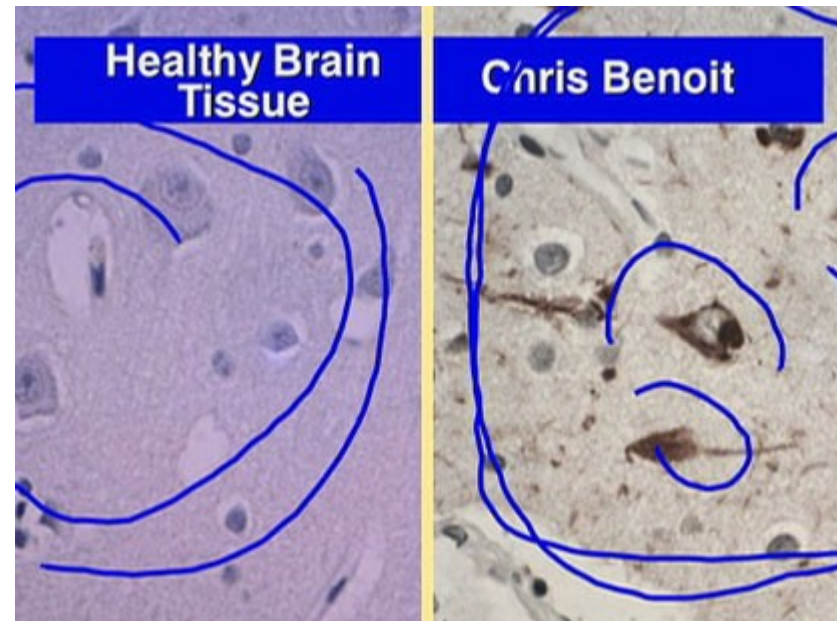
Nutrition (Diet?)

- ▶ Anti-Inflammatory Diet: MIND-DASH Diet
- ▶ Reduces incidence of SDAT 50-30%
- ▶ <https://www.webmd.com/alzheimers/features/mind-diet-alzheimers-disease#1>
- ▶ Work with registered or certified dieticians or nutritionists
- ▶ Stay hydrated (harder to be concussed with wet brain)
- ▶ Record keeping
- ▶ Basic metabolic equation: if you take in more calories than you expend, you will gain weight.
- ▶ Supertracker website: <https://www.supertracker.usda.gov>
- ▶ Paleo & Ketogenic – not permanent weight loss

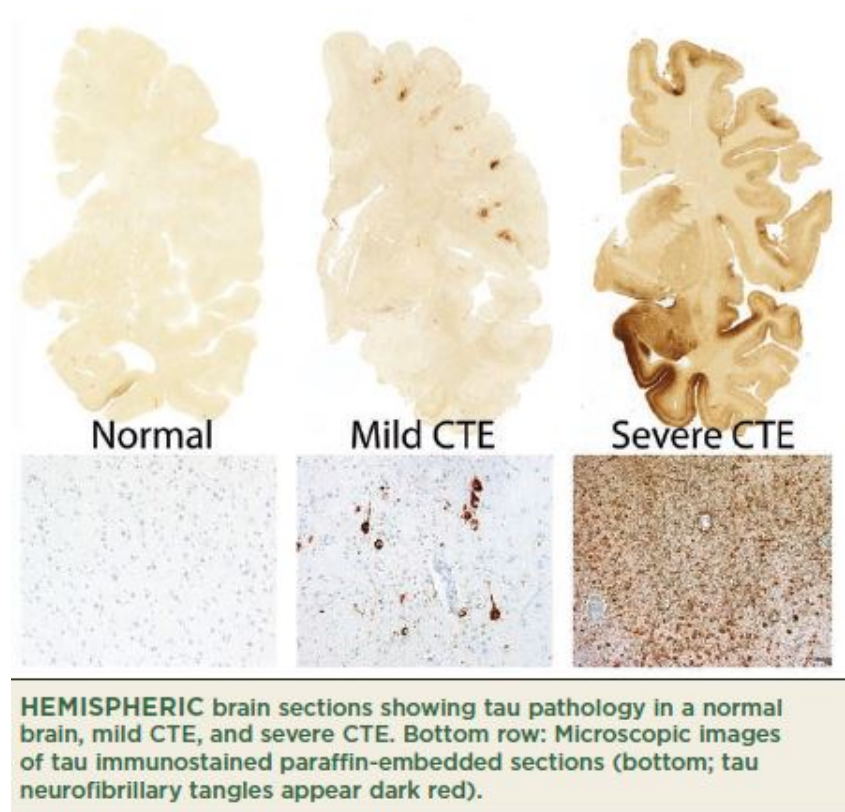
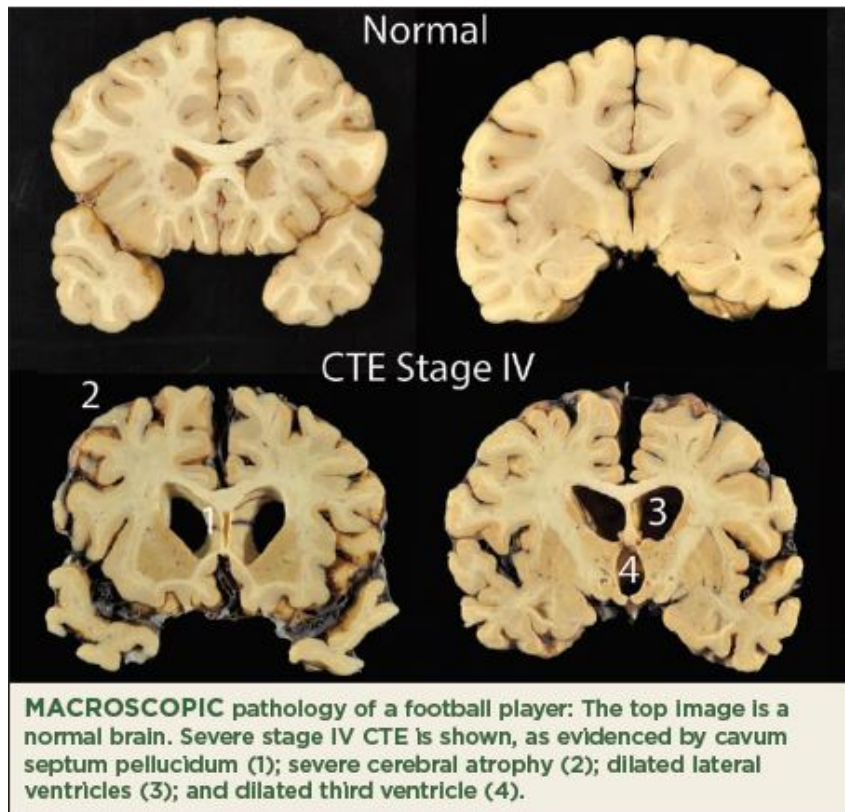


Controversies

- ▶ **Second Impact Syndrome**
 - ▶ Idea that an injured brain is more vulnerable to catastrophic injury, leading to death
 - ▶ Theory varies, but based on vasogenic factors
 - ▶ Rare and only seen in young athletes
 - ▶ But...The injured brain is more vulnerable to further injury and damage
- ▶ **Chronic Traumatic Encephalopathy CTE**
 - ▶ Dementia Pugilistica
 - ▶ Now found in older and younger athletes
 - ▶ Tau protein, not B-Amyloid



CTE - Real but Over-Stated



Comic Relief: Cerebral Laterality and Cognitive Abilities



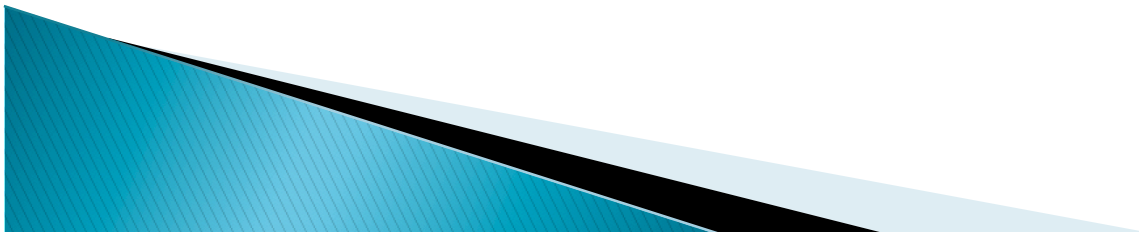
ASSESSMENT TYPES

▶ Baseline

- ❖ Computer Screening
- ❖ Vestibular/Balance
- ❖ SCAT-5 or Child SCAT
- ❖ Ipad SCAT

▶ Sideline

- ❑ SAC-3
- ❑ Balance
- ❑ Oculomotor
- ❑ Ask the Trainer
- ❑ Ask Mom
- ❑ Maybe ask teammate
- ❑ Don't bother coach



Pencil and Paper Concussion Assessment

- ▶ **First develop by Jeff Barth at UVA: SLAM model**
- ▶ **Penn State Sports Concussion Project (Echemendia)**
- ▶ **Designed to measure specific areas sensitive to concussion**
- ▶ **Now used with NHL & NFL**

- ▶ **Designed to be administered in brief amount of time (30 –45 min)**
- ▶ **Designed for repeated administrations so should have multiple, equivalent forms or know RCI**

Specific Domains measured:

- ▶ **Attention/Concentration:**
Auditory and Visual
Immediate and Sustained
Working Memory
- ▶ **Learning & Memory:**
Auditory and Visual
- ▶ **Executive & Fluency:**
Verbal and Visual
- ▶ **Processing Speed/Reaction Time/Visual Scanning**
- ▶ **Concussion Symptom Checklist**

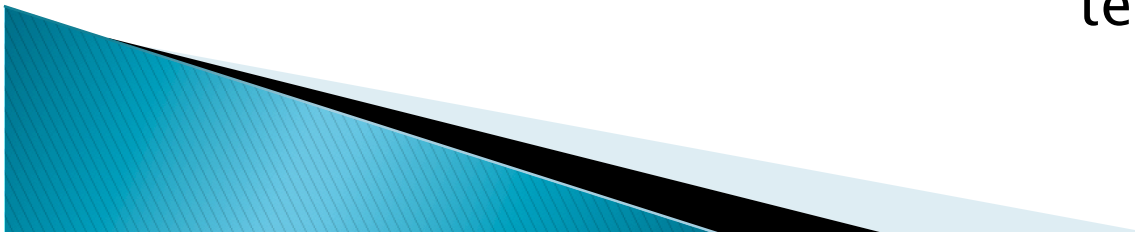
Computer Assessment

▶ **Advantages:**

- ▶ Can access large numbers quickly
- ▶ Standardized administration of test stimuli
- ▶ Time and cost efficient
- ▶ Doesn't require human administration
- ▶ Sensitivity – accuracy of reaction time measures to within milliseconds
- ▶ Alternative forms or randomized stimuli

▶ **Disadvantages:**

- ▶ Hardware issues: keyboard, screen, mouse
- ▶ Lack of human oversight
- ▶ Limited domains of functioning assessed
- ▶ Questionable Psychometrics
- ▶ Seems overly valid – Interpretation errors
- ▶ Subject to “abuse” in clinical & educational settings by users not familiar with limits of tests & measurement



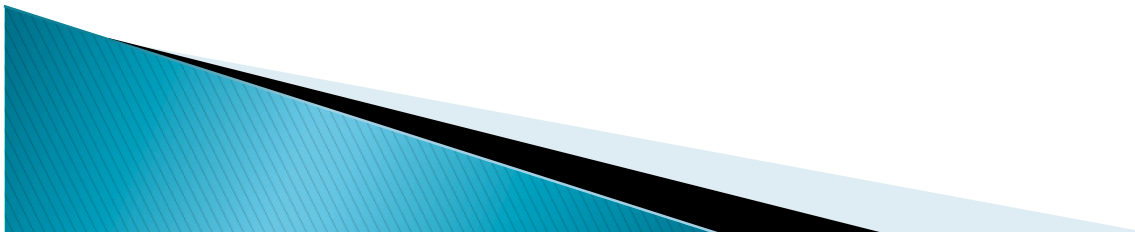
Concussions are Dysregulation

- ▶ *Autonomic Dysregulation*

- ▶ + Sympathetic NS
- ▶ + Heart Rate
- ▶ – Cardiac Cerebral perfusion
- ▶ – HRV
- ▶ – Temperature Regulation

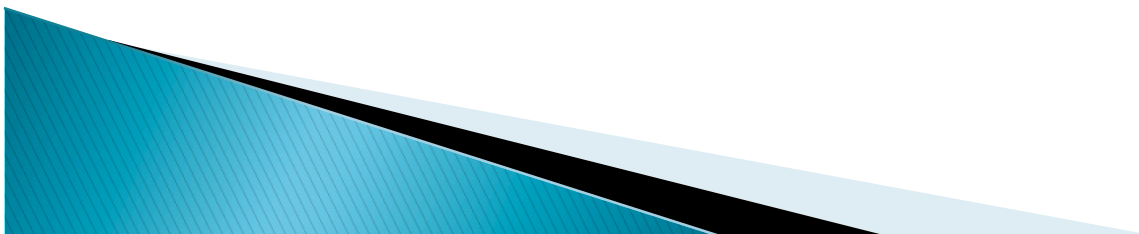
- ▶ *CNS Dysregulation*

- ▶ Coherence: Hypo or Hyper
- ▶ Increases in Delta & Theta slow activity
- ▶ Reduction in Beta faster waves
- ▶ General decrease in Frontal Regions



Goal: Teach Self Regulation

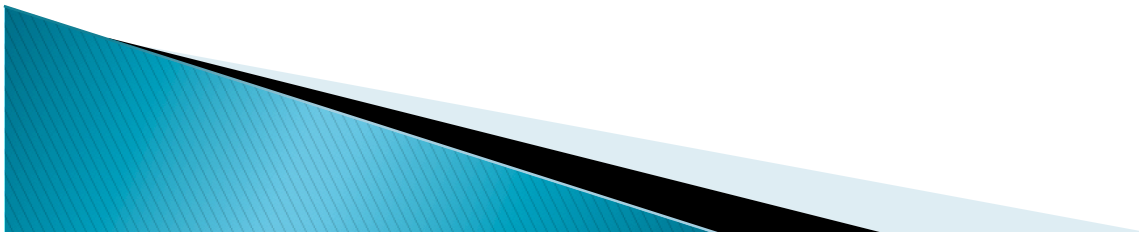
- ▶ Goal:
- ▶ Teach Self Regulation & Self Efficacy
- ▶ “Flexible & integrative neural network...allowing an organism to effectively organize emotional, cognitive & behavioral responses in service of goal-directed behavior & adaptation...”
-modified Gillie & Thayer
- ▶ Strategies:
- ▶ CBT/BFB/NFB
- ▶ Increase Stress management skills; Pain management skills, & Pro-active problem solving
- ▶ Reduce autonomic arousal & reactivity
- ▶ Increase quick recovery from errors



EAP Interventions

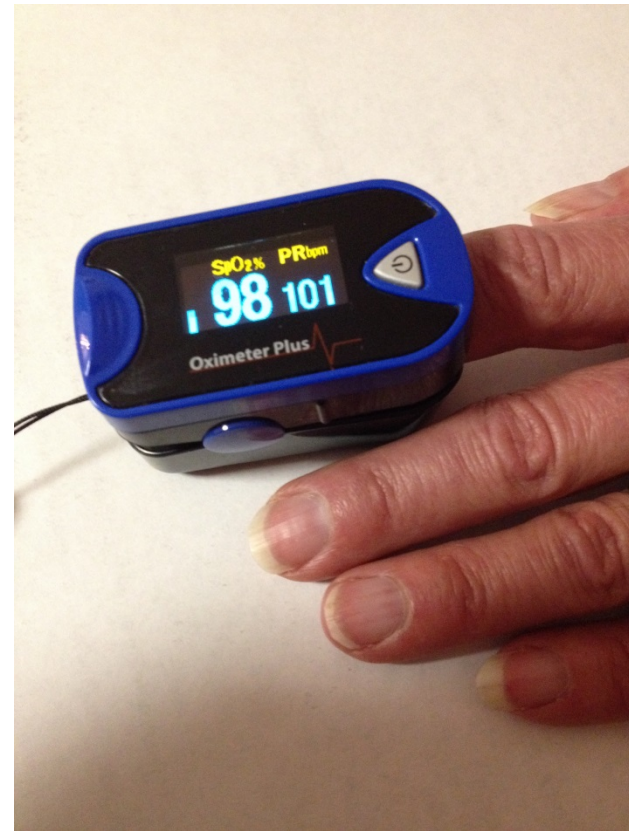
Office Visits 1-2

- ▶ Clinical Mental Status Exam (60-90 minutes)
- ▶ Pulse Ox & HR Monitor
- ▶ Assess Sleep, Diet and Exercise
- ▶ Stress Temp Card (Business Card)
- ▶ Thought Tech Sue Wilson OH&P Protocol
- ▶ Teach Diaphragmatic Breathing
- ▶ Diaphragmatic Breathing Handout
- ▶ CDC Concussion Education Handouts
- ▶ Homework Record Sheet
- ▶ *Alcohol Thermometers*
- ▶ Link for MP3 files to download



EAP –First Step – Pulse Ox

- ▶ –Keep on desk and use after talking a few minutes. Measure O₂ saturation and pulse.
- ▶ Athletes should be in low 60's
- ▶ General indicator of aerobic fitness



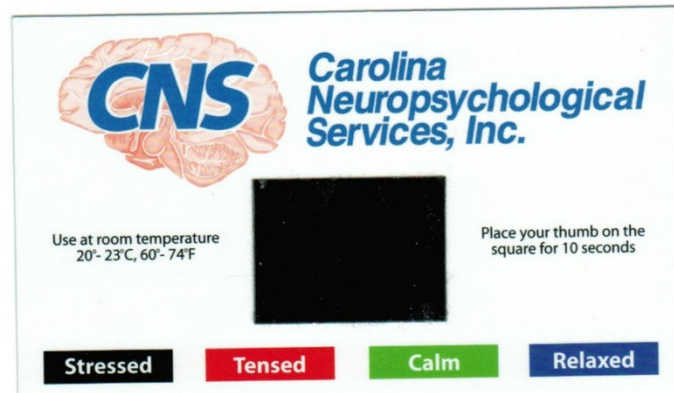
First step

Pulse Oximeter

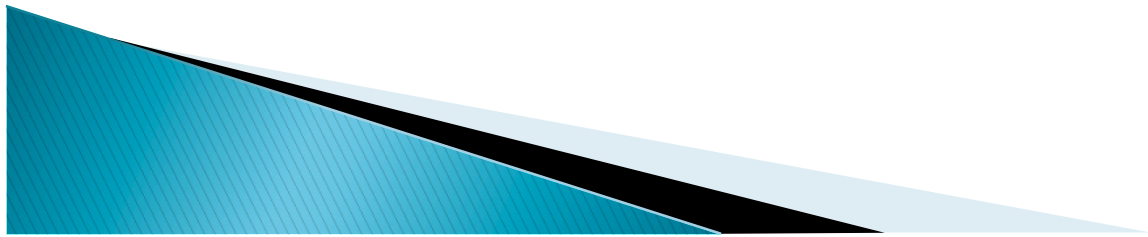
EAP: Second Step – Stress Card

75-80 °F STRESSED
80-85 °F TENSE
85-90 °F CALM
90-95 °F RELAXED

Thank you,
Brian Milstead
Bio-Medical Instruments Inc
800-521-4640
586-756-9891 fax
www.bio-medical.com



On Tue, Feb 25, 2014 at 5:22 PM, Bob Conder <bconder10@gmail.com> wrote:

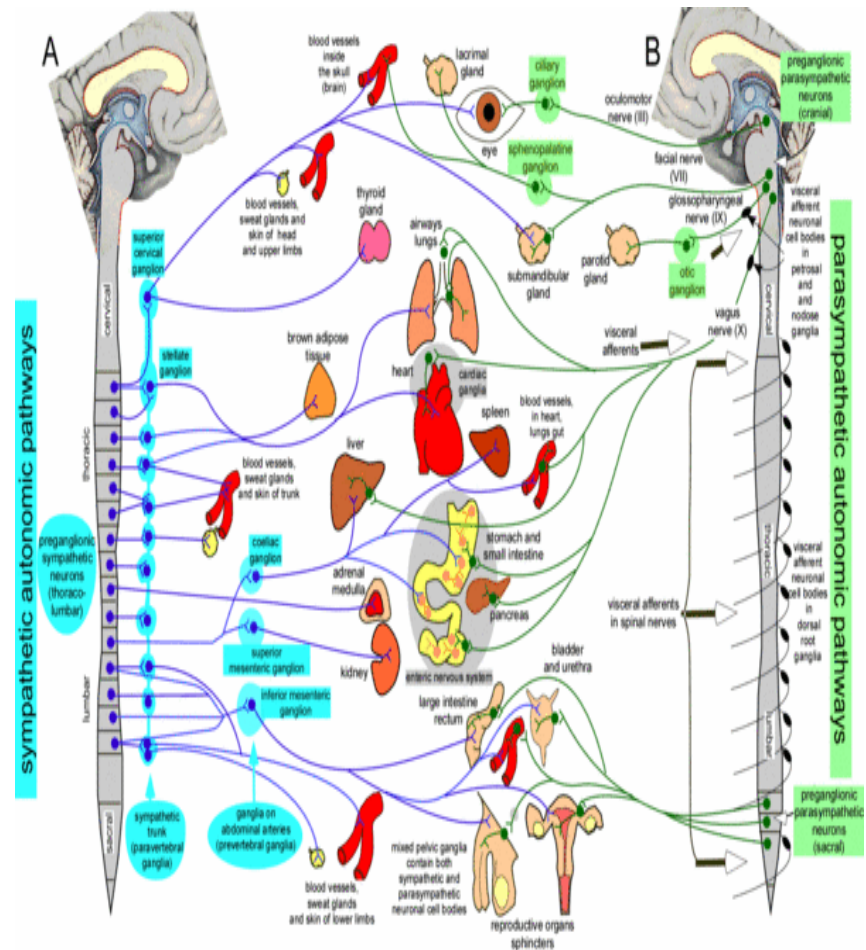


Types of Biofeedback & Indications

 IMOTIONS	What is measured?	How is it measured?	Which metrics can be derived?	How can the data be interpreted?
 Eye tracking (infrared)	Corneal reflection & pupil dilation	Infrared camera point towards eyes	Eye moments (gaze, fixations, saccades), blinks, pupil dilation	Visual attention, engagement, drowsiness & fatigue, emotional arousal
 GSR (galvanic skin response)	Changes in skin conductance due to sweating	Electrodes attached to fingers, palms or soles	Skin conductance response (SCR)	Emotional arousal, engagement, congruency of self-reports
 Facial Expression Analysis	Activity of facial muscles & muscle groups	(Web-)cam point towards face along with computer algorithms for feature extraction	Position and orientation of head & facial landmarks, activation of action units (AUs) & emotion channels	Emotional valence, engagement, congruency of self-reports
 (Facial) EMG (electromyogram)	Changes in electrical activity caused by muscle contraction	Electrodes attached to the skin (above muscles)	Muscle contraction onset, offset & duration, AU activity	Emotional valence, responsiveness to stimuli
 ECG / EKG (electrocardiogram)	Changes in electrical activity caused by heart contraction	Electrodes attached to chest or limbs	Heart rate (HR, BPM), interbeat interval (IBI), heart rate variability (HRV)	Emotional arousal, stress, physiological activity
 PPG (photoplethysmogram)	Changes in light absorption of blood vessels	Optical sensor attached to finger, toe or earlobe	Optical heart rate (HR)	Emotional arousal, stress, physiological activity
 EEG (electroencephalogram)	Changes in electrical activity of the brain	Electrodes places on scalp	Frequency band power (delta, theta, alpha, beta, gamma bands), frontal lateralization & asymmetry index event-related potentials, wavelets	Attention, emotional arousal, motivation, cognitive states, mental workload, drowsiness & fatigue,

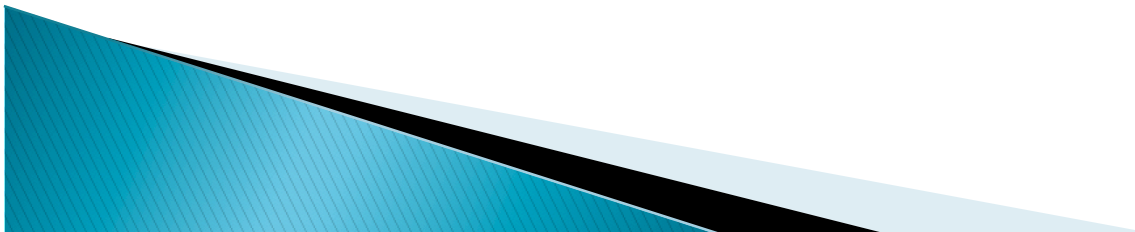
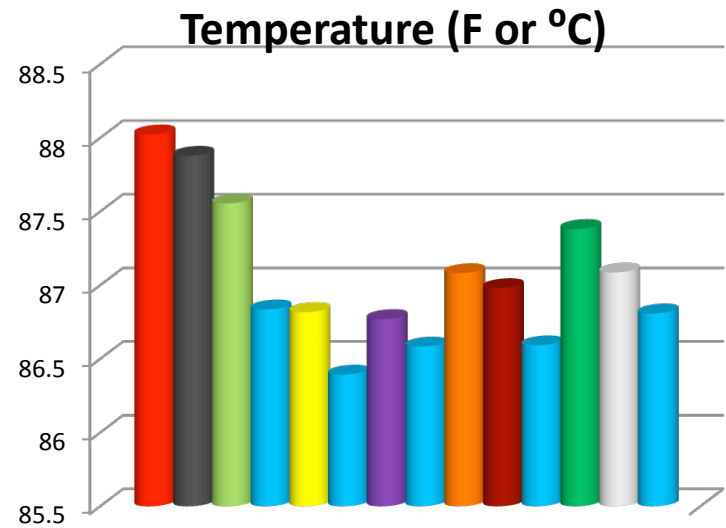
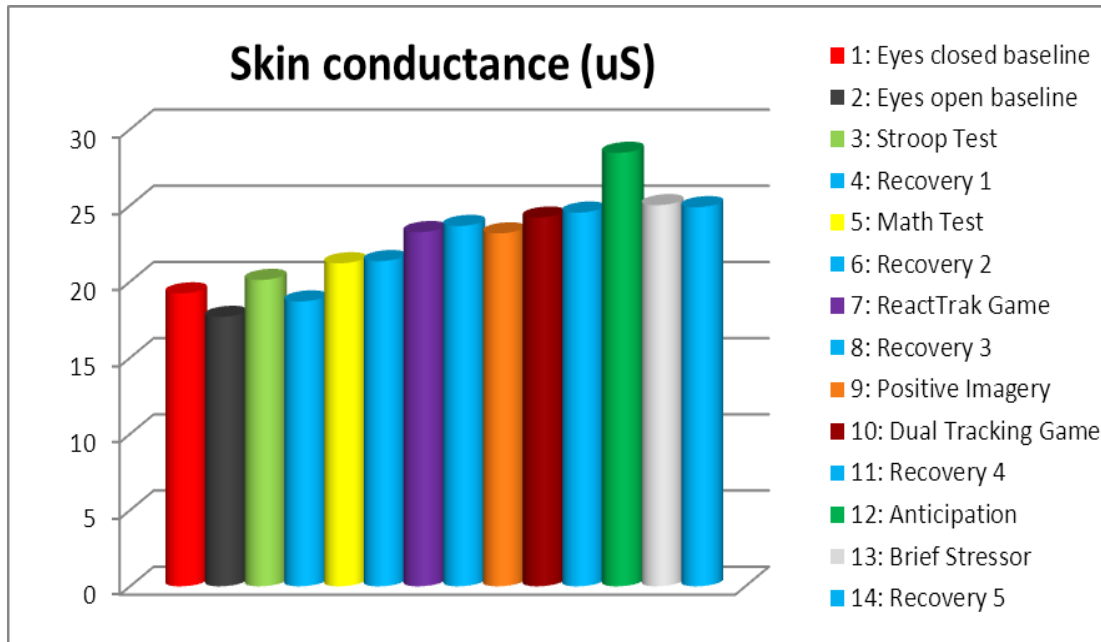
ANS Correlates of Concussion

- ▶ **SYMPATHETIC**
- ▶ *Flight or Fight*
- ▶ Peripheral Temperature
- ▶ ElectroDermal Response
- ▶ **PARASYMPATHETIC**
- ▶ *Rest and Digest*



ANS Reaction to Concussion

Sue Wilson's Optimizing Health



ANS Treatment

- ▶ “Bottle” Breathing – Diaphragmatic Breathing
- ▶ Use Temperature as feedback
- ▶ Can use autogenic phrases
- ▶ Low stimulus complex, good for pts with migraines & phono-photo phobia
- ▶ EDR/GSR BFB – sound may be upsetting
- ▶ Can also have meter display or computer

Heart Rate Monitors for Training & Rehab

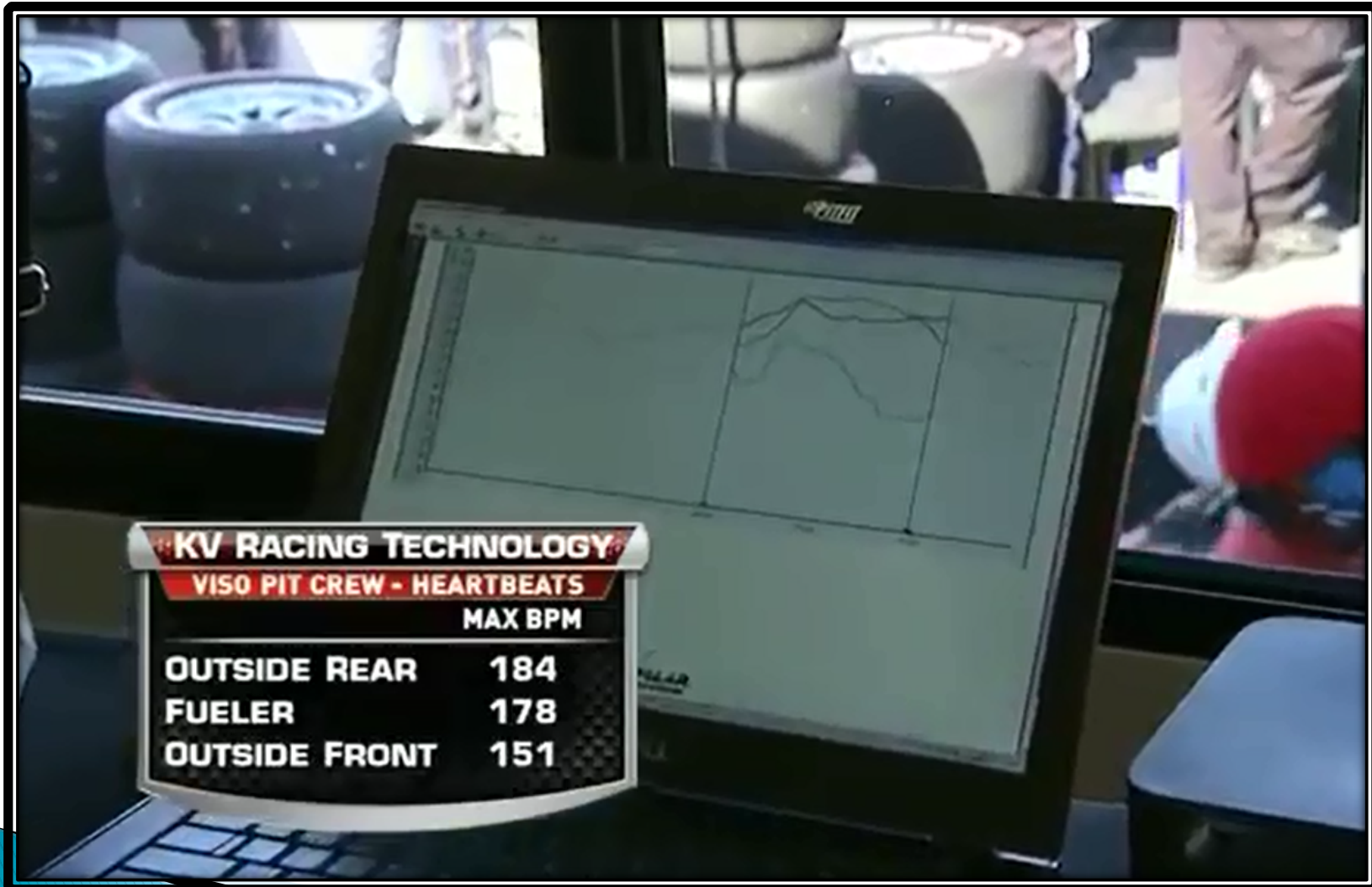
Sub-maximal HR exertion for PCS

- ▶ **Wearable Wireless Devices:**
- ▶ **Wrist Monitors** for HR, Time, Distance, GPS Tracking,
- ▶ **Chest EKG** – can also be used for HRV Training



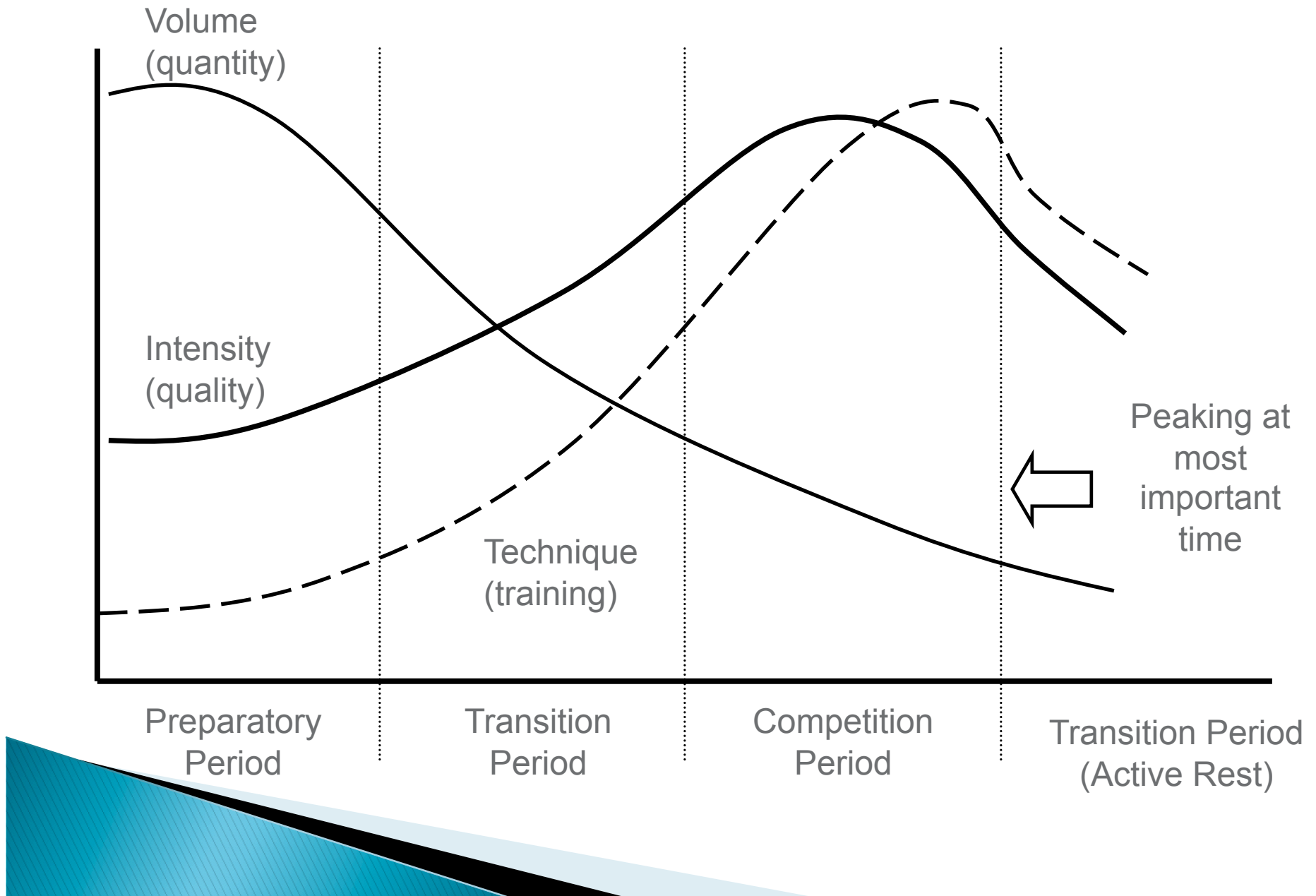
NASCAR Pit Crews: Jim Leo, PitFit

Courtesy David DeFabio, Polar



Training v Play Model

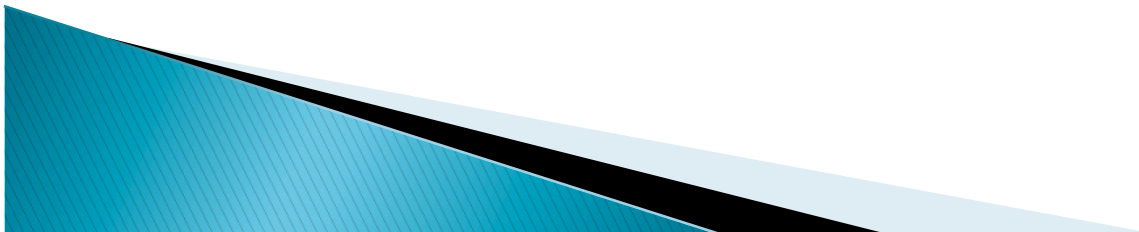
Courtesy David DeFabio, Polar

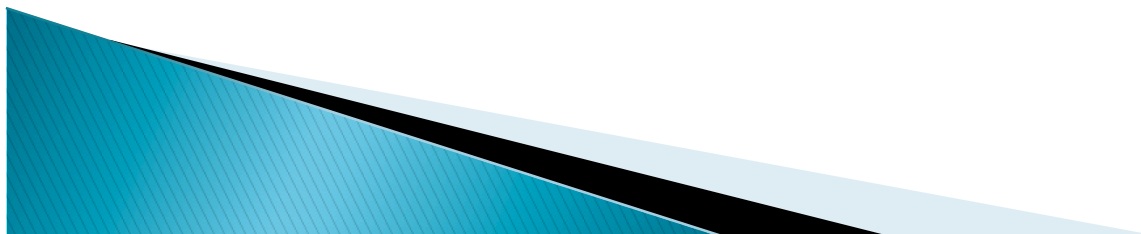
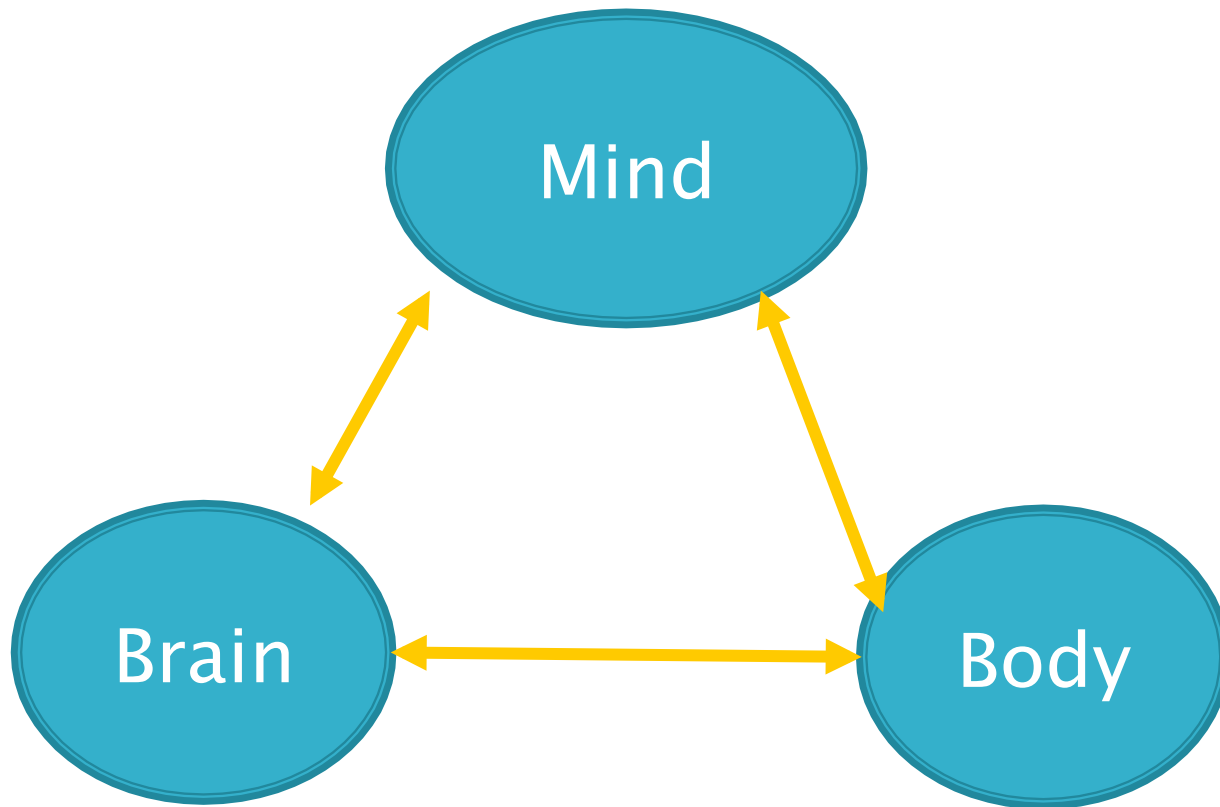


Rutgers Soccer HR Training Strategies

Courtesy David DeFabio Polar

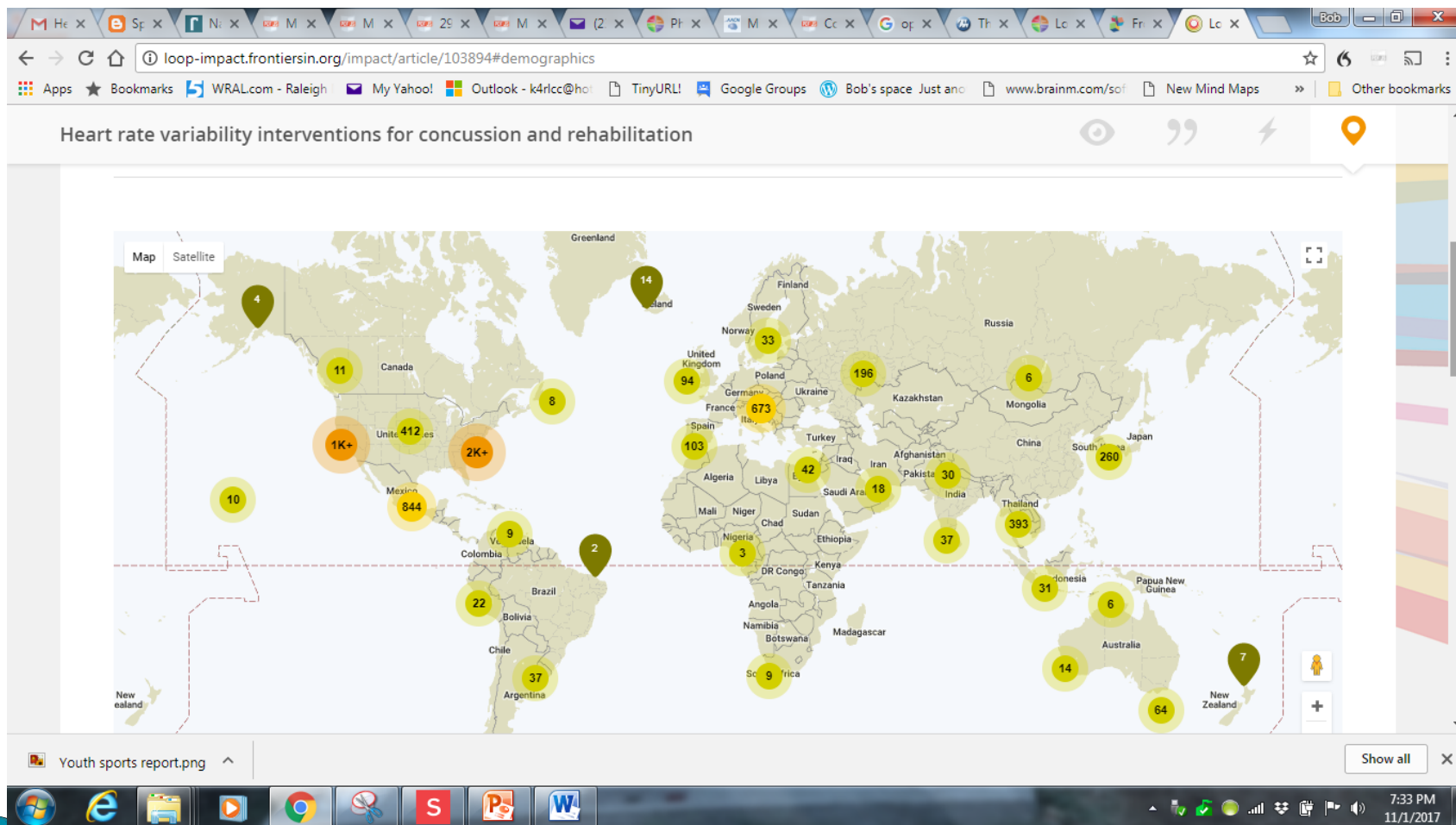
- ▶ Affects of monitoring HR after one year:
 - Injuries reduced by over 70%
 - They found pre-game warm up was as intense as first ½ of game according to TL
 - VJ increased by ~2 inches from T1 to T2; VO_{2max} remained fairly constant (~48.8 ml/kg/min)
 - Largest decreases in test measurements seen for players exceeding 1200 training load points (Polar Team2 System)
 - Looking back 2 ACL injuries could have been predicted by HR data





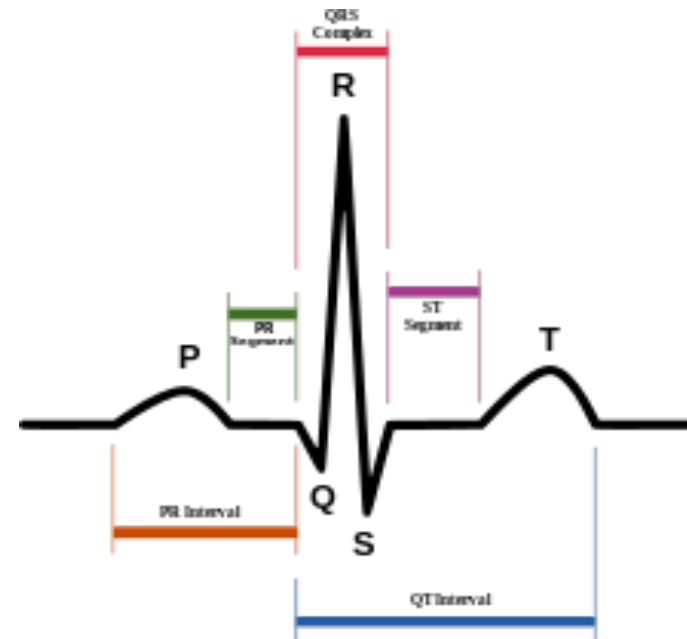
HRV Concussion Article – 18,123 Hits

Conder & Conder 2015

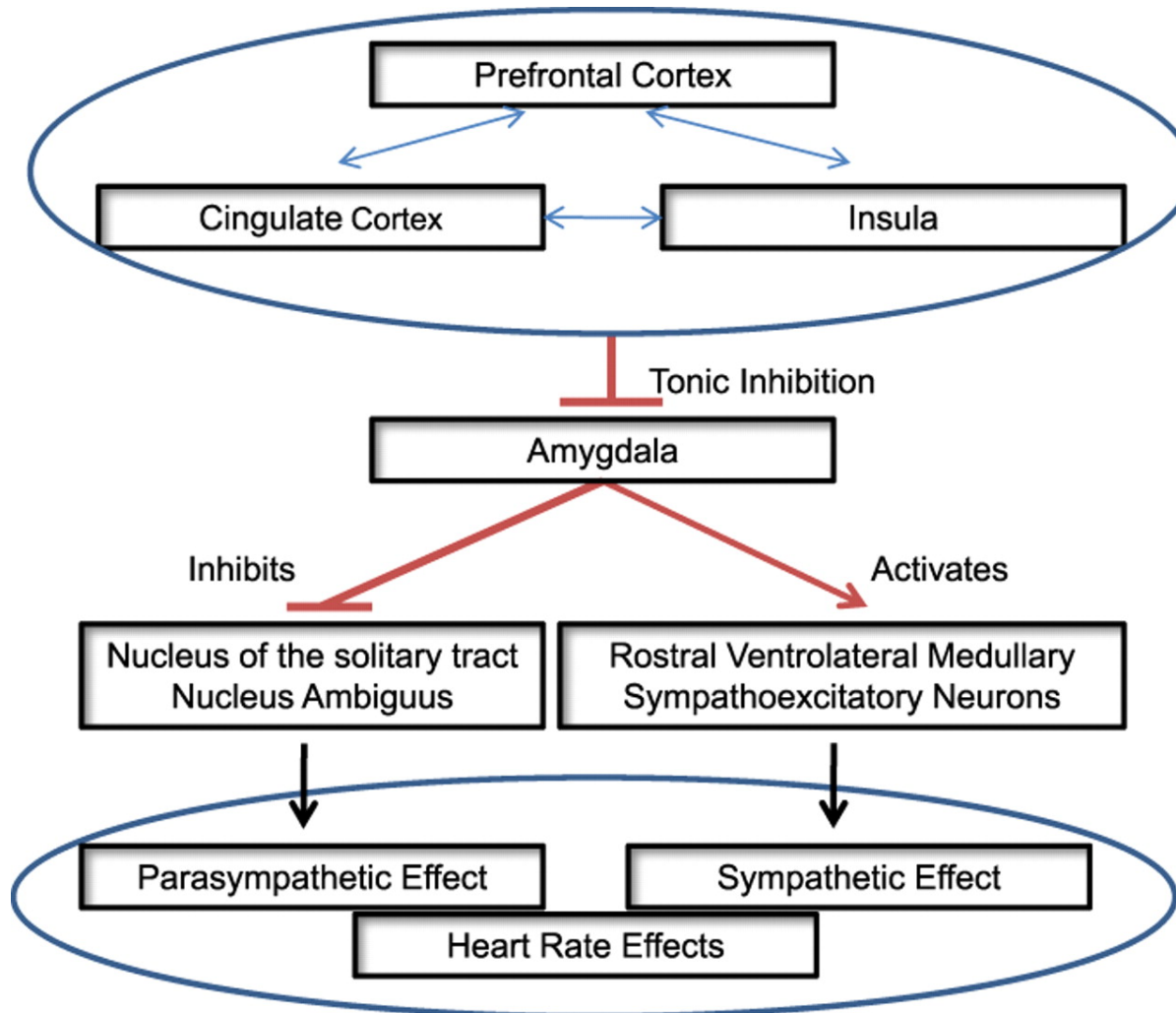


Cardiac Correlates of Concussion

- ▶ Heart Rate Variability
- ▶ Heart is not a Metronome
- ▶ Variability is good
- ▶ Lack of variability in cardiopathology
- ▶ Post concussion, lack of variability in R–R intervals
- ▶ Reduced cerebral perfusion, especially to aerobic demands




Association of neural structures involved in neurovisceral integration theory associating executive function and autonomic function.



Shah A J et al. Psychosom Med 2011;73:475-482

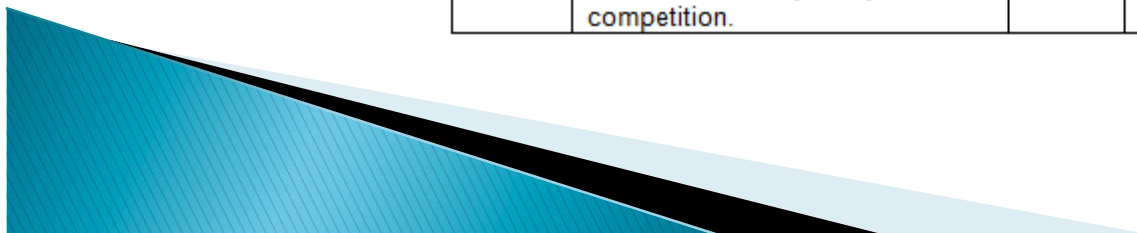
Actions of HRV Training

(Proposed - Lehrer & Gevirtz, 2014)

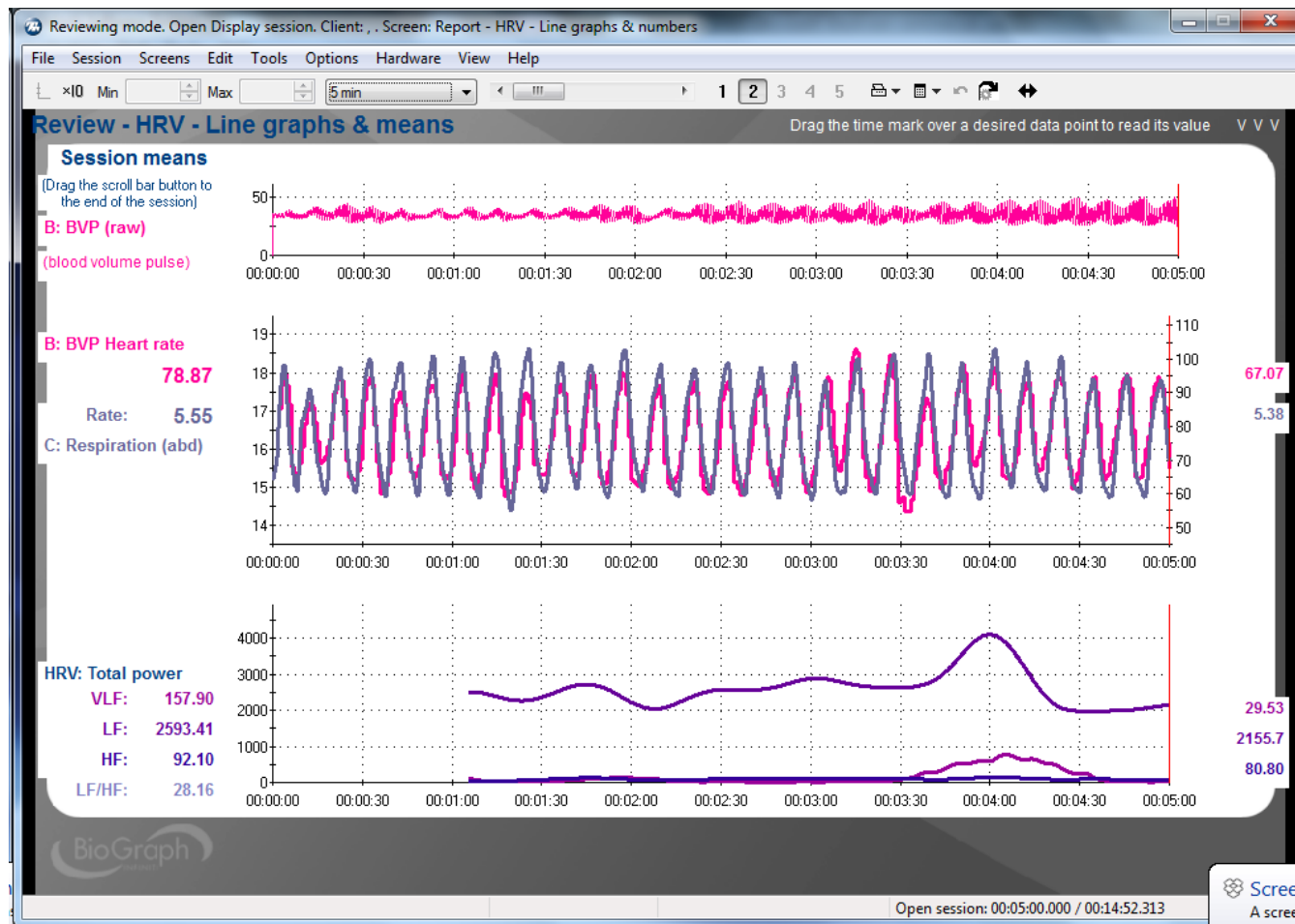
- ▶ Strengthening of homeostasis of baroreceptor
 - ▶ Strengthening of circuit between vagus nerve, amygdala and frontal lobes
 - ▶ Strengthens Sympathetic & Parasympathetic Nervous System balance
 - ▶ Increases Resilience in physical, emotional and cognitive systems
 - ▶ Increases Flexibility in physical, emotional and cognitive systems
 - ▶ Reduces Inflammation (C-RP) & Cardiopulmonary pathology
 - ▶ Increases athletic performance
- 

Heart Rate Exertional Interventions for Concussion Rehab & Training

STAGE	EXERCISE	DATE	COMPLETED/COMMENTS
1	20-30 min of cardio activity: walking, stationary bike, weightlifting at light intensity (no bench, no squat): low weight, high reps. Goal:30-40% of maximum HR.		
2	30 min of cardio activity: Jogging at a medium pace. Sit-ups, push-ups, lunge walks x 25 each. Weightlifting at moderate intensity. Goal: 40-60% of maximum HR.		
3	30 min of cardio activity: running at a fast pace. Sit-ups, push-ups, lunge walks x 50 each. Sport specific agility drills in three planes of movement. Resume regular weightlifting routine. Goal: 60-80% of maximum HR.		
4*	Participate in non-contact practice drills, warm-up and stretch x 10 minutes. Intense non-contact, sport-specific agility drill x 60 minutes. Goal 80-100% of maximum HR		
5	Participate in full contact practice.		
6.	Resume full participation in competition.		

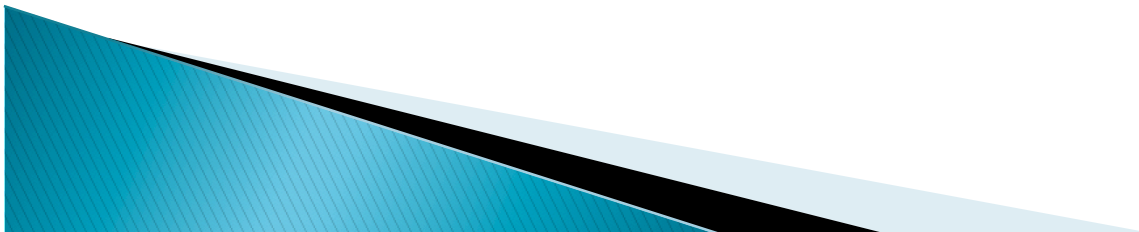


Jordan – Marathon Runner PhD Student – Refractory PCS

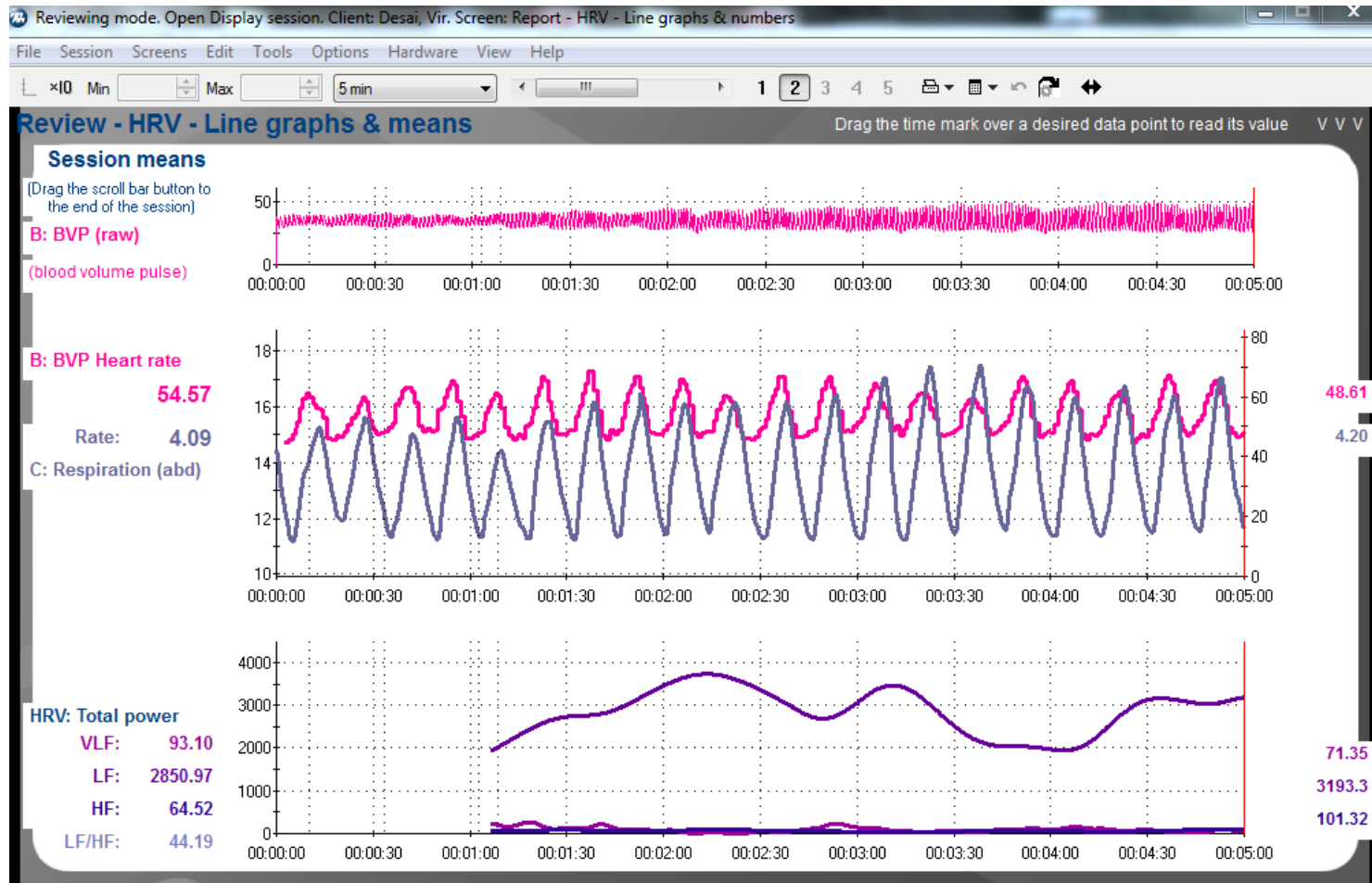


Jordan

- ▶ Reduced number of Post-Concussive Sx & Reduced Intensity Sx
- ▶ More restful sleep
- ▶ Reduced Anxiety
- ▶ Increased stamina
- ▶ Ability to write dissertation on computer instead of pencil & paper

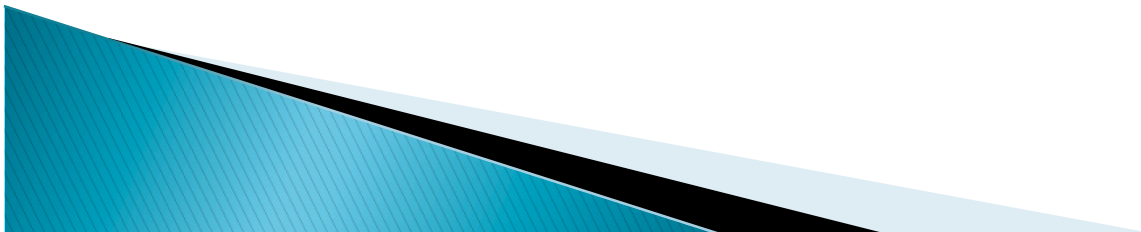


Joe – BioMed Enginr Student – Club Sports – 4th sports concussion



Joe – BioMed Enginr Student – Club Sports – 4th sports concussion

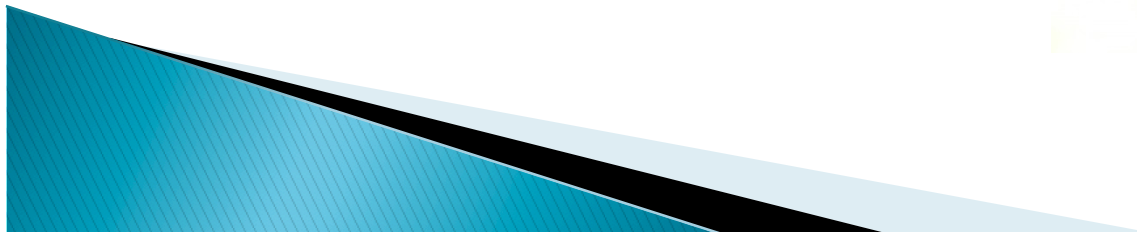
- ▶ Able to concentrate better & longer in difficult classes
- ▶ Reports fewer PCS symptoms
- ▶ Oh, by the way...our team came in 3rd nationally in our play-off
- ▶ I played my best game ever....didn't miss a ball....we beat West Point, who had been national champs for past 3 yrs
- ▶ Also, Dean's List; Graduate with Honors



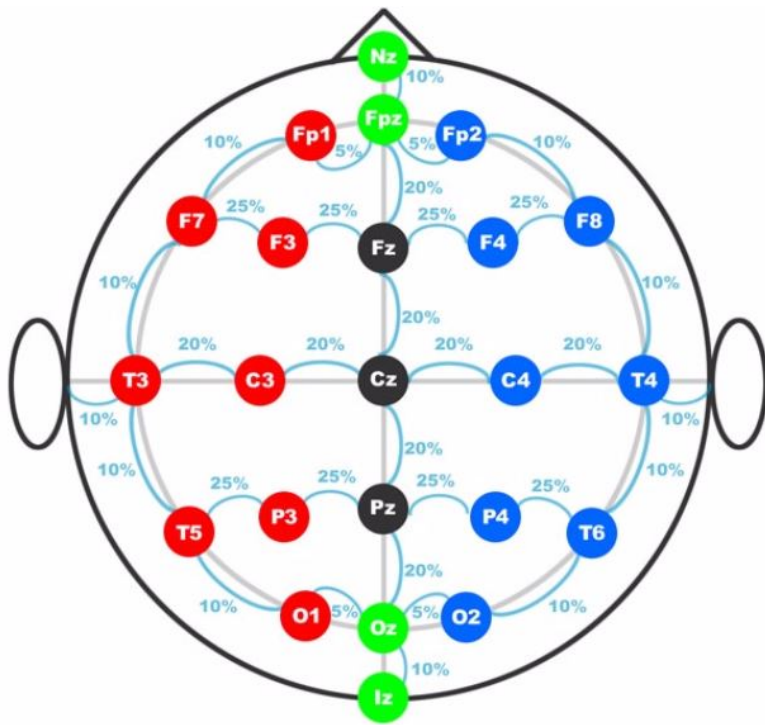
Technology - Then 1990



Technology - Now 2017



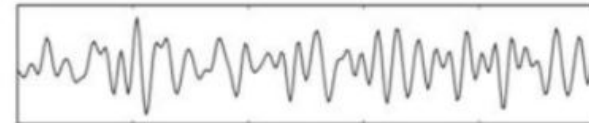
Electrode Placement & EEG Bands



Comparison of EEG Bands



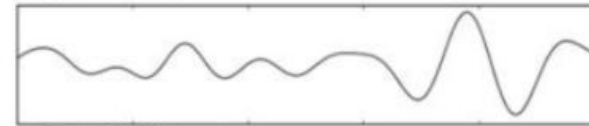
Gamma: 30-100+ Hz



Beta: 12-30 Hz



Alpha: 8-12 Hz



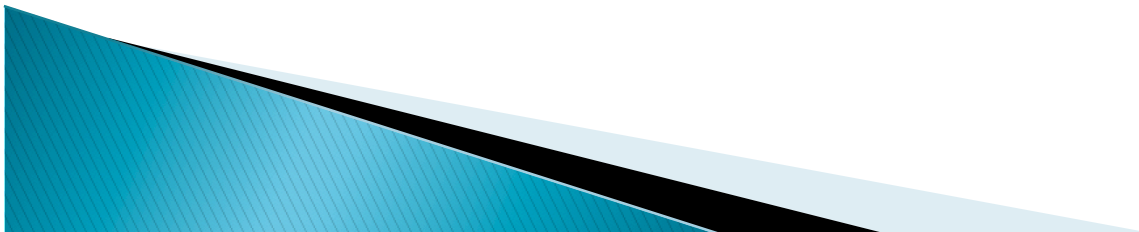
Theta: 4-7 Hz



Delta: 0-4 Hz

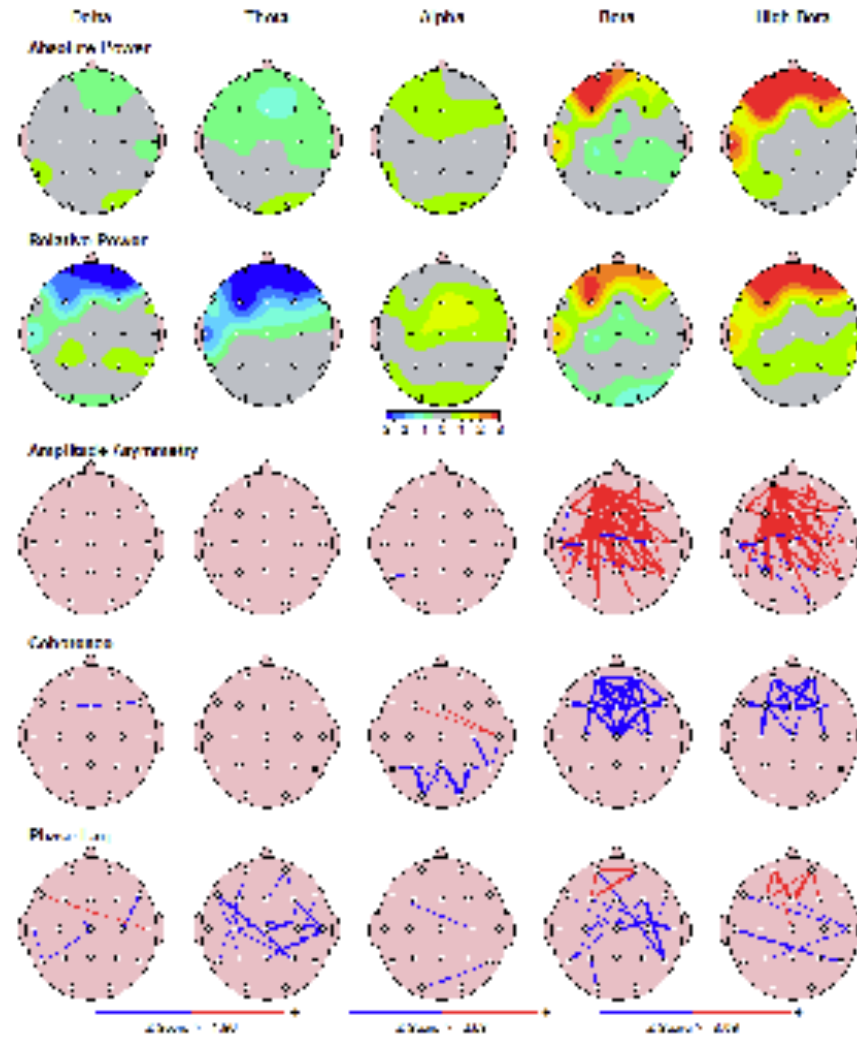
NeuroFeedback Txmt of Concussion

- ▶ QEEG needed to understand neuropathology
- ▶ Goal: Reduce Slow Wave amplitude (Delta, Theta, Low Alpha)
- ▶ Goal: Increase Fast Wave amplitude (Beta, High Alpha, SMR)
- ▶ Goal: Increase flexibility of networks to provide appropriate allocation of neurocognitive resources needed for the task at hand



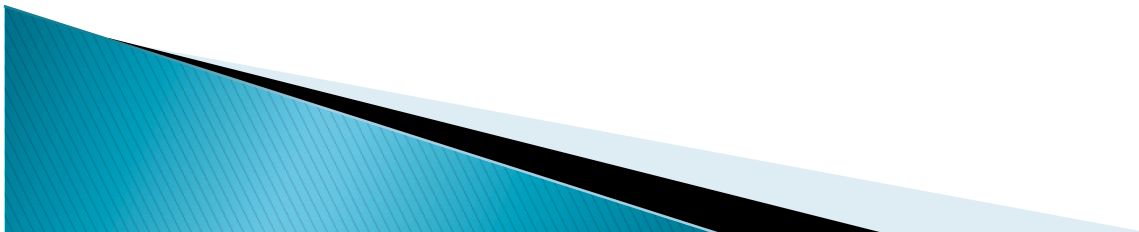
Meigs - Lutz

Z Scored FFT Summary Information



Ace-Commercial Pilot with concussion

- ▶ Bicycling for exercise
- ▶ Collided with tree limb on Greenway
- ▶ TBI +LOC
- ▶ FAA medical failed
- ▶ FAA Neuropsych Exam failed
- ▶ FAA pulled his medical
- ▶ Was able to fly, but not pilot in command
- ▶ Interventions:
- ▶ Cognitive Rehab
- ▶ HRV BFB with flight simulator
- ▶ NFB: SMR and Live Z Score 4 channel
- ▶ HRV home practice
- ▶ Diet, Exercise, Sleep
- ▶ Pass FAA Neuropsych Exam



Comparison post treatment

mind maps

BRAIN MAP COMPARE TOOL

Download Report



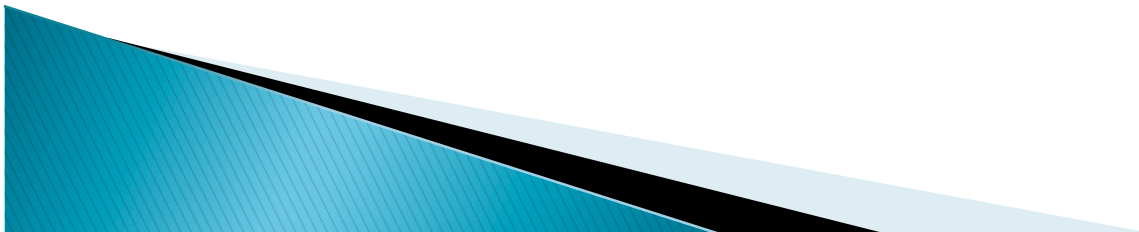
43% Overall Change

Top 4 - locations with highest change towards normalization



Eddie – Military & EMS Pilot

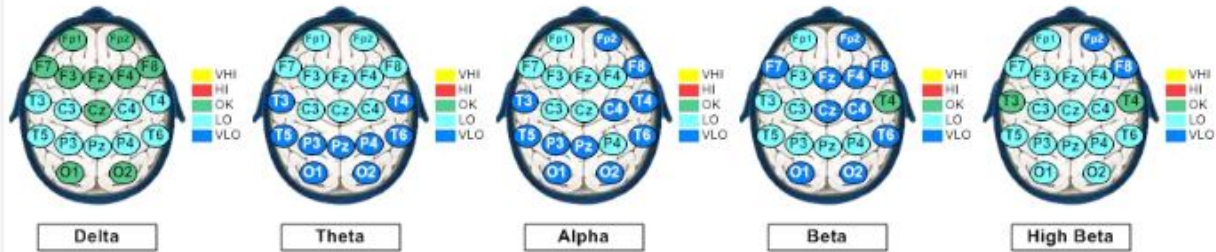
- ▶ Former military helicopter pilot
- ▶ Iran & Afghanistan
- ▶ PFO w/R Parietal CVA
- ▶ Surgical repair PFO
- ▶ No residual CVA Sx
- ▶ FAA pulled medical, failed FAA Neuropsych Exam
- ▶ Interventions:
- ▶ Cognitive Rehab
- ▶ HRV BFB with flight simulator
- ▶ NFB: SMR and Live Z Score 4 channel
- ▶ HRV home practice
- ▶ Diet, Exercise, Sleep
- ▶ Passed FAA Neuropsych Exam



Eddie - Pre Treatment

Eyes Closed Brain Maps

Magnitude

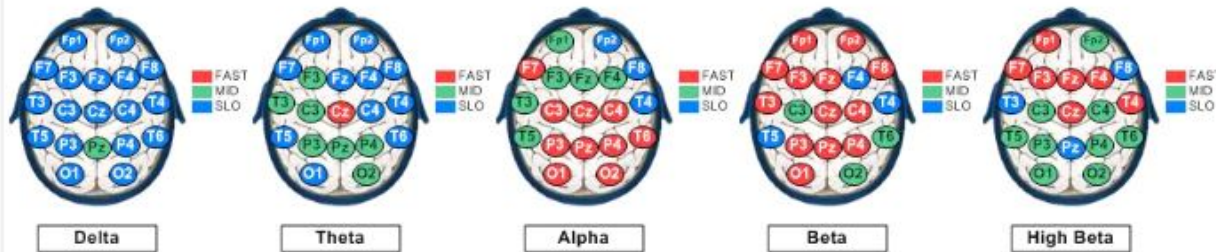


Magnitude Contrast

Adjust Up Suggested

Down Up

Dominant Frequency

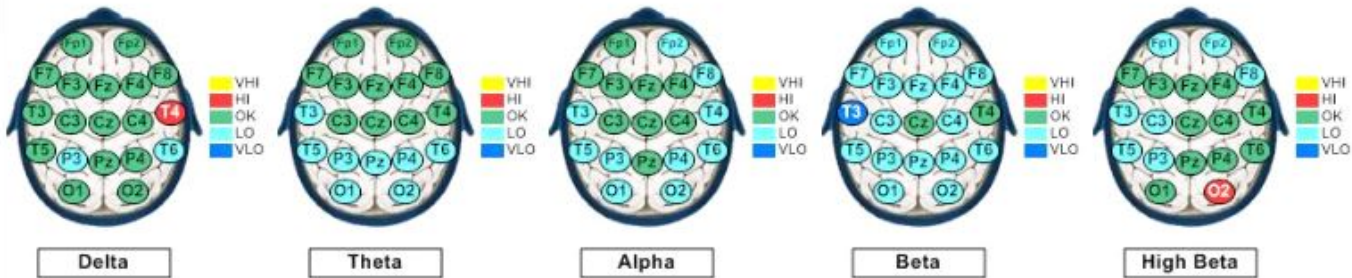


⚠ Check Physiology

600+ NHL Games; 3 Cups

Eyes closed brain maps

Magnitude



Magnitude Contrast

Down Up









Dominant Frequency



Neurotransmitters

THE STRUCTURES OF NEUROTRANSMITTERS

STRUCTURE KEY: ● Carbon atom ○ Hydrogen atom ○ Oxygen atom N Nitrogen atom R Rest of molecule

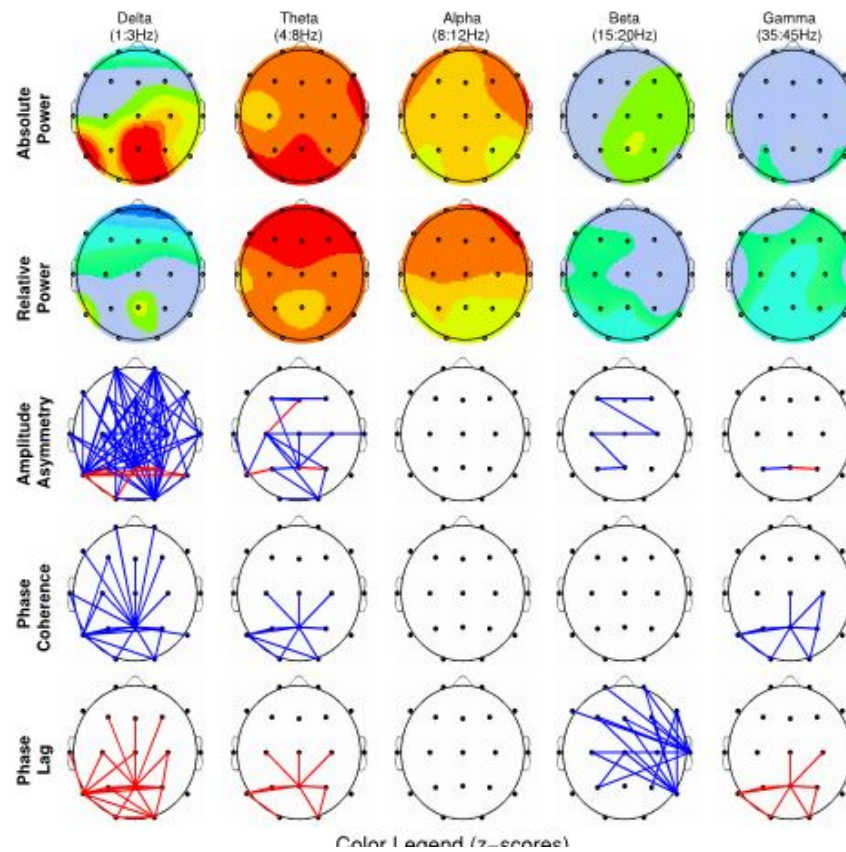
<p>ADRENALINE Fight or flight neurotransmitter</p>  <p>Produced in stressful or exciting situations. Increases heart rate & blood flow, leading to a physical boost & heightened awareness.</p>	<p>NORADRENALINE Concentration neurotransmitter</p>  <p>Affects attention & responding actions in the brain, & involved in fight or flight response. Contracts blood vessels, increasing blood flow.</p>	<p>DOPAMINE Pleasure neurotransmitter</p>  <p>Feelings of pleasure, and also addiction, movement, and motivation. People repeat behaviours that lead to dopamine release.</p>	<p>SEROTONIN Mood neurotransmitter</p>  <p>Contributes to well-being & happiness; helps sleep cycle & digestive system regulation. Affected by exercise & light exposure.</p>
<p>GABA Calming neurotransmitter</p>  <p>Calm firing nerves in CNS. High levels improve focus; low levels cause anxiety. Also contributes to motor control & vision.</p>	<p>ACETYLCHOLINE Learning neurotransmitter</p>  <p>Involved in thought, learning, & memory. Activates muscle action in the body. Also associated with attention and awakening.</p>	<p>GLUTAMATE Memory neurotransmitter</p>  <p>Most common brain neurotransmitter. Involved in learning & memory, regulates development & creation of nerve contacts.</p>	<p>ENDORPHINS Euphoria neurotransmitters</p>  <p>Released during exercise, excitement, & sex, producing well-being & euphoria, reducing pain. Biologically active section shown.</p>

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Alpine Climber – Pre

Montage: Linked Ears
Eyes Closed

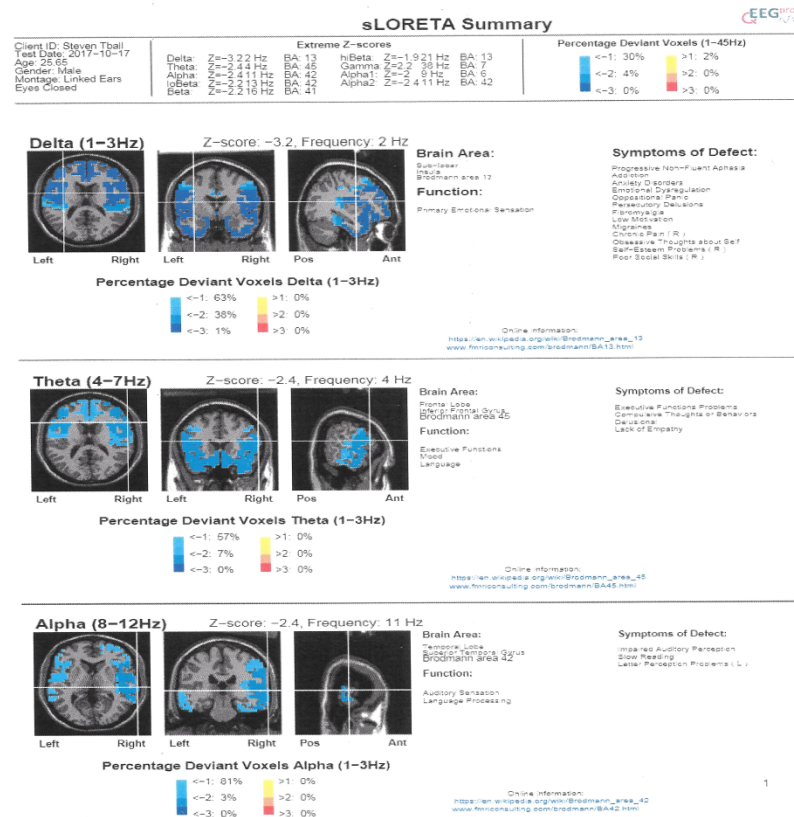
Summary of the Z-score analyses



Steven Tball - sLoreta

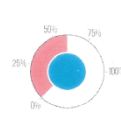
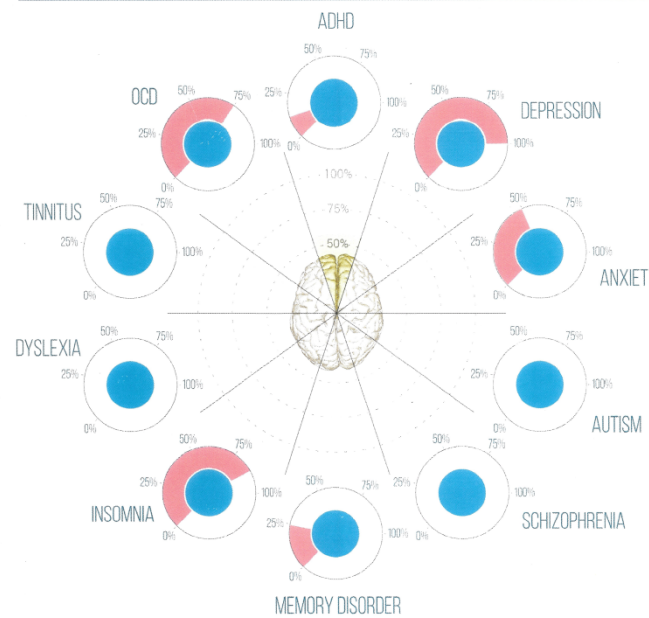
11/2/2017

298558_qEEGpro_EC_sLoreta_summary.pdf



EEG Biomarkers

BRAIN WAVES PROFILE:
EEG BIOMARKER MATCH



The red bars reflect the patient's symptom severity. Epilepsy, Substance Use Disorder and Traumatic Brain Injury are not depicted, since these disorders have not shown to be reliably associated with EEG biomarkers.



The relationships between the patient's brain activity deviations and the patient's symptoms are depicted in the green pie chart. The stronger the presence of certain biomarkers for a particular disorder, the larger the segment. The color intensity depicts the scientific support for the association between these markers and the disorder.

SteveT Default Mode Network

RESTING-STATE NETWORKS:

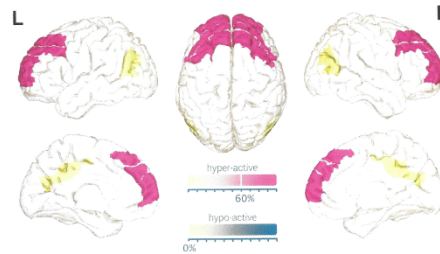
THE DEFAULT MODE NETWORK



The Default Mode Network (DMN) is active during rest and is associated with self-reflective processes or mental simulation. Low DMN activity may reflect an inability to switch from a task-oriented state to a rest-oriented state. Abnormal DMN activity has been associated with a number of psychological disorders.

NETWORK ACTIVITY

The DMN consists of frontal brain areas that are known to be involved in higher executive functions such as working memory, planning and cognitive control. The Angular Gyrus is known to be involved in allocation of attention and the Posterior Cingulate Gyrus is associated with self-referential processes.



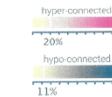
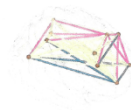
Brain Areas Involved:

Supplementary Motor Area
Middle Frontal Gyrus
Posterior Cingulate Gyrus
Angular Gyrus

Brodmann Areas:

8, 9, 10, 31, 39

NETWORK CONNECTIVITY



11%
Reduced DMN connectivity has been associated with the cognitive decline and the deterioration of memory functions which are associated with the aging brain.

AROUSAL



Low DMN activity can reflect high arousal, but high DMN activity can also be related with excessive rumination, which is associated with high arousal.

Attentional 'lapses' may be caused by an over-active DMN. High DMN activity may also reflect excessive introspective thought, which is related with anxiety and mood disorders, while decreased introspective thought often occurs in autism.

The deviance of brain activity in a certain region is determined by the ratio between deviances in amplitude of fast (~15 Hz) and slow neural oscillations (~12 Hz). Abnormal activity means that there is either an excess or a deficit of both fast and slow wave activity. The deviance of connectivity is not determined by this ratio, but by the average hyper- or hypoconnectivity across frequencies.



PATHOLOGY



SteveT Emotion-Regulation

RESTING-STATE NETWORKS:

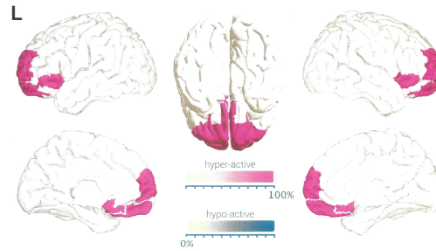


THE EMOTION-REGULATION CORTEX

The Emotion-Regulation Cortex (ERC) plays a role in emotion regulation, empathy, risk assessment, decision making and fear processing.

NETWORK ACTIVITY

The ERC consists of the Middle Frontal Gyrus, which is involved in emotional decision making and the Orbitofrontal Gyrus, which is known for its role in the evaluation of emotional stimuli and the representation of the somewhat intangible concepts of personality or 'cognitive style'.



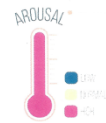
Brain Areas Involved:
Middle Frontal Gyrus
Orbitofrontal Gyrus

Brodmann Areas:
10, 11, 26, 47

NETWORK CONNECTIVITY



Deviations in phase coherence between the different areas of the ERC reflect sub-optimal functioning of the ERC which may result in impaired emotion-related processes.



Affective processes are known to influence arousal. Phasic increases of arousal have been shown to correlate with ERC activity.

Low activity in the ERC has been linked with mood and anxiety disorders, while high activity in the ERC has been associated with OCD. Substance Use Disorder results in low ERC activity during abstinence but high ERC activity during exposure to drug-related cues. Grey matter in the ERC has also been shown to decrease in response to psychological trauma.

PATHOLOGY



The deviance of brain activity in a certain region is determined by the ratio between deviances in amplitude of fast (>15 Hz) and slow neural oscillations (<12 Hz). Abnormal activity means that there is either an excess or a deficit of both fast and slow wave activity. The deviance of connectivity is not determined by this ratio, but by the average hyper- or hypoconnectivity across frequencies.



TREATMENT OPTIONS Following Concussion



Psychotherapy



Cognitive
Rest



Biofeedback
&
Neurofeedback



Medication



Vestibular
Therapy



Cognitive
Remediation

Physical & Cognitive Rest : Primary Treatment for SRC

- ▶ As concussion impairs cerebral metabolism needed for physical & cognitive activity, need to reduce both types of activities for first few days post-injury
 - ▶ For athletes, no sport activity or practice, or gym or field workouts
 - ▶ For students, this includes shut down from fun stuff like iPods, video games, Texting, as well as academic demands
 - ▶ Often necessary to shut kids down for short periods, but not extended periods
- ▶ Longer rest can be counter-productive

Vestibular Therapy & Oculomotor/Visual Therapy

- ▶ Based on results of NeuroCom Balance Eval
- ▶ Works with PT Vestibular Therapist
- ▶ Very important component of concussion assessment & therapy
- ▶ Oculomotor Treatment: component of vestibular system. Sees ocular specialist, usually optometrist with special training

Psychological Treatment

- ▶ Education and Support – use CDC Handouts
- ▶ Behavioral Management:
- ▶ Modified CBT for Sports
- ▶ Behavioral &/or CBT for Sleep Disturbance
- ▶ Mindfulness
- ▶ All these create sense of self-efficacy

Heart Rate Variability

- ▶ Goal: Obtain synchrony between heart and brain
- ▶ Goal: Increase power in Low Frequency range (0.4 to 15 Hz)
- ▶ LF Activation around 0.4–0.5 Hz associated with optimal performance on Trails B & Choice Reaction time (Executive abilities)
- ▶ Leah Lagos, PsyD has tx'd over 200 kids with PPCS with the Lehrer Rutgers protocol

Medication Management

- ▶ No gold standard RX treatment
- ▶ Treat comorbidities: Migraines & Sleep
- ▶ Amantadine (DA agonist) short term 100mg BID
- ▶ Acetaminophen – short term (Check allergies)
- ▶ Stop Psychostimulant meds initially
- ▶ Headache medications, such as Nortriptyline & Atenolol
- ▶ Sleep meds (not benzos) Trazodone or Melatonin
- ▶ Diet: Lean Protein, Complex Carbs, Hydration, DHA, MultiVitamins
- ▶ Stop medication before Return to Play

Exercise is Medicine™

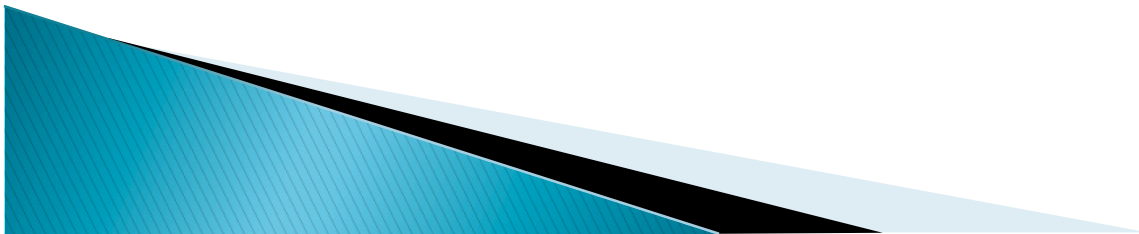
American College of Sport Medicine

- ▶ Use of sub-maximal aerobic exercise for treatment
- ▶ If balance problems or headaches, begin with stationary bike or AirDyne
- ▶ Monitor HR; start at 30–40% max & go up by 5–10%, if non-symptomatic
- ▶ If symptomatic, drop back down to level with no SX
- ▶ Athletes need positive effects / neurochemistry of exercise

Optimal or Peak Performance

Flow, **Zone**, Groove ?

- ▶ Automatic performance, without overt control
- ▶ Total Focus
- ▶ Confidence
- ▶ Loss of self-consciousness
- ▶ Altered perception of time & objects
- ▶ At one with visualization
- ▶ Joy
- ▶ Effortless recovery from stress & failure
- ▶ Optimism without illusion



Thank you
bconder10@gmail.com

