MTBI IN THE CIVILIAN POPULATION

New Frontiers in Diagnosis and Treatment

Mark R. Lovell, PhD

Professor and Director,
Sports Medicine Concussion Program
University of Pittsburgh Medical Center
Departments of Orthopaedics and Neurological Surgery

STATEMENT OF DISCLOSURE

Dr. Lovell is the developer of the ImPACT program and has served as a consultant to the following organizations:

The National Football League
The National Hockey League
Major League Baseball
Major League Soccer
Indianapolis Racing League
NASCAR
Formula 1 Racing
CART, CHAMP Car
Irish National Rugby
The US Ski and Snowboard Team
South African Rugby
USA Olympic Team

The Pittsburgh Penguins
The Pittsburgh Steelers

Epidemiology

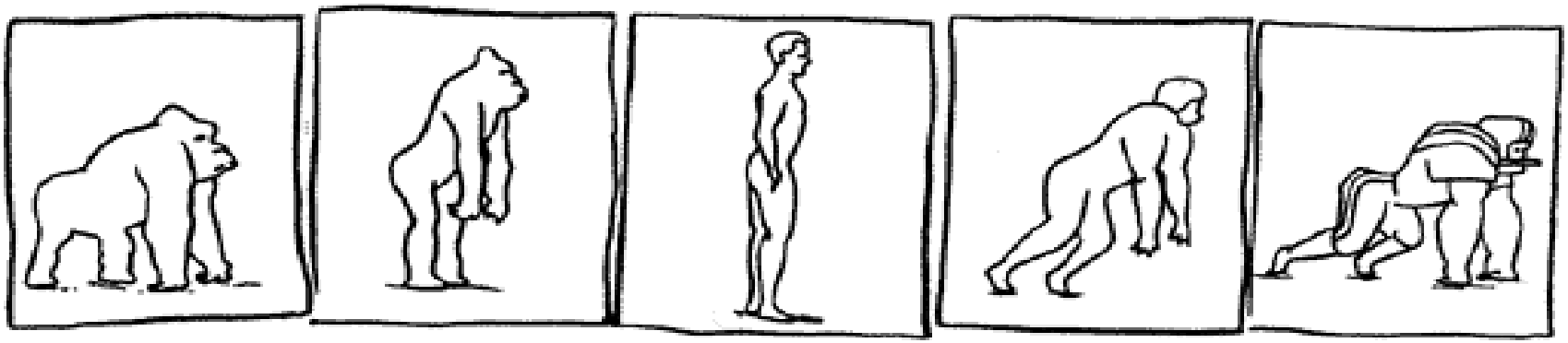
- In the US, it is estimated that more than 1 million children sustain a TBI annually and that TBI accounts for more than 250,000 hospital admissions/yr and accounts for approximately 10% of all pediatric ED evaluations per year

- It is thus estimated that for every one concussion that occurs in the NFL, 5650 concussions occur in American youth sports.

- The CDC estimates that approximately 1.6 to 3.8 million sports-related mTBI's occur each year

(CDC Toolkit for Physicians)

Sports as a Laboratory for MTBI



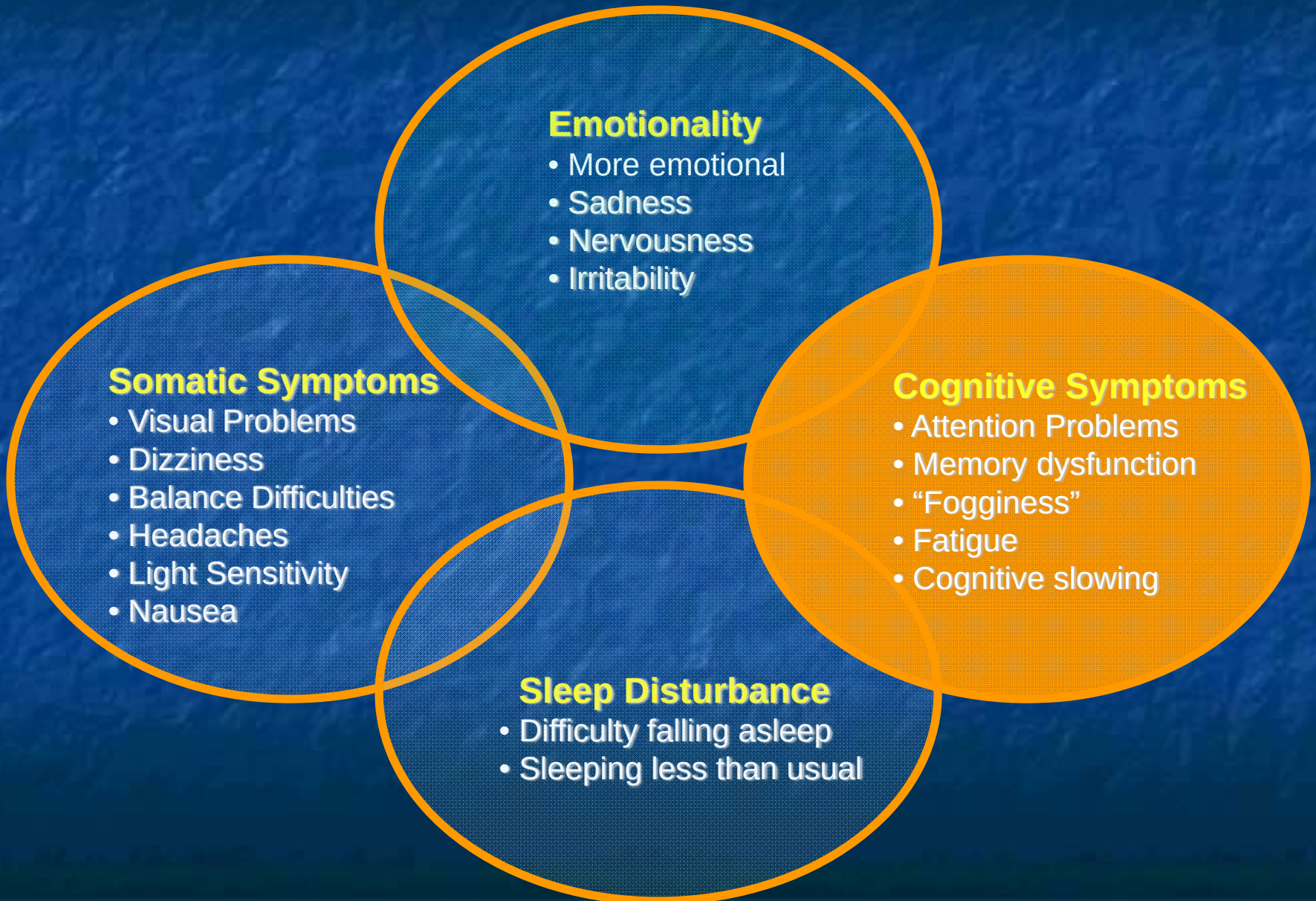
- ✓ Pre-injury "baseline" information is available on many athletes.
- ✓ Access to large groups of individuals who have a *relatively* high likelihood of injury.
- ✓ Promotes longitudinal study of mTBI.
- ✓ Relative absence of factors that interfere with recovery in other groups (e.g. litigation).

Concussion Definition

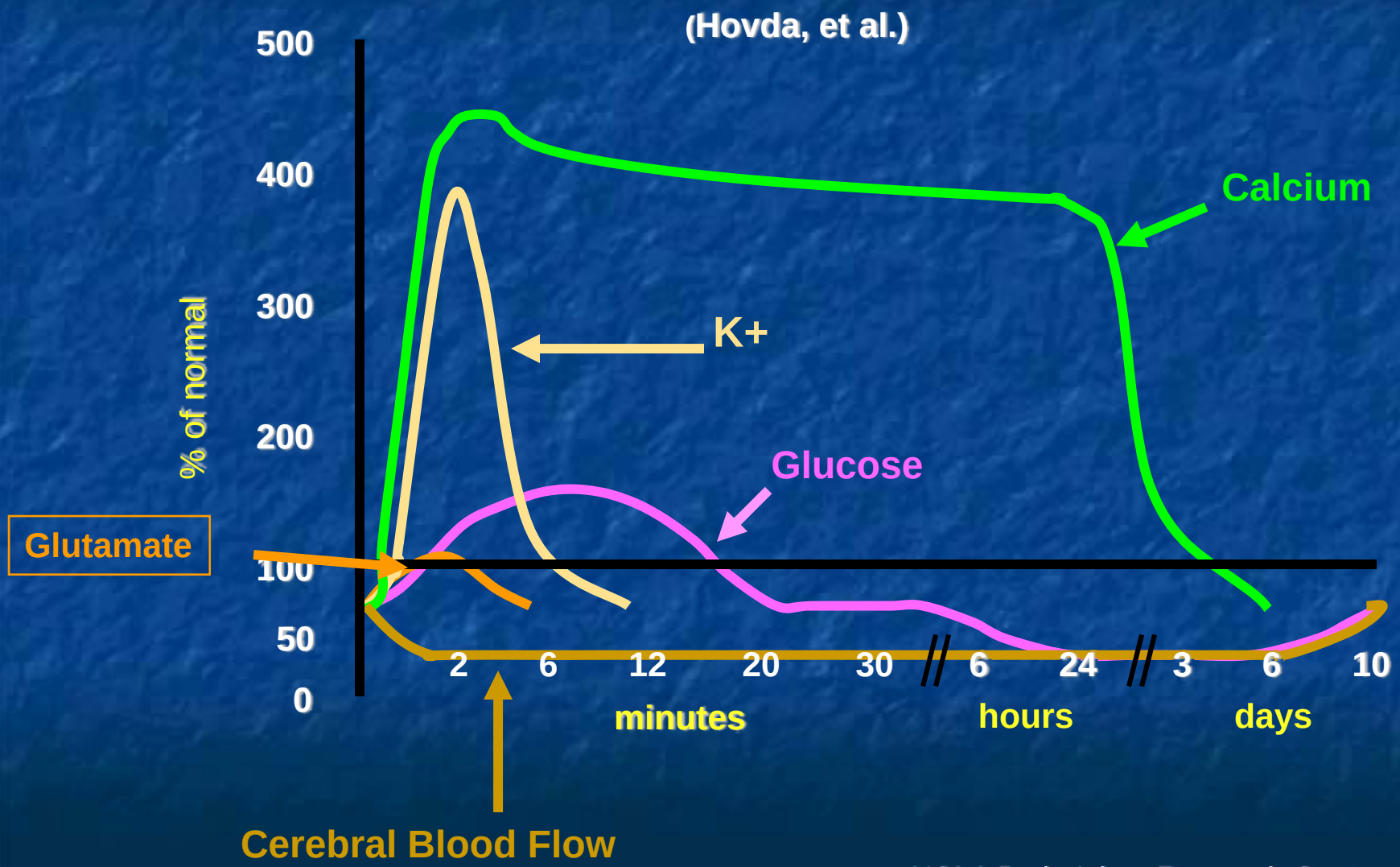
- A complex pathophysiological process affecting the brain
- No damage to brain anatomy?
- Primarily a disturbance in brain physiology
- Common features
  - ✓ Usually direct blow to the head or body
  - ✓ Loss of consciousness not necessary
  - ✓ Rapid onset of symptoms?
  - ✓ Traditional medical tests usually normal (CT/MRI)

From, CISG, Vienna, 2001, Clinical Journal Sports Medicine, 2002

Factor Analysis, Post-Concussion Symptom Scale (Pardini, Lovell et al. 2004)
N=327, High School and University Athletes Within 7 Days of Concussion



Neurometabolic Cascade Following Cerebral Concussion



UCLA Brain Injury Research Center


UPMC
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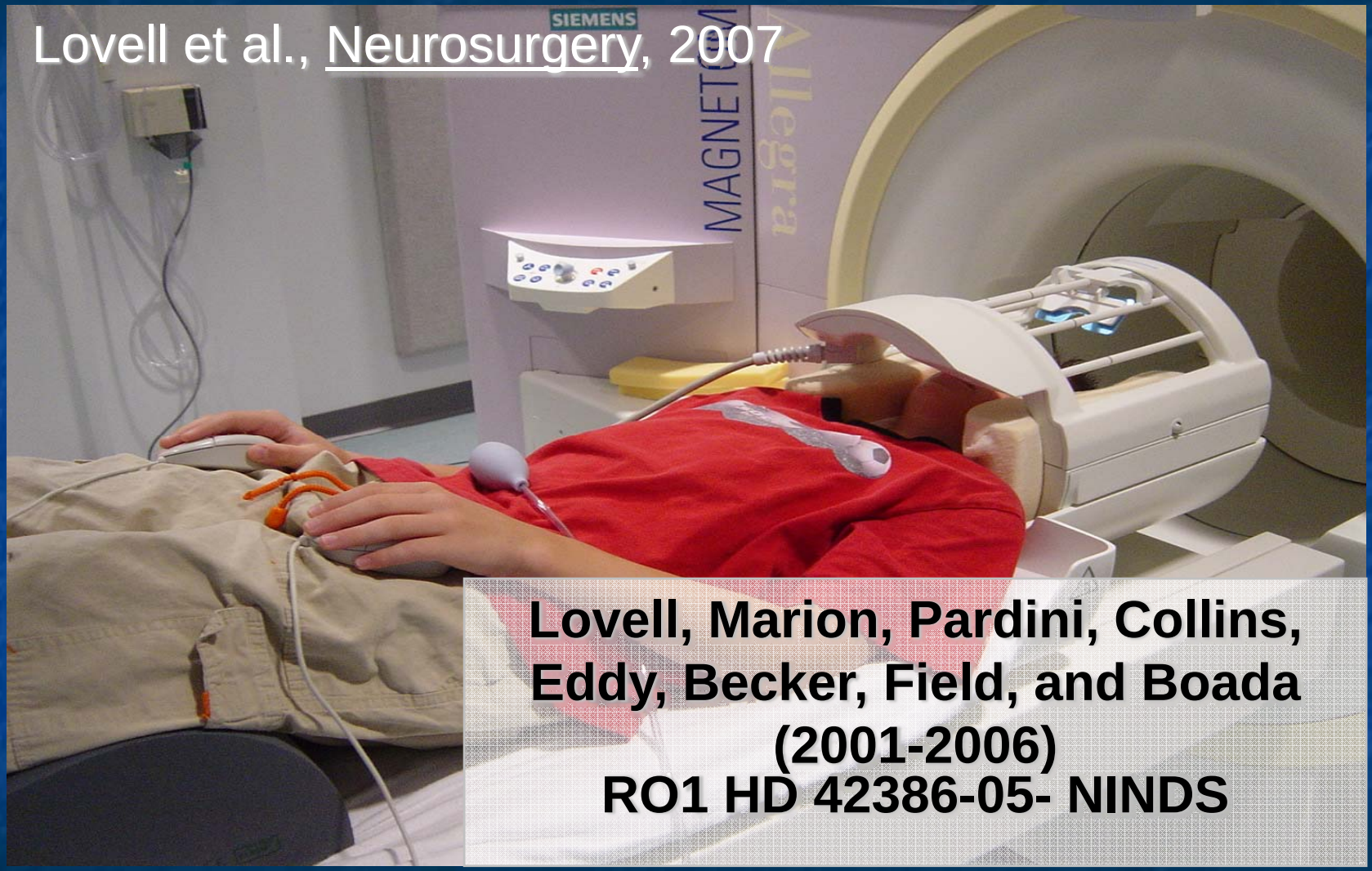
Functional MRI and Sports mTBI

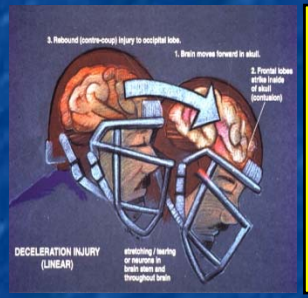


Lovell, Marion, Pardini, Collins, Eddy, Becker, Field, and Boada (2001-2006)
RO1 HD 42386-05- NINDS

STUDY TIMELINE

N=220 injured athletes (male and female)
N=50 age-matched controls

1-7 DAYS AFTER INJURY

BASELINE NP TESTING		NP TESTING and fMRI	NP TESTING and fMRI	RETURN TO PLAY?

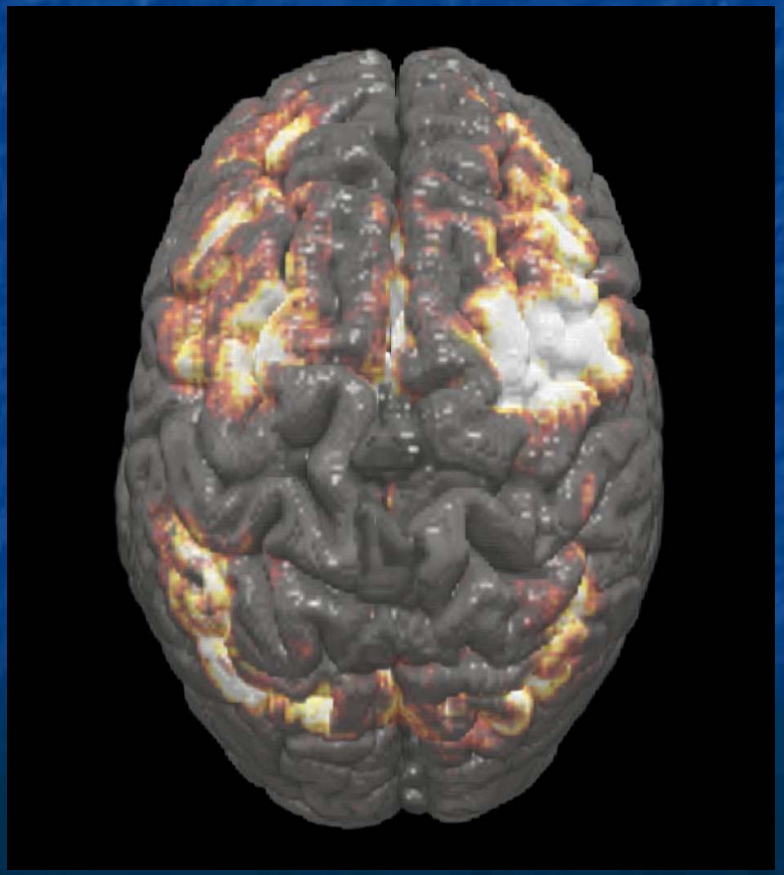
INJURY

PRE-SEASON

When Symptom Free or after 6 weeks

Brain Physiology is Related to Recovery

- ✓ Hyperactivation predicted CLINICAL recovery time
- ✓ Athletes with hyperactivation in frontal lobe within 7 took twice as long to recover (average= 46 days)



How Long Does it Take to Recover?

How Long Does it Take to Recover?

It Depends!!

Risk Factors for Poor Recovery

- Psychiatric History
- Personal or family HX of headache
- LD
- Repetitive (cumulative) effects of injury
- Age
- Gender?

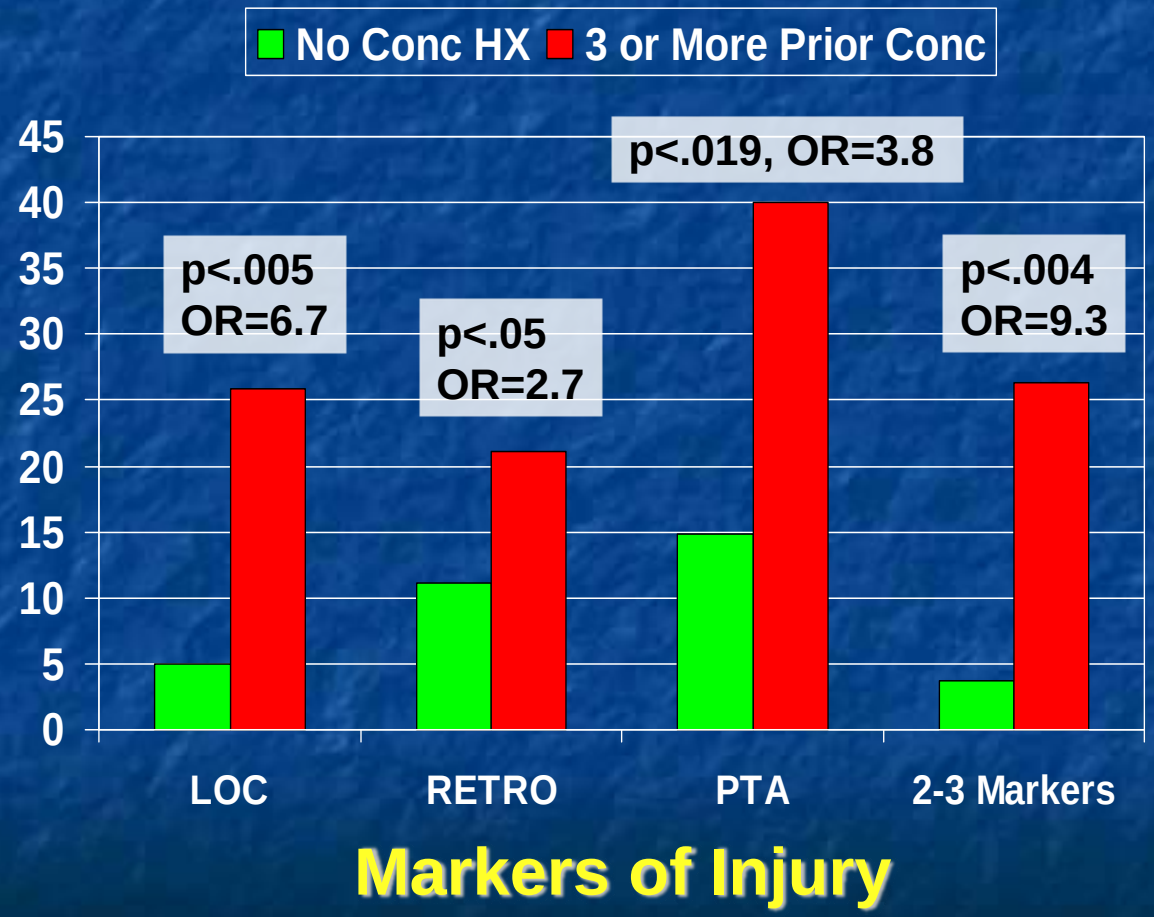
Cumulative Effects of Repetitive Injury

- *Past studies have suggested that repetitive trauma in athletes is associated with poorer outcome.*

- ✓ Athletes with 3 or more mTBI's were 3 times more likely to have an additional injury (Guskiewicz et al, JAMA, 2003)
- ✓ Athletes with 3 or more prior mTBI's were more likely to demonstrate markers of concussion during the period of our study (Collins, Lovell et al., Neurosurgery,

On-Field Severity Markers of Concussion as Determined by Concussion History

Percentage of Athletes Demonstrating On-Field Markers of Injury



Collins MW, Lovell MR, Iverson GL, Cantu et al; Neurosurgery 51:1175-81, 2002

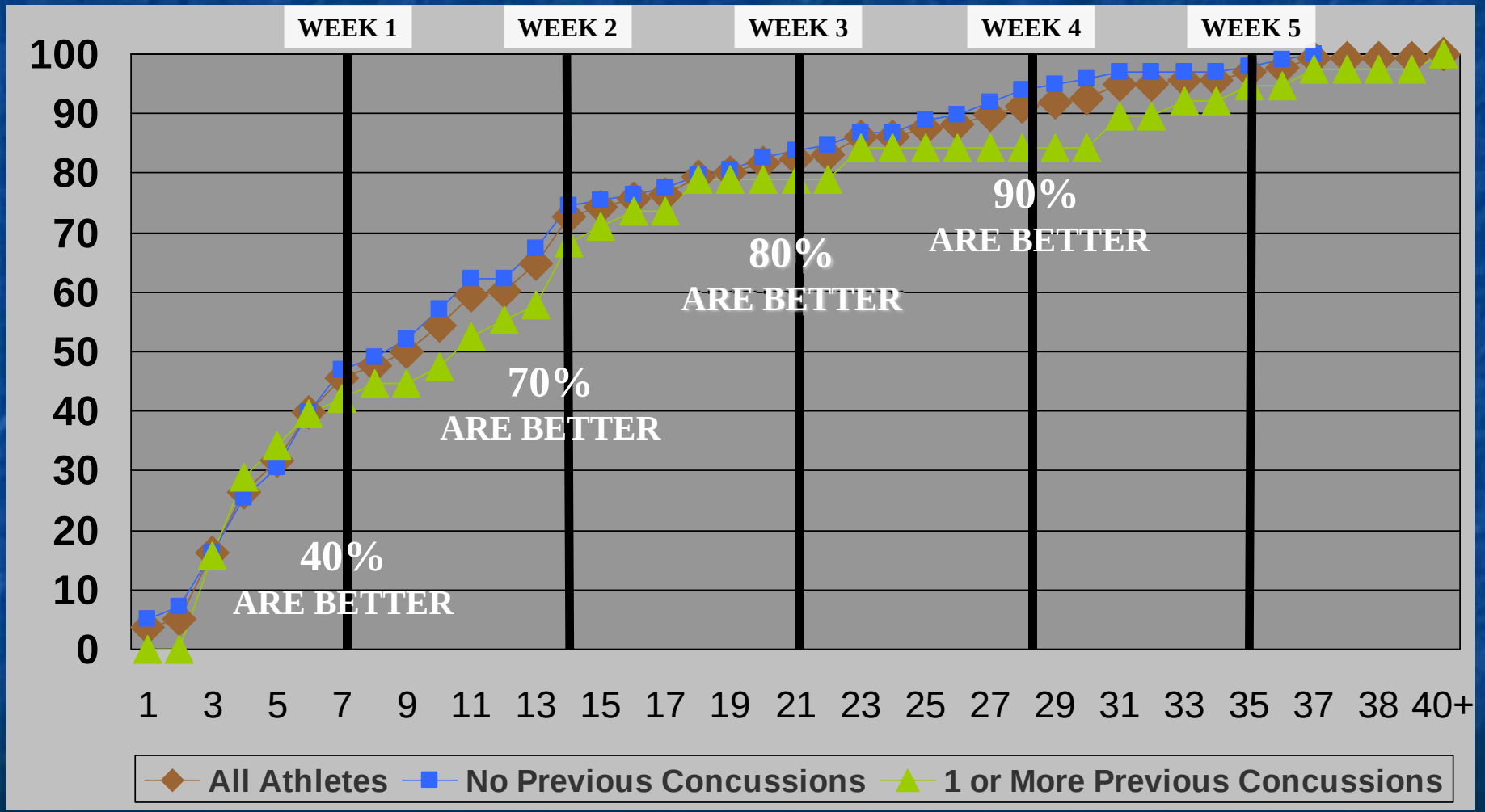
Age and Recovery from mTBI

- *Younger age has been associated with prolonged recovery.*

- ✓ High school athletes had prolonged recovery times compared to college athletes (Field et al., J. Pediatrics, 2004).
- ✓ High school athletes demonstrated longer lasting memory deficits compared to college athletes (Sim et al., J. Neurosurgery, 2008)
- ✓ High school athletes had prolonged recovery times compared to NFL athletes (Pellman, Lovell et al.,Neurosurgery, 2003).

Recovery From Concussion In HS Boys

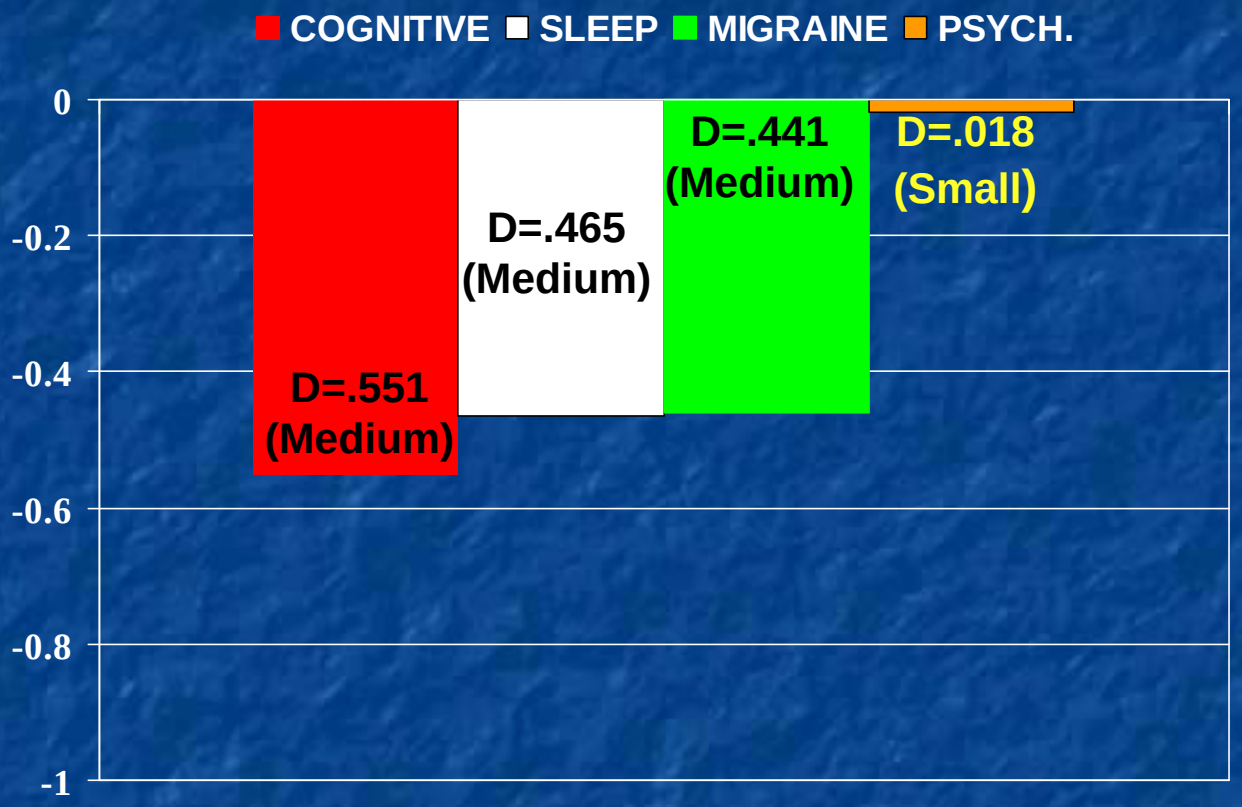
How Long Does it Take?



N=134 High School Male Football Athletes

Collins et al., 2006, Neurosurgery

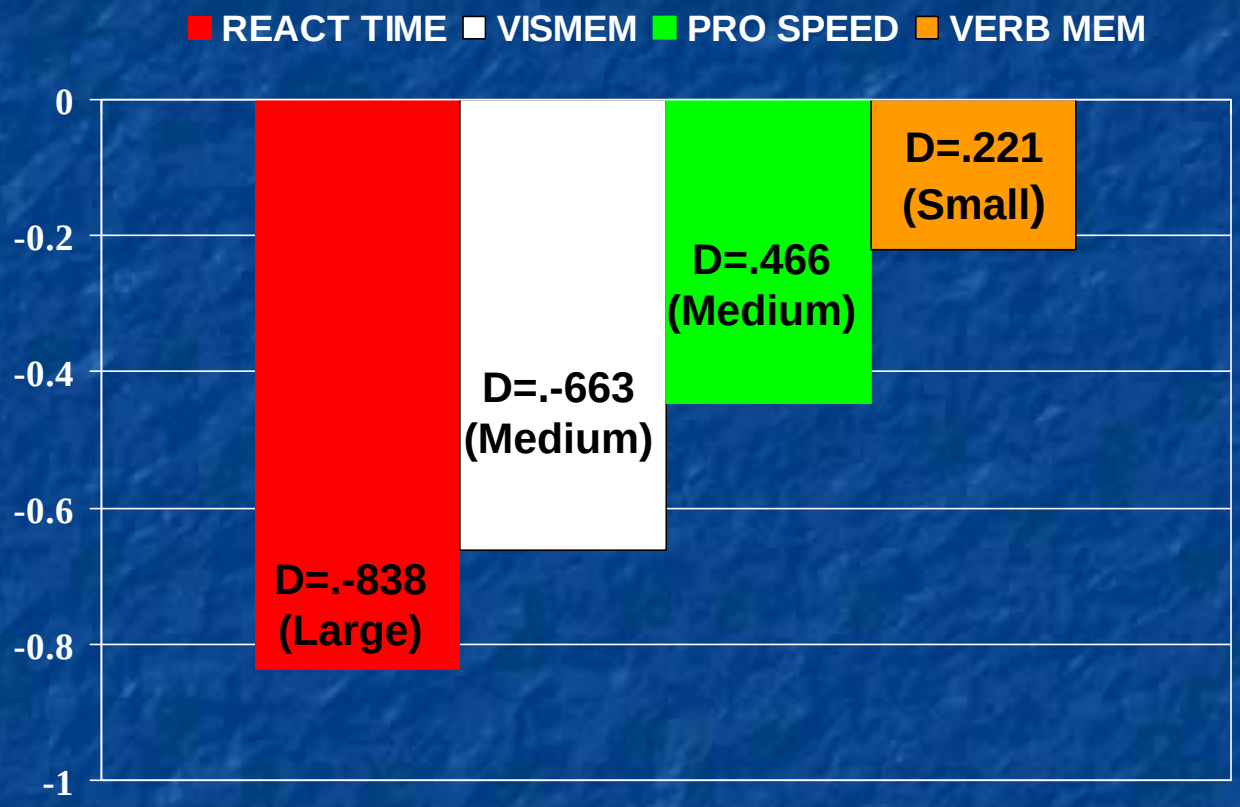
SYMPTOM PREDICTORS OF PROLONGED RECOVERY
(Greater than 10 days to Recovery)



Scores represent comparison of “Quick” and “Slow” (> 10 days) recovery groups.
Effect Sizes compare poor recovery to good recovery groups. (Cohen’s D)

Lau, Lovell, Collins et al. 2008

ImPACT PREDICTORS OF PROLONGED RECOVERY
(Greater than 10 days to Recovery)



Scores reflect Z scores that compare initial post-injury performance to baseline
Effect Sizes compare poor recover to good recovery groups. (Cohen's D)

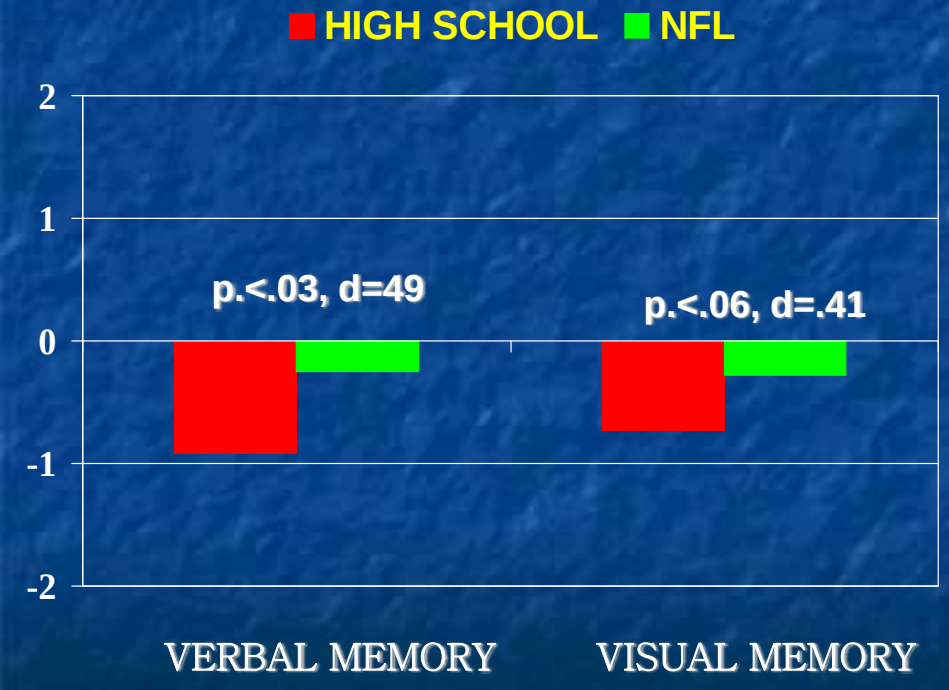
Lau, Lovell, Collins et al. 2008

High School vs. NFL Athletes

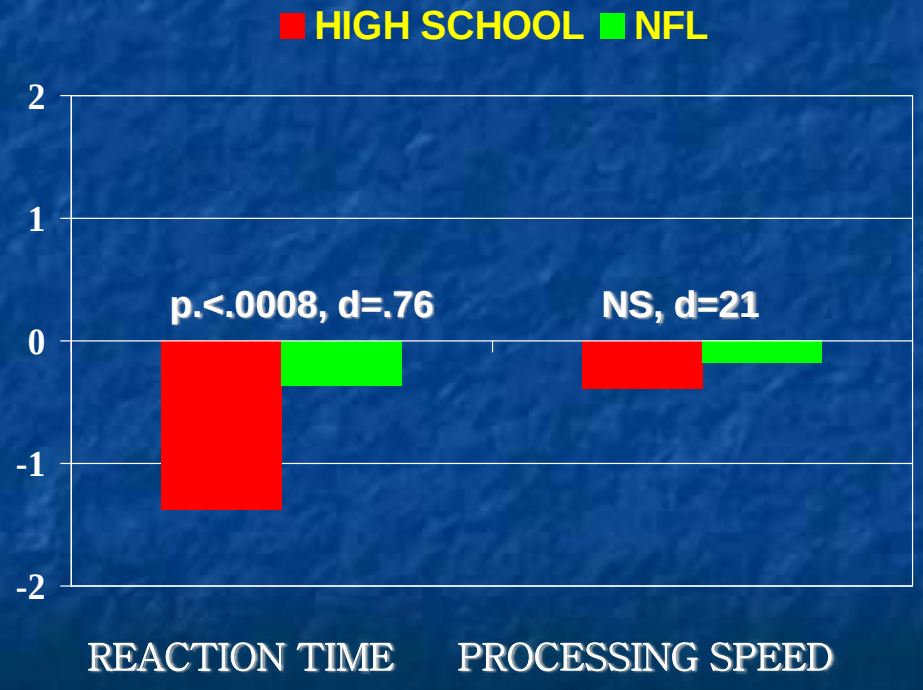
TEST PERFORMANCE AT FIRST FOLLOW-UP

Within 2 days for Pro's 3 days for HS

MEMORY MEASURES



SPEED MEASURES



Pellman, Lovell et al., Neurosurgery, 2006

Gender and Recovery from mTBI

- *Initial studies have suggested that females may be at greater risk compared to males.*

- ✓ In sports played by both sexes, females sustained a a higher rate of mTBI than males (Comstock et al, JAT, 2007). Based on high school and NCAA data.

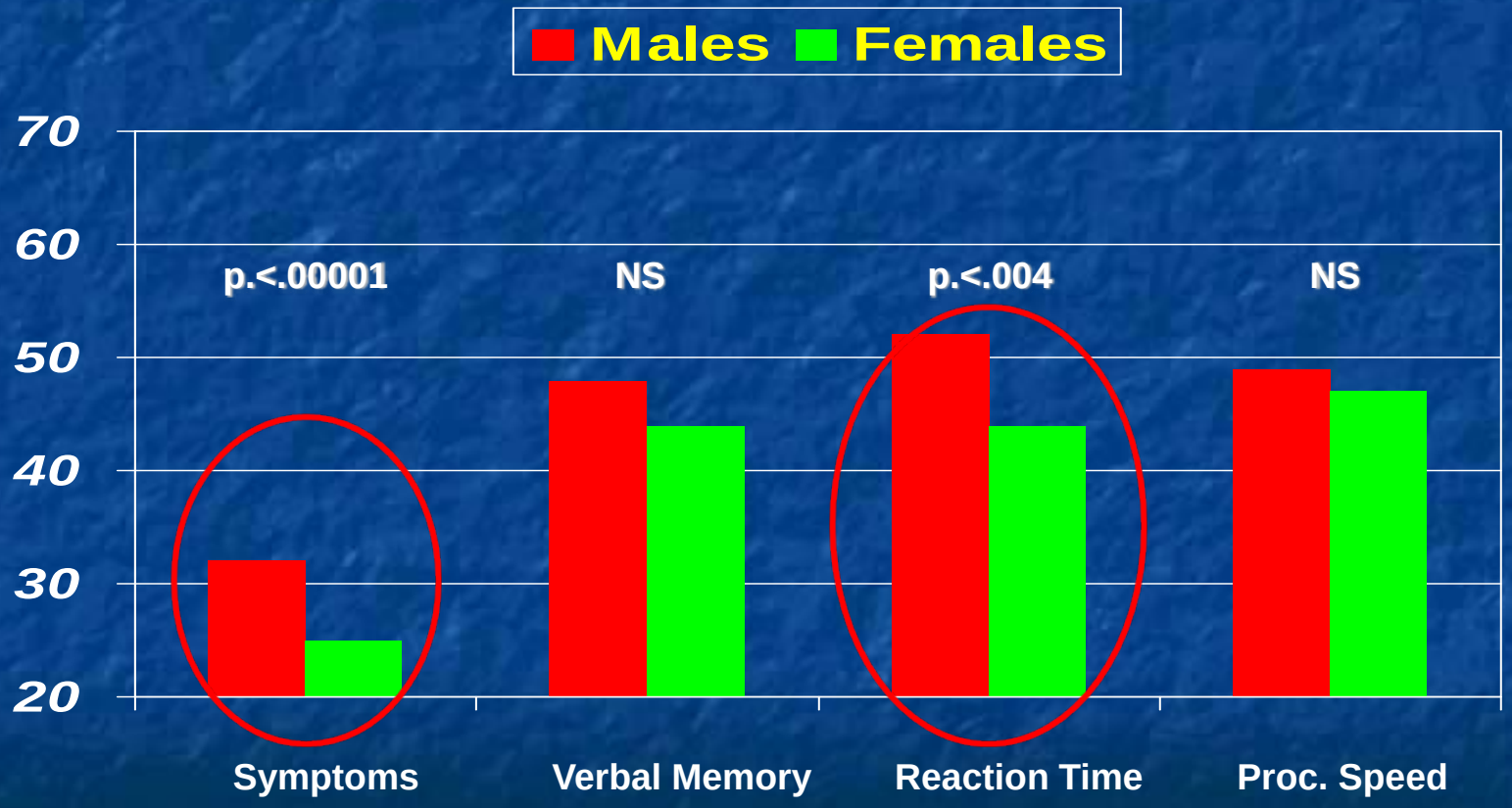
- ✓ In a large sample of Junior high, HS and Collegiate soccer athletes, females had longer recovery time than males (Colvin, Lovell et al., *in press, AJSM*).

Neuropsychological Test Performance

Male vs. Female Athletes

T Scores with Mean of 50 and S.D. of 10

(Colvin, Lovell et al., AOSSM, 2008)



N=238 (143 Females, 95 Males)

Groups were not different at baseline and were matched for age and BMI

CLINICAL MANAGEMENT OF MTBI

UPMC Return to Play Protocol
Stage ONE Sideline Testing

- On-field Assessment
  - ✓ Signs/Symptoms Evaluation
  - ✓ Neurologic Examination
  - ✓ Mental Status Testing
    - Orientation, Concentration, Anterograde / Retrograde Amnesia
- Symptoms May Worsen with Exertion
- Serial Evaluation Necessary
- Any Positive Findings Preclude Return to Play

UPMC Return to Play Protocol
Stage TWO Follow Up Evaluation

1. Neuropsychological Assessment, Clinical Evaluation

- Evaluation should occur in first few days after concussion

  - ✓ Assessment includes Clinical Interview and ImPACT, balance assessment
  - ✓ Follow-up evaluations can occur approx every 5-7 days or longer as cases determine

2. Return to Baseline (or estimated preinjury status)

- Symptom data
- Vestibular assessment (Space-motion discomfort?)
- Cognitive data

3. Progress to Exertion/Practice (carefully assess symptoms)

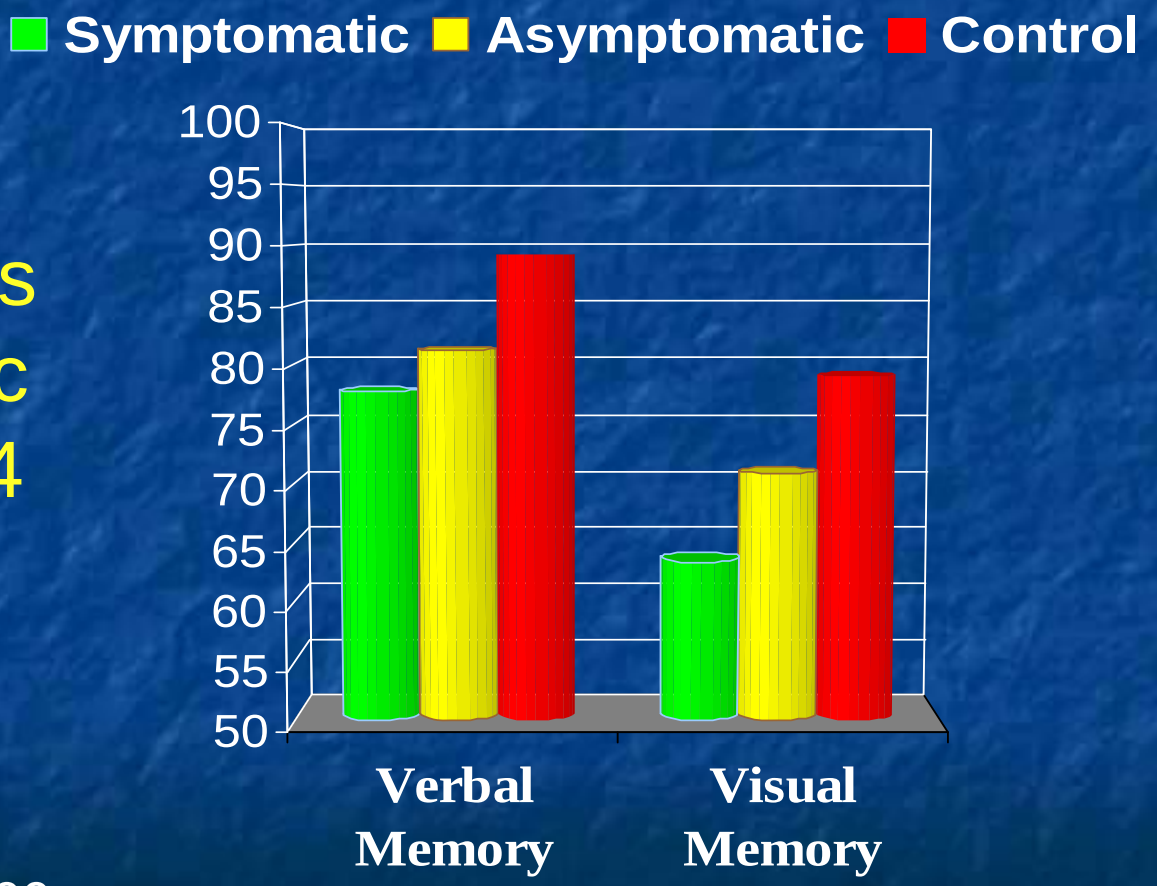
4. Return to Competition

The Value Added of Neuropsychological Testing?

Pressure to Play in Sports:
Can We Trust What the Athlete Tells Us?

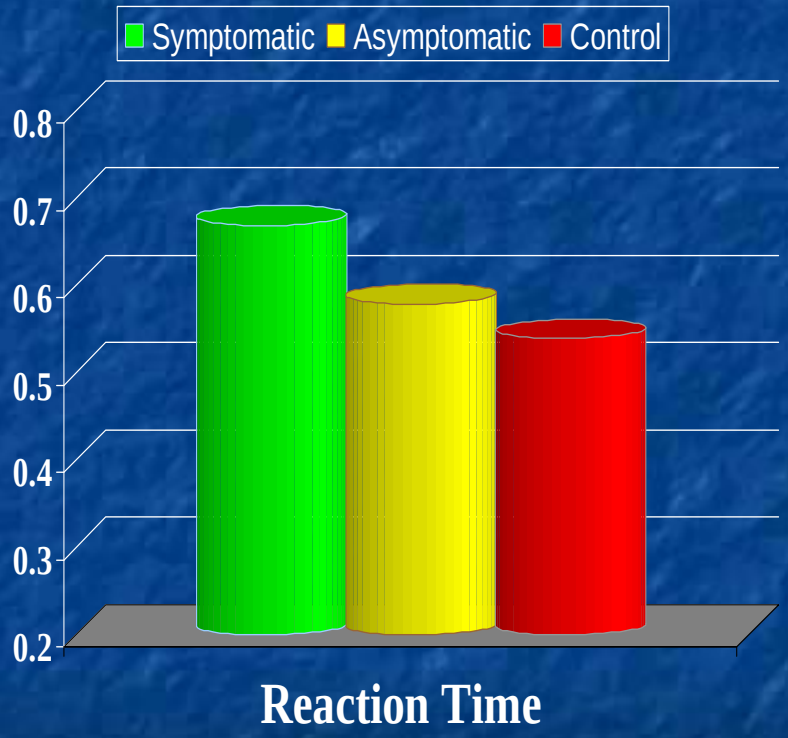
Unique Contribution of Neurocognitive Testing to Concussion Management

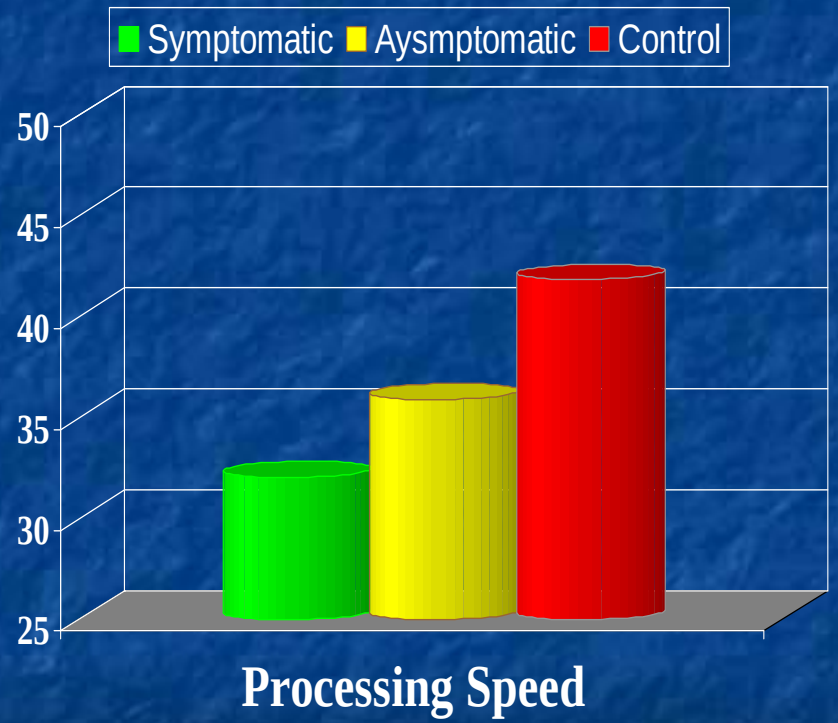
Testing reveals cognitive deficits in asymptomatic athletes within 4 days post-concussion



N=215, MANOVA p<.000000
(Fazio, Lovell et al., NeuroRehabilitation, 2006)

Unique Contribution of Neurocognitive Testing to Concussion Management





MANOVA p<.000000 (ImPACT Test Battery)

UPMC TREATMENT PHILOSOPHY

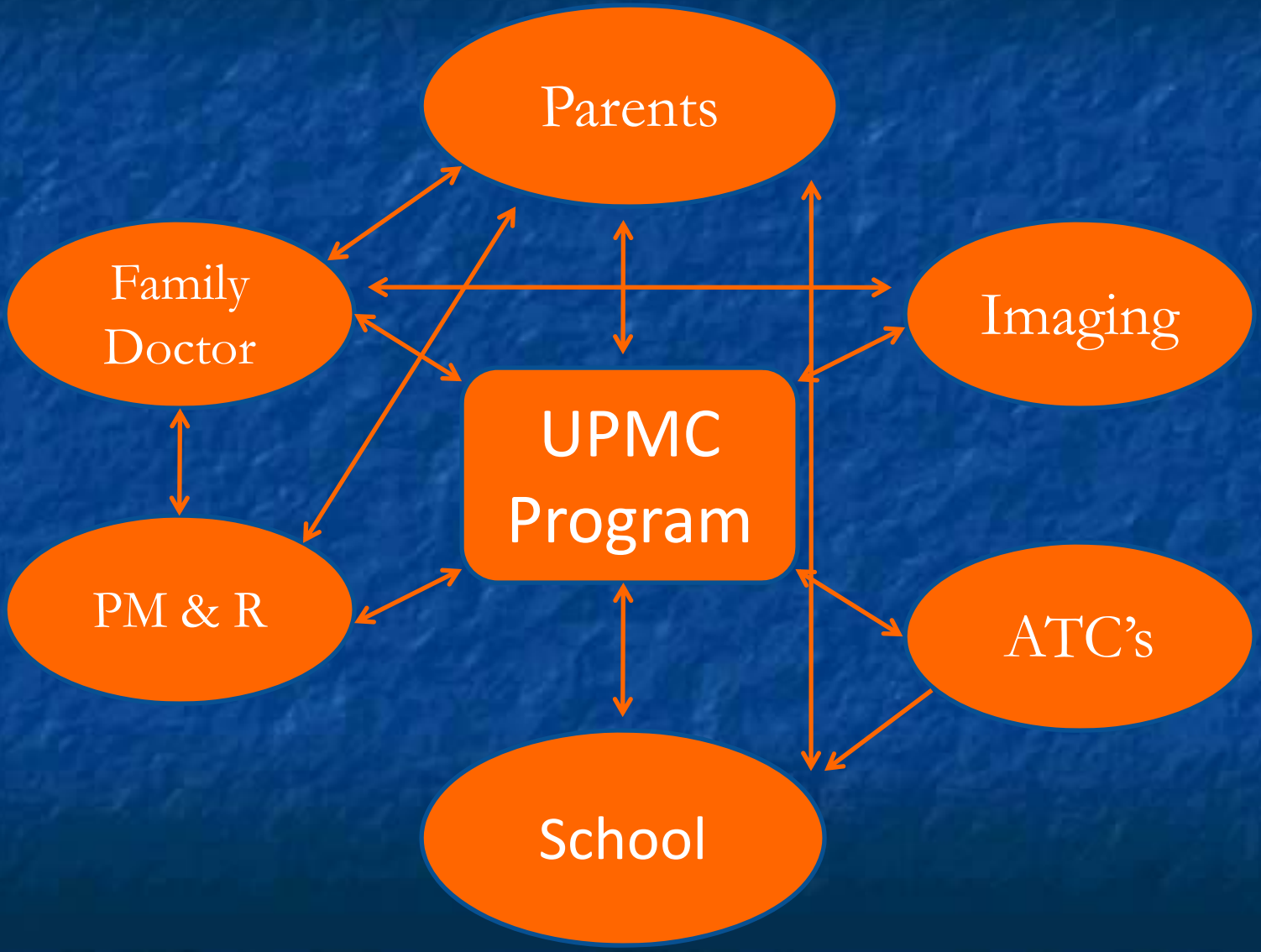
- Initial treatment through rests/removal
- Approximately 85% return to normal
- 15% of patient's do not recover on own (within 3 to 4 weeks)

✓ Interface with schools

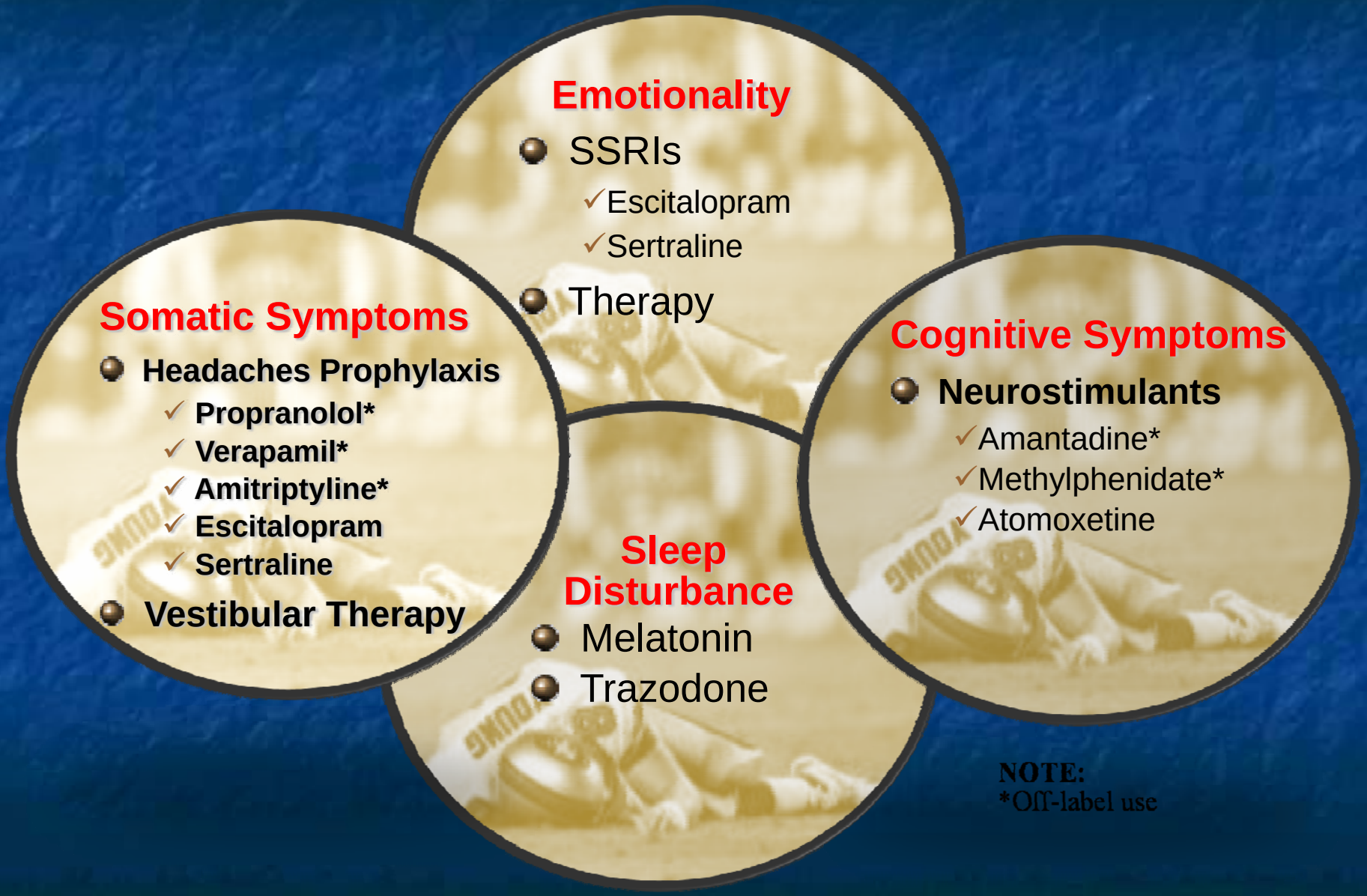
✓ Medical Management

✓ Vestibular/balance therapy

The UPMC Multidisciplinary Approach



UPMC Concussion Program
Treatment/Rehabilitation Protocol



NOTE:
*Off-label use

SUMMARY and TAKE HOME POINTS

- Sports is an excellent laboratory
- Scientific developments occurring rapidly
- Initial management of injury is key
- Multi-modal assessment recommended
- More aggressive multi-disciplinary management is needed in some case
- Continued study of long-term effects needed


THANK YOU
lovellmr@upmc.edu