The NCAA Perspective on the Relationship Between Head Trauma and CTE

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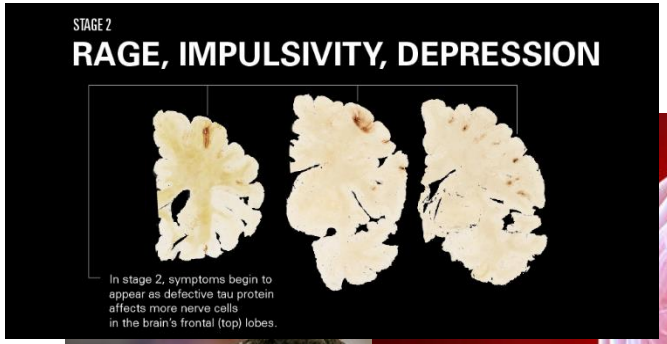
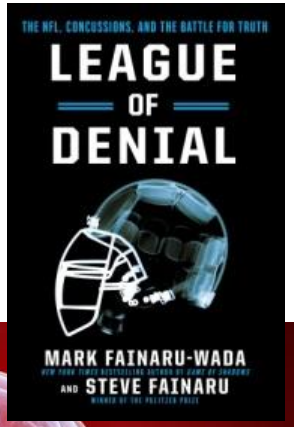
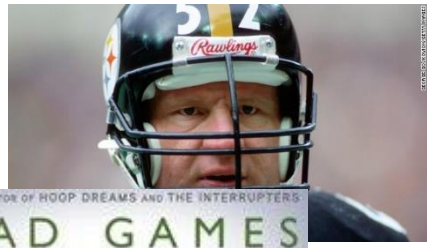
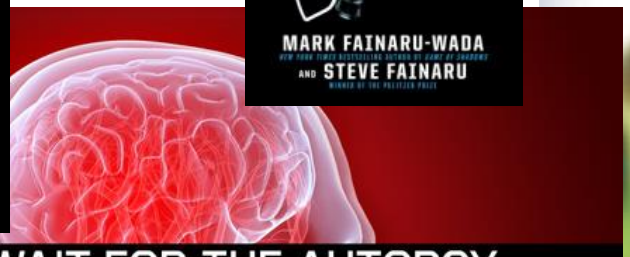
NeuroTrauma Research Laboratory

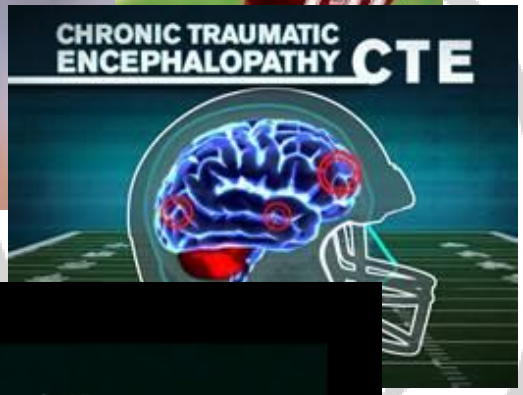
A manufactured crisis?

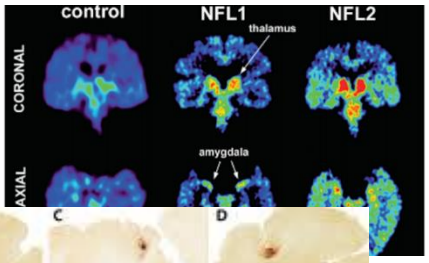


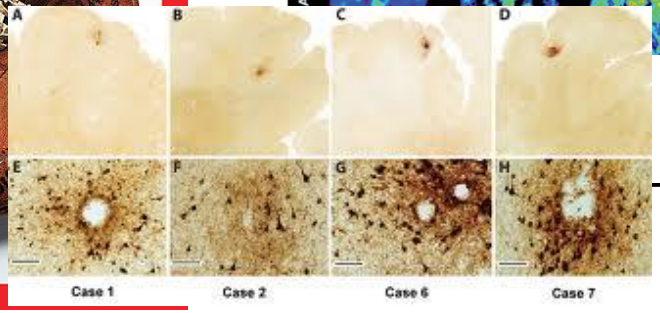












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How did we get here?

The Retired Athlete Studies

- 758 retired professional American football athletes
  - 53.8 (13.4) years old
  - 6.6 (3.6) years professional career
  - At least one concussion - 61%
  - Three or more concussions - 24%

- Significant association between multiple concussions and
  - MCI
  - Memory impairments (self-report)
  - Depression

- When compared to non-concussed, those with 3+ have:
  - 5x prevalence of MCI
  - 3x prevalence of significant memory problems

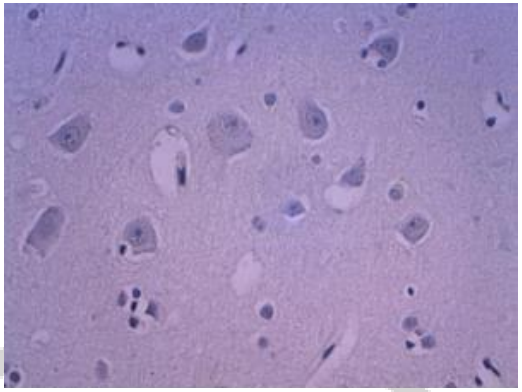
- Earlier onset of Alzheimer's disease in concussed retirees

Guskiewicz Neurosurgery 2005
Guskiewicz Med Sci Sport Exerc, 2007

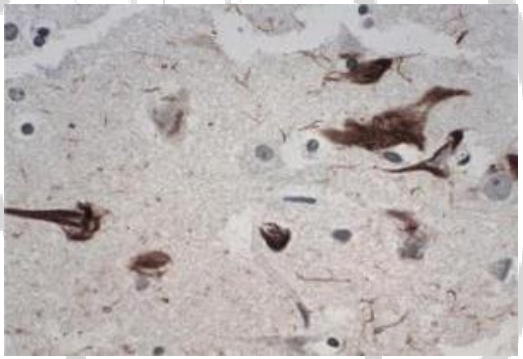
Concussions and Chronic Traumatic Encephalopathy

- Two case studies of cerebral autopsies of retired athletes
  - With recurrent concussion history
  - Depression related suicide deaths

- Abnormal Tau deposition, neurofibrillary tangles and neuropil threads present upon examination



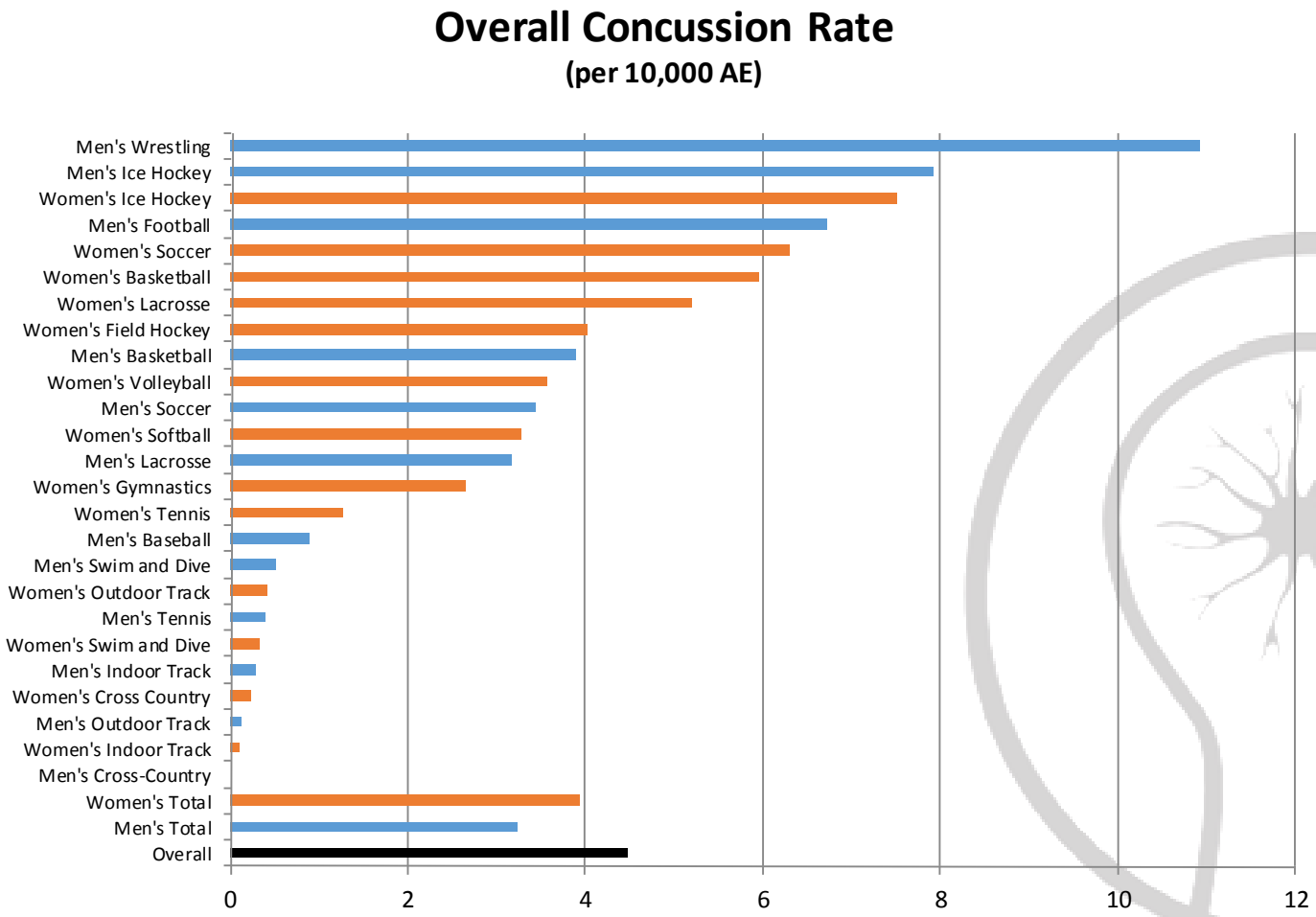
x600 magnification of immunostained neocortex in normal cerebral tissue.



x600 magnification of tau-immunostained neocortex showing neurofibrillary tangles, neuritic threads, and several ghost tangles

Omalu, Neurosurgery, 2005& 2006

Football is not the only culprit



Zuckerman, AJSM 2015

Female athletes

- Higher rates
- Longer recovery

~75% of military concussions are unrelated to combat (Cameron *J Neuro Trauma*, 2012)

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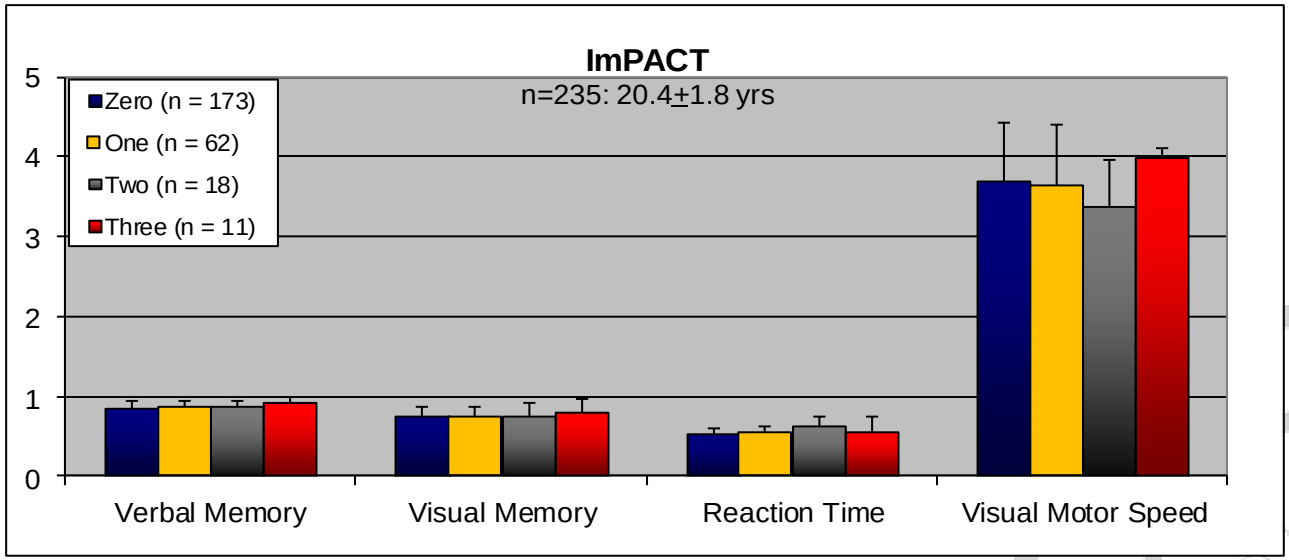
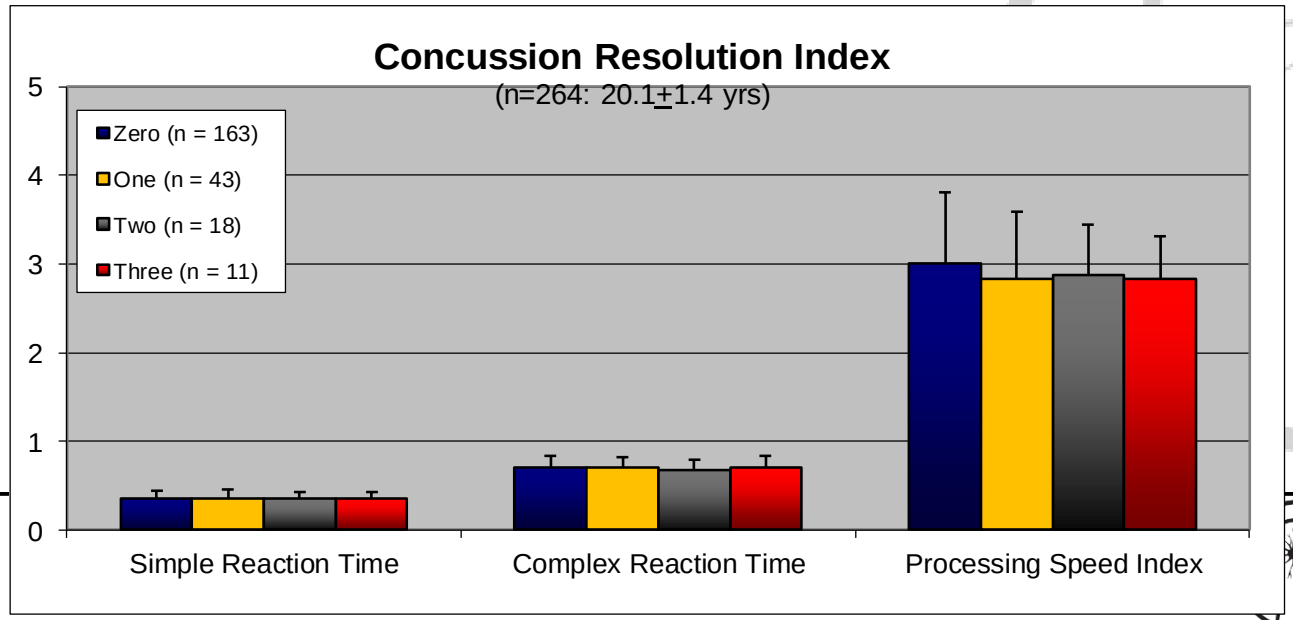
Cognitive function and concussion





Broglio, *Br J Spts Med, 2006*
Funding: Kindig Research Award

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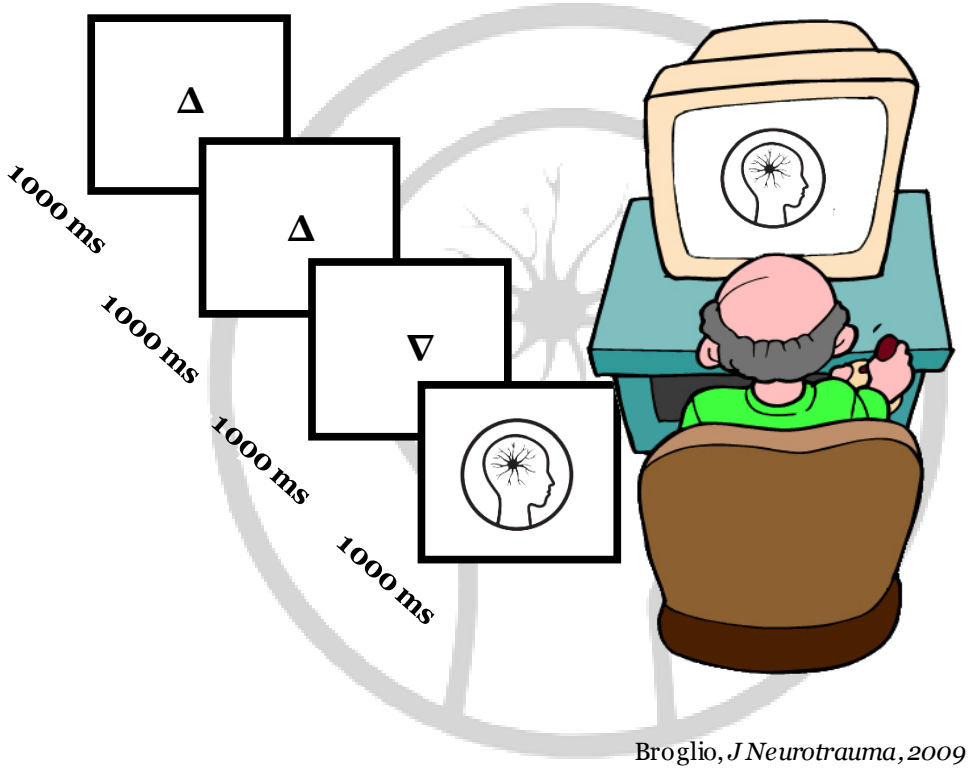
Electrophysiology and concussion

	0 Concussions	1+ Concussions
n	44	46
Age (Years)	19.41 ± 1.28	20.04 ± 1.17
Height (m)	1.72± 0.09	1.76 ± 0.07
Weight (kg)	77.72 ± 12.51	80.84 ± 12.42
Mean # Concussions	--	1.65 ± 0.97
Time From Last Injury (yrs)	--	3.21 ± 2.90



Tasks

- Clinical assessment - ImPACT
- Novelty Oddball Task with ERPs

Broglio, *J Neurotrauma, 2009*

Funding: Mary Jane Neer Foundation

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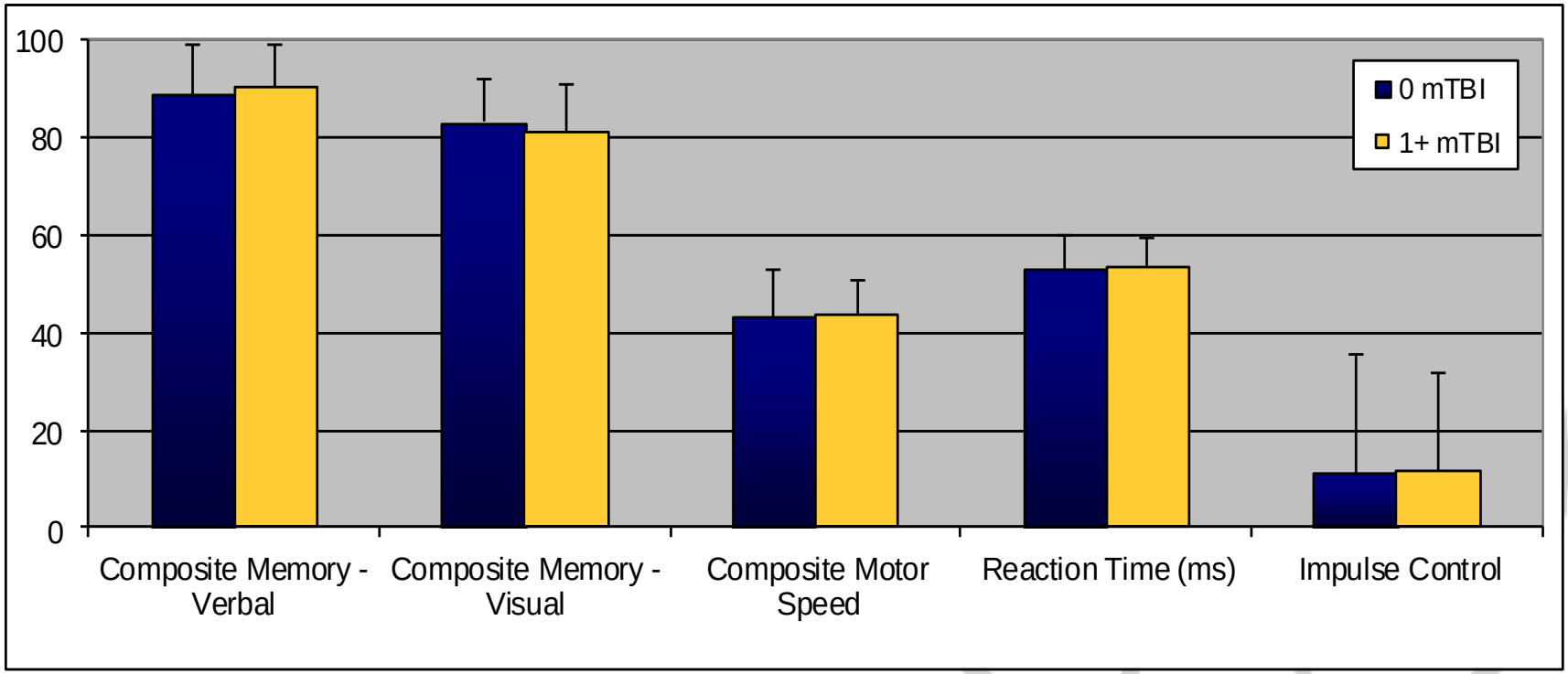
Electrophysiology and concussion



No significant differences between groups ($p>0.05$)

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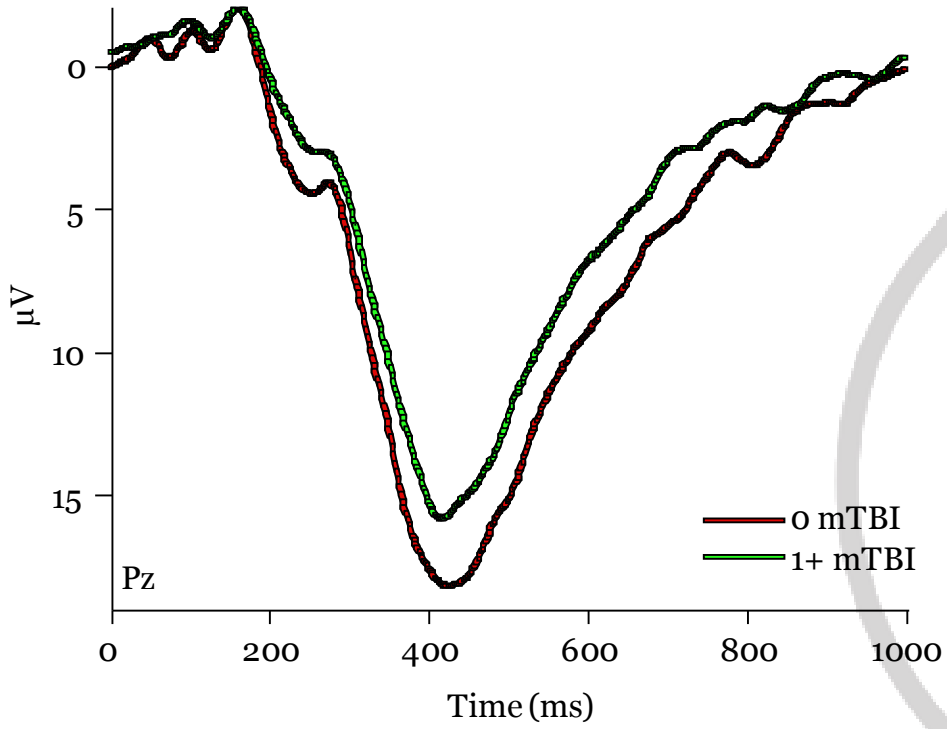
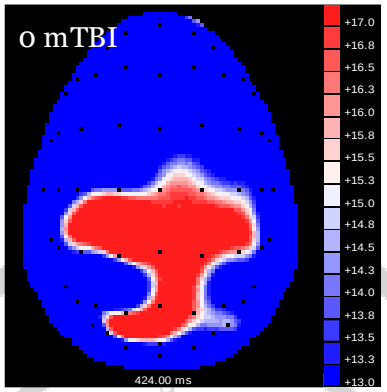
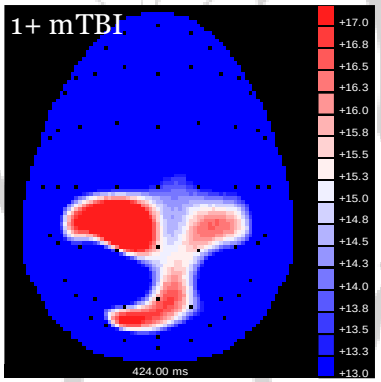
Electrophysiology and concussion
-expected picture



P3b amplitude differences between groups ($p<0.05$)





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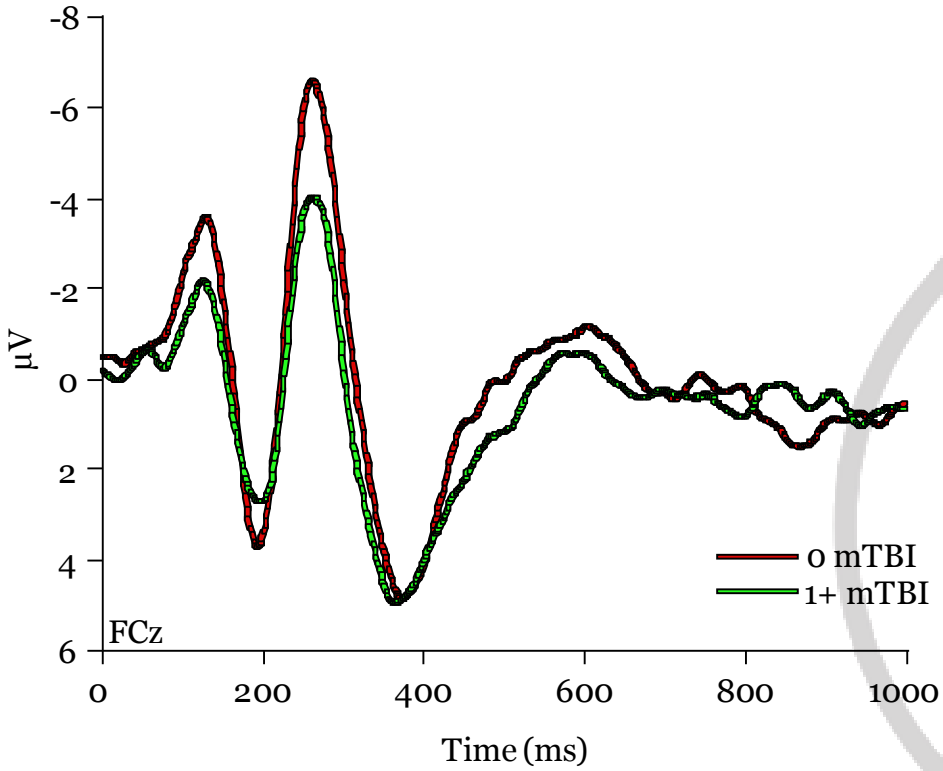
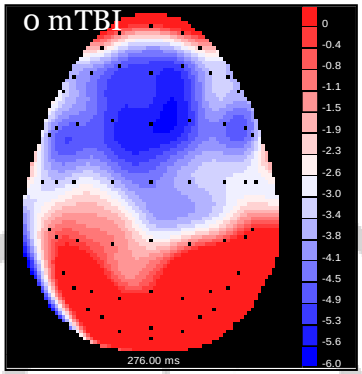
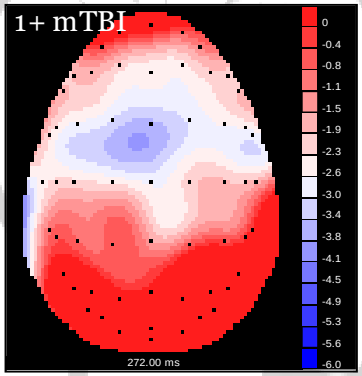
Electrophysiology and concussion
-unexpected picture







N2 amplitude differences between groups ($p<0.05$)

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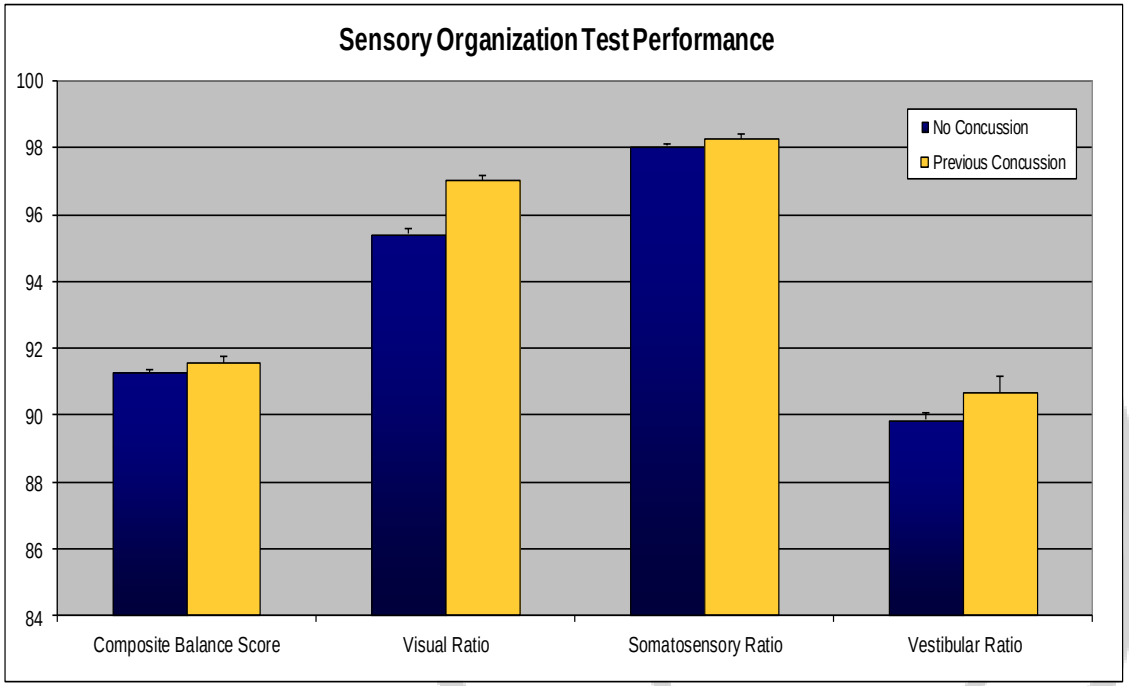
Balance and concussion



- Previous concussion: n = 64
  - 1 mTBI = 53
  - 2 mTBIs = 6
  - 3 mTBIs = 4
  - 4 mTBIs = 1
- Median 2.91 yrs prior

No concussion: n = 163

Sosnoff, *J Athl Train*, 2011

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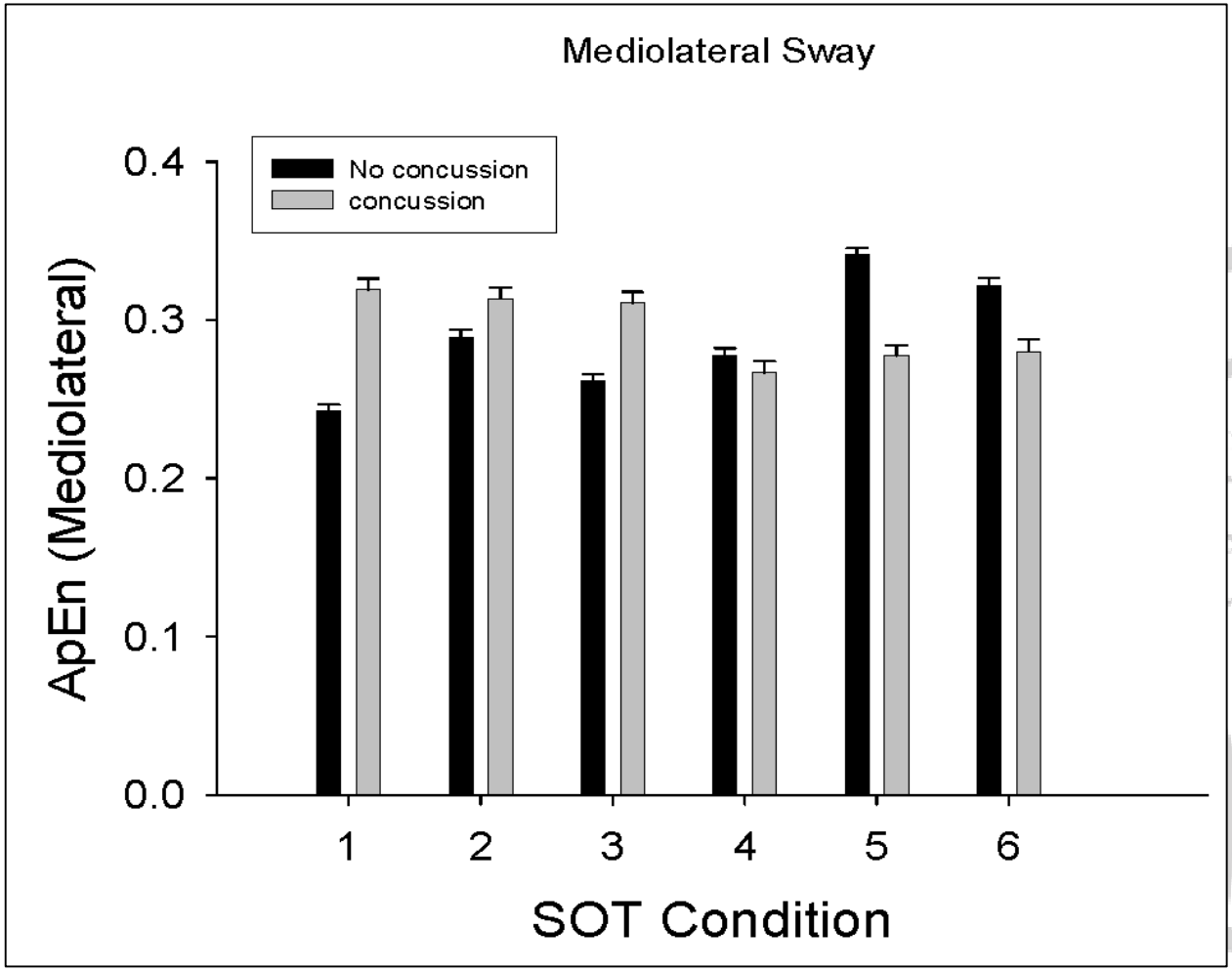
Balance and concussion



- Sway variability, as measured by approximate entropy(ApEn), reveals groups differences

Gait and concussion

	Concussed (n=28)	Non-Concussed (n=40)
Male	17	20
Female	11	20
Age (yrs)	21.0	20.7
Height (cm)	173.6	169.2
Weight (kg)	78.1	72.0
Previous # Concussion	2.0	--
Time from Injury (yrs)	6.3	--

Tasks

- Gait (3.6m) with and without .5m obstacles
- Brooks Mental Task while walking and seated

	8	7	6
	1	2	5
		3	4

Martini et al, *Arch Phys Med*, 2011

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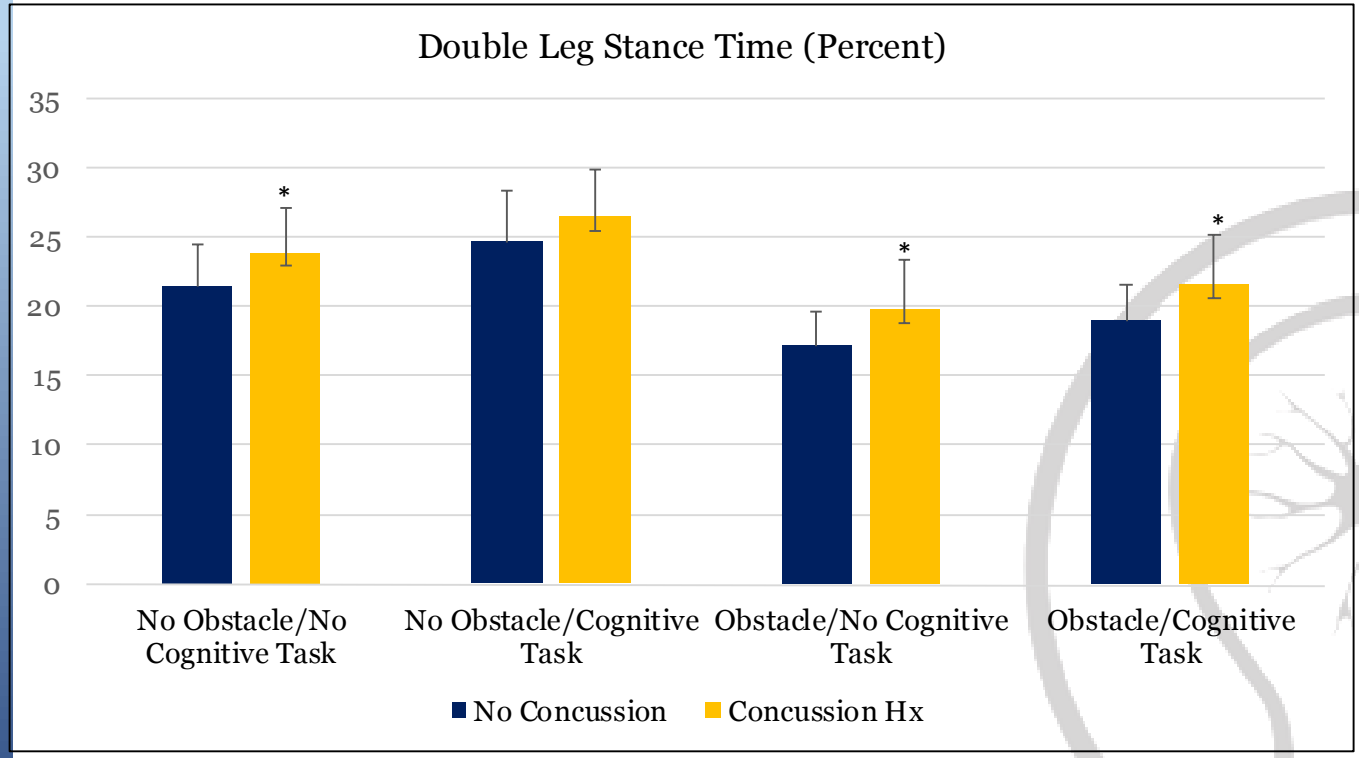
Gait and concussion



No group differences:

- Gait velocity
- Step length
- Stride width
- Brooks task accuracy

* Significant differences between groups ($p<0.05$)

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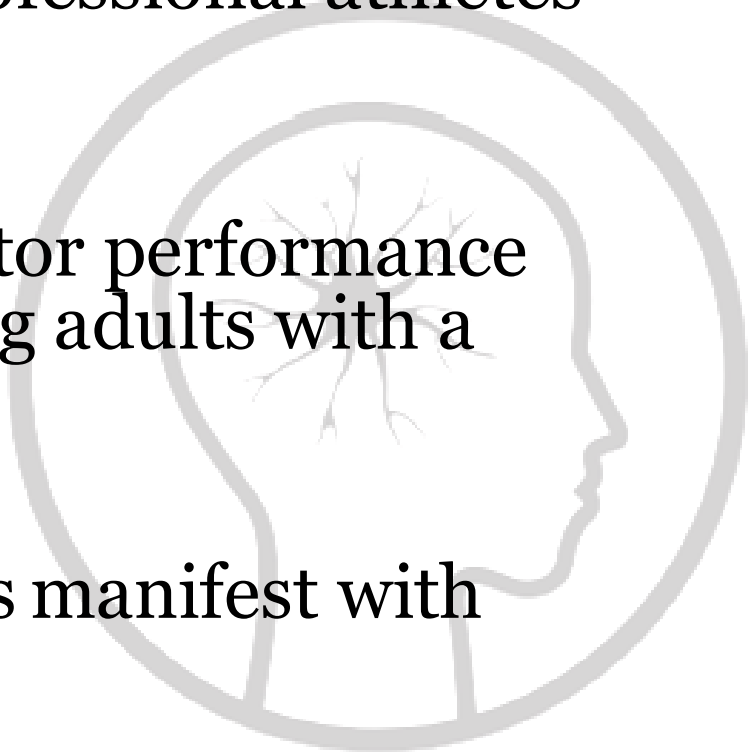
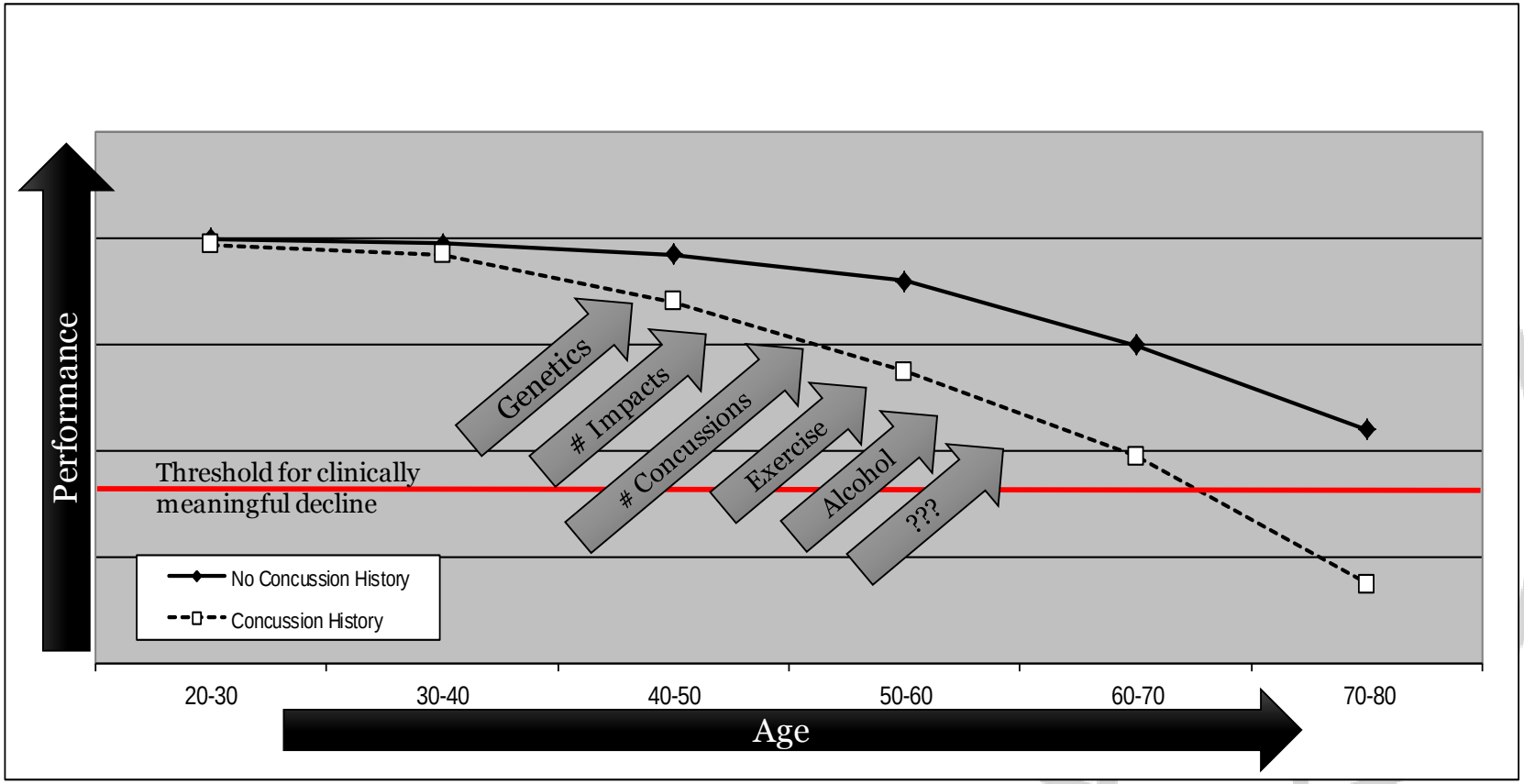
Summary

- Behavioral, cognitive, and neurological deterioration reported in professional athletes with concussion history
- Subtle physiological and motor performance alterations observed in young adults with a concussion history
- How do these subtle changes manifest with age?



The accelerated decline hypothesis



Broglio, Ex Sport Sci Rev, 2012

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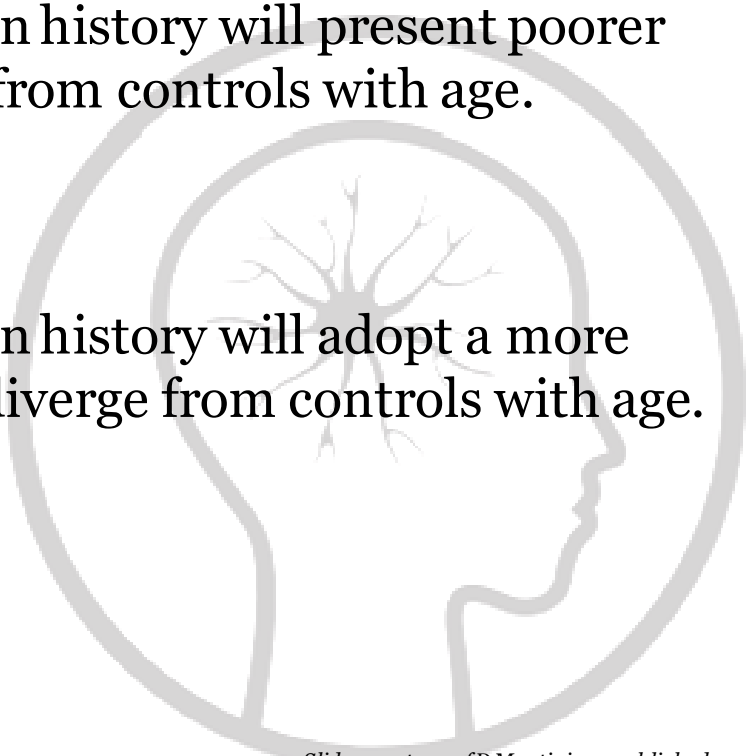
Motor and cognitive performance across the lifespan

- Aim 1: Cognitive Function
  - Hypothesis: Those with a concussion history will present poorer cognitive function that will diverge from controls with age.

- Aim 2: Gait Performance
  - Hypothesis: Those with a concussion history will adopt a more conservative gait strategy that will diverge from controls with age.



Slide courtesy of D Martini, unpublished, 2015

Funding: NATA-REF

Motor and cognitive performance across the lifespan

	20 Year Olds		40 Year Olds		60 Year Olds	
	Control (n = 27)	Concussed (n = 19)	Control (n = 15)	Concussed (n = 4)	Control (n = 16)	Concussed (n = 9)
Sex (% male)	44	47	47	75	44	88
Age (yrs)	23.41 (8.09)	20.26 (1.63)	45.13 (3.38)	47.25 (3.50)	63.50 (3.52)	63.75 (5.04)
Height (cm)	171.94 (8.94)	173.19 (9.74)	171.33 (11.67)	180.98 (10.24)	169.62 (10.02)	174.94 (6.29)
Weight (Kg)	68.59 (11.94)	68.74 (14.75)	79.80 (11.14)	94.69 (20.06)	78.35 (14.17)	78.36 (8.38)
Previous # Concussions	.	1.63 (0.68)	.	2.75 (1.71)	.	2.63 (1.92)
Time Since (yrs)	.	5.64 (3.20)	.	23.71 (13.22)	.	49.49 (5.53)

Mean(SD). No significant within age, concussion group differences (p's > .05).

Slide courtesy of D Martini, unpublished, 2015

Funding: NATA-REF

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Cognitive function across the lifespan

	20 Year Olds		40 Year Olds		60 Year Olds	
	Control (n = 26)	Concussed (n = 19)	Control (n = 15)	Concussed (n = 4)	Control (n = 13)	Concussed (n = 7)
Processing Speed	97.97 (4.86)	96.04 (8.22)	97.07 (5.40)	97.45 (6.55)	98.26 (4.75)	96.54 (4.66)
Attention	103.49 (4.63)	104.04 (5.33)	102.56 (4.40)	100.53 (2.87)	102.55 (2.57)	101.77 (2.71)
Learning	103.18 (7.19)	104.52 (4.98)	106.16 (7.91)	101.53 (9.40)	103.95 (7.58)	105.99 (5.19)
Working Memory Speed	101.75 (5.90)	100.42 (7.49)	99.49 (4.34)	94.38 (6.51)	96.10 (3.46)	97.16 (1.96)
Working Memory Accuracy	106.16 (7.55)	102.74 (4.93)	106.38 (8.74)	97.48 (4.37)	102.78 (11.17)	108.86 (7.05)

Mean(SD). No significant within age, concussion group differences (p's > .05).

Slide courtesy of D Martini, unpublished, 2015

Funding: NATA-REF

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Gait across the lifespan

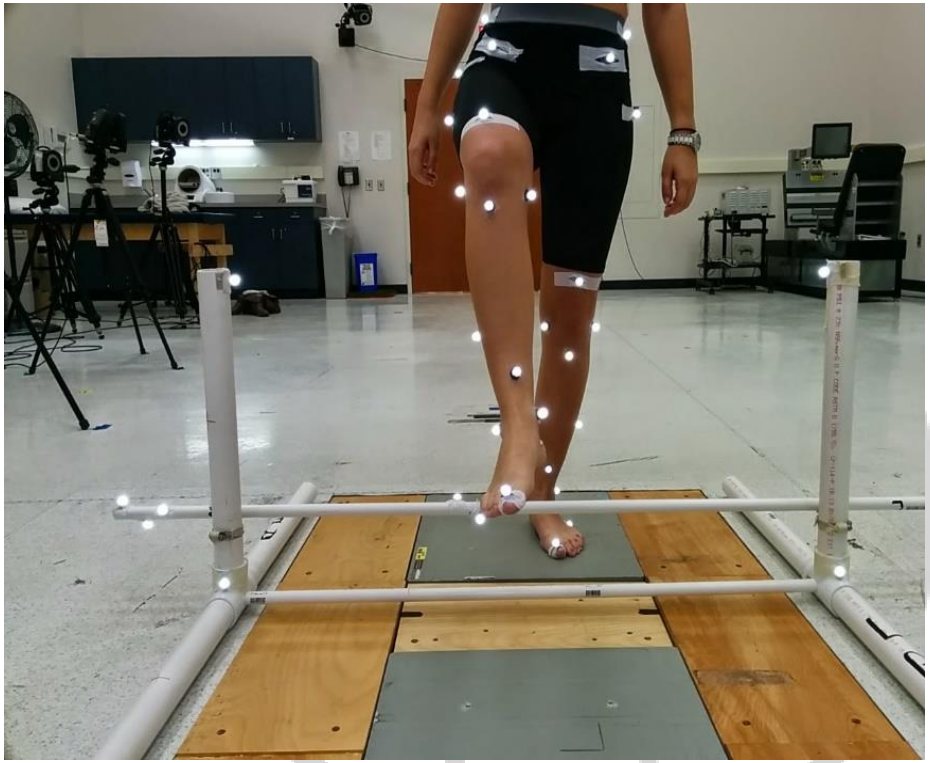
Tasks

10m self-selected pace for:

1. Normal walk
2. Normal walk with Brooks task
3. Obstacle walk
4. Obstacle walk with Brooks task

5 trials per condition

	8	7	6
	1	2	5
		3	4



Slide courtesy of D Martini, unpublished, 2015

Funding: NATA-REF

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Gait across the lifespan

No significant differences for:

- Velocity
  - 3 Conditions
- % time double stance
  - All conditions
- Stride width (m)
  - All conditions
- Stride Length
  - All conditions
- Max ankle plantarflexion
  - All conditions
- Max hip extension
  - 3 Conditions

When significant differences are present, they are inconsistent

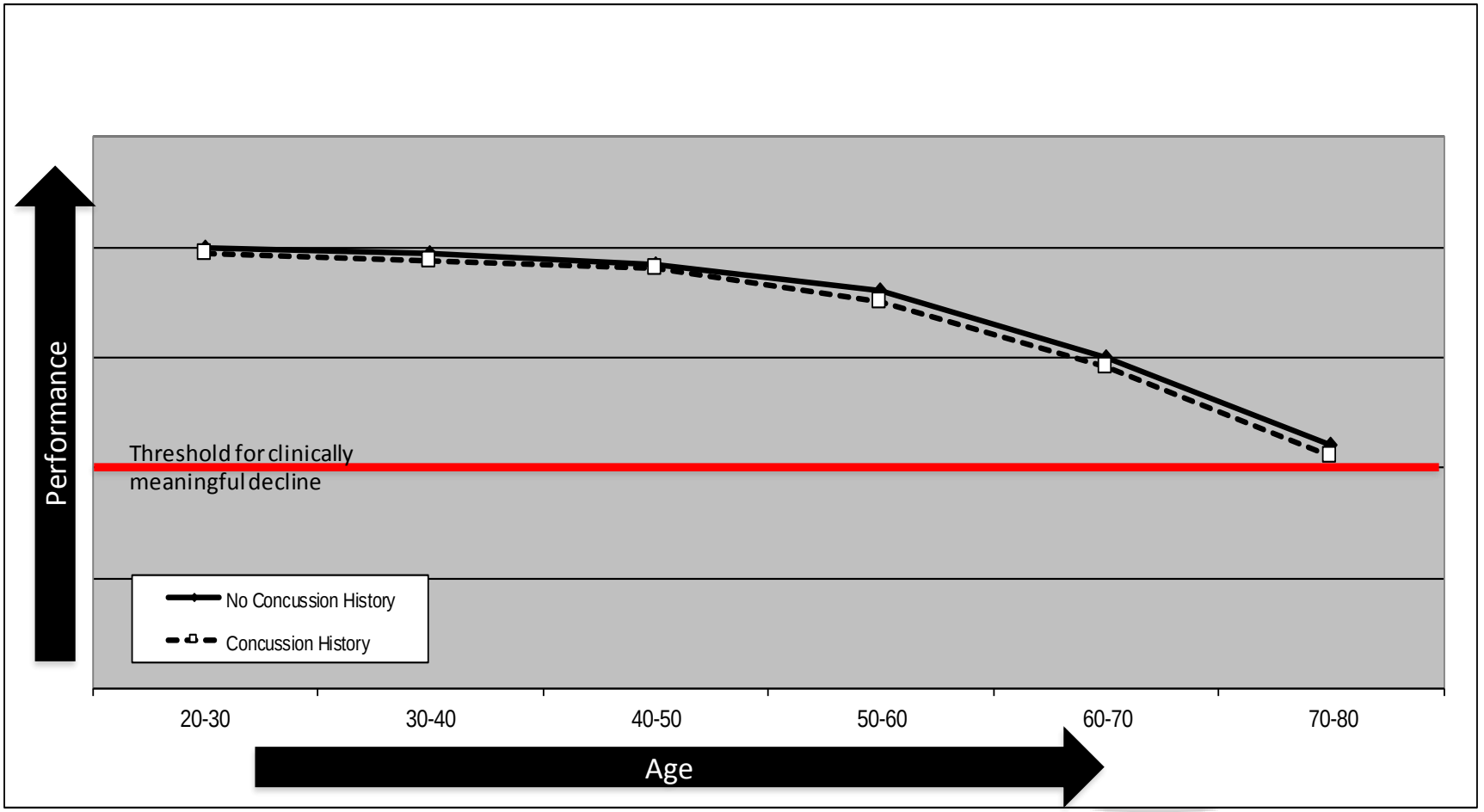
Slide courtesy of D Martini, unpublished, 2015

Funding: NATA-REF

Summary

- No differences in cognitive functioning between concussed/non-concussed groups with age
- No meaningful differences in gait between concussed/non-concussed groups with age
- No distinct pattern in fine motor control to suggest a negative relationship between concussion history and motor performance.

The REVISED accelerated decline hypothesis



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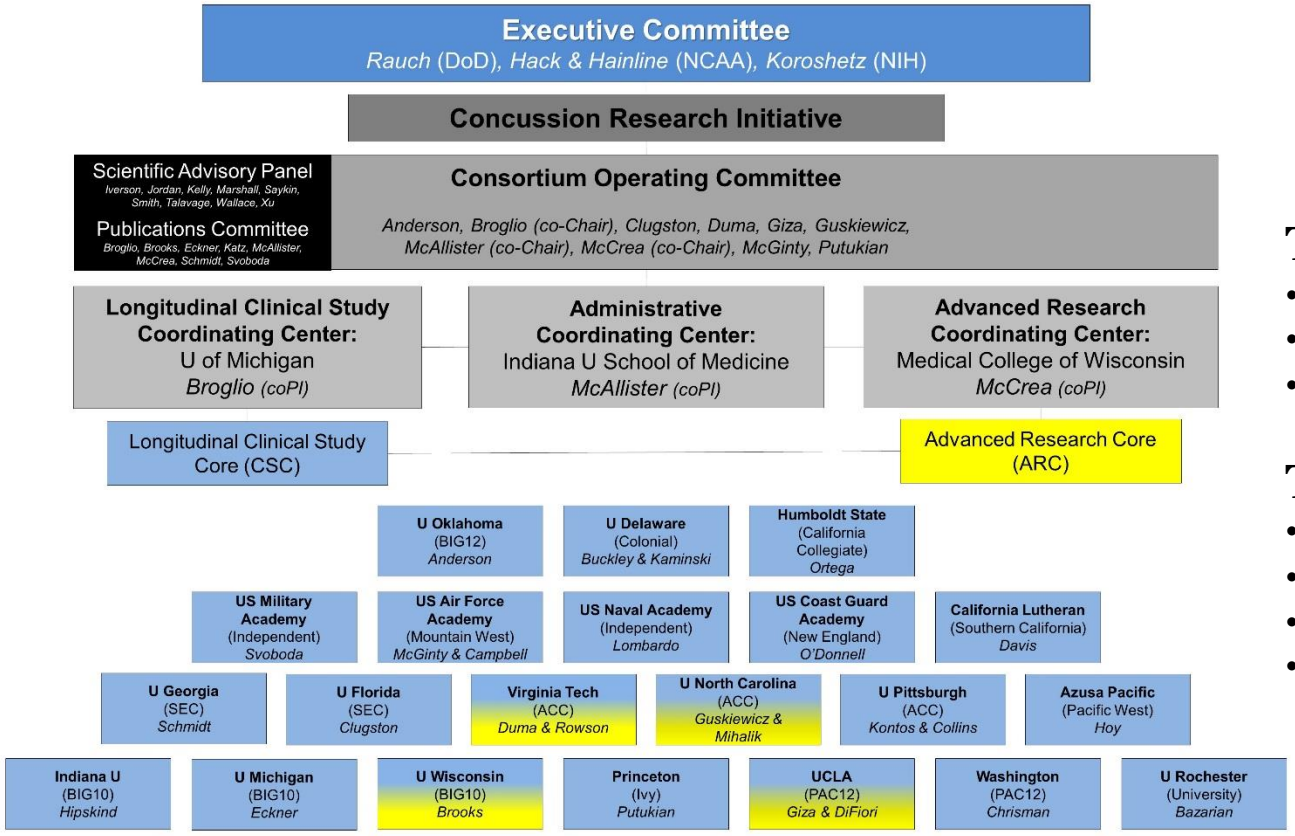
NCAA-DOD Grand Alliance CARE Consortium



The Plan

- 3 Years
- 30 Schools
- 30,000 Athletes & Cadets

To Date

- 16 months completed
- 21 Schools
- ~14,000 Athletes & Cadets
- 398 Concussions

Funding by: National Collegiate Athletic Association & Department of Defense

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Thank You

Funders

- NCAA-DoD: *Grand Alliance – Concussion Assessment, Research and Education Consortium*
- NIH-NINDS (1R15NS081691): *Change in brain function in high school football athletes*
- U Michigan Injury Center/Office of Research: *Chronic effects of concussion on driving*
- NATA-REF: *Long-term effects of neurocognitive functioning and motor control*
- Michigan Injury Center: *The Effect of Transcranial Magnetic Stimulation on Neural Plasticity in Young Adults with a Concussion History*
- NCAA: *National Sport Concussion Outcomes Study*

Colleagues

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  - Undergraduates: *Tony McKeiver, Rebecca Sigourney*
- Indiana University
  - *Tom McAllister, MD*
- Medical College of Wisconsin
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