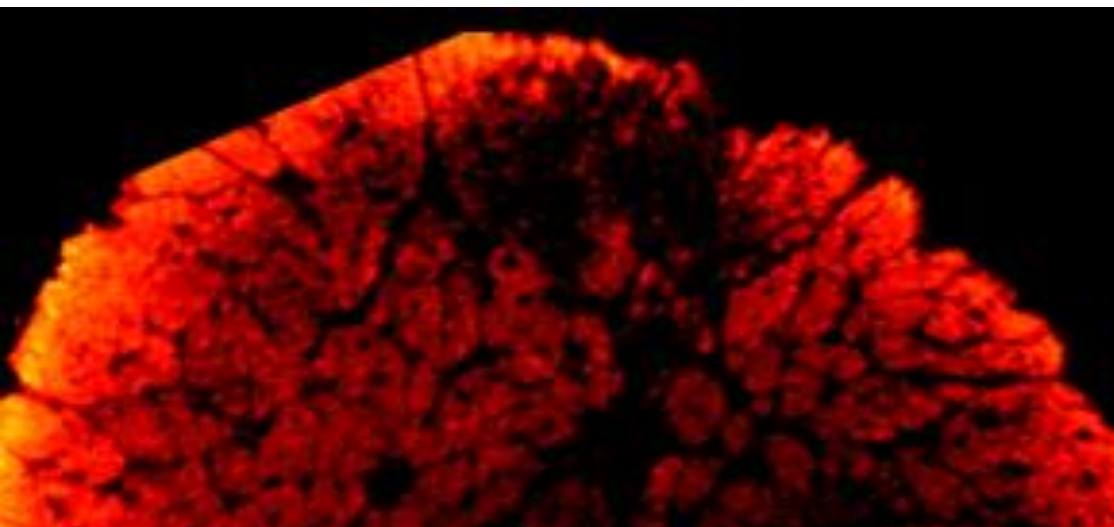




Curtin University



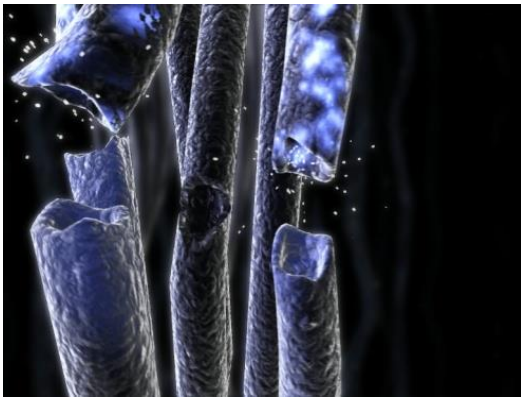
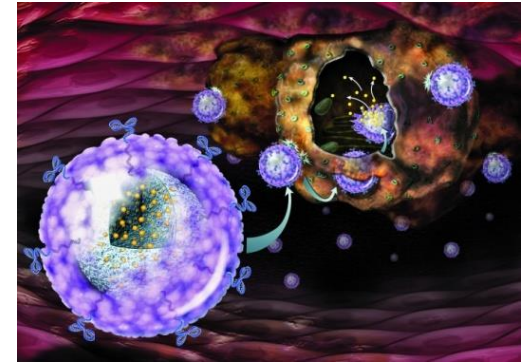
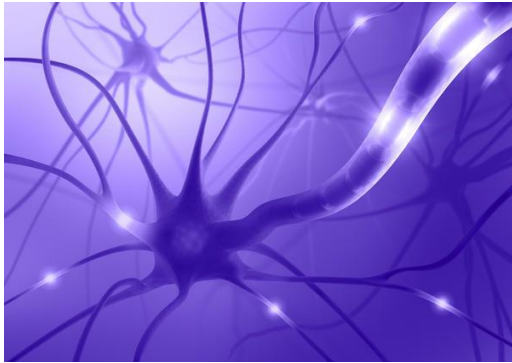
Working Towards Predicting Post-Concussion Syndrome in the ED

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22.11.2018



Neurotrauma Research



Mild Traumatic Brain Injury / Concussion



80-90% of TBIs are concussion

Multiple causes of concussion: falls, vehicle accidents etc.

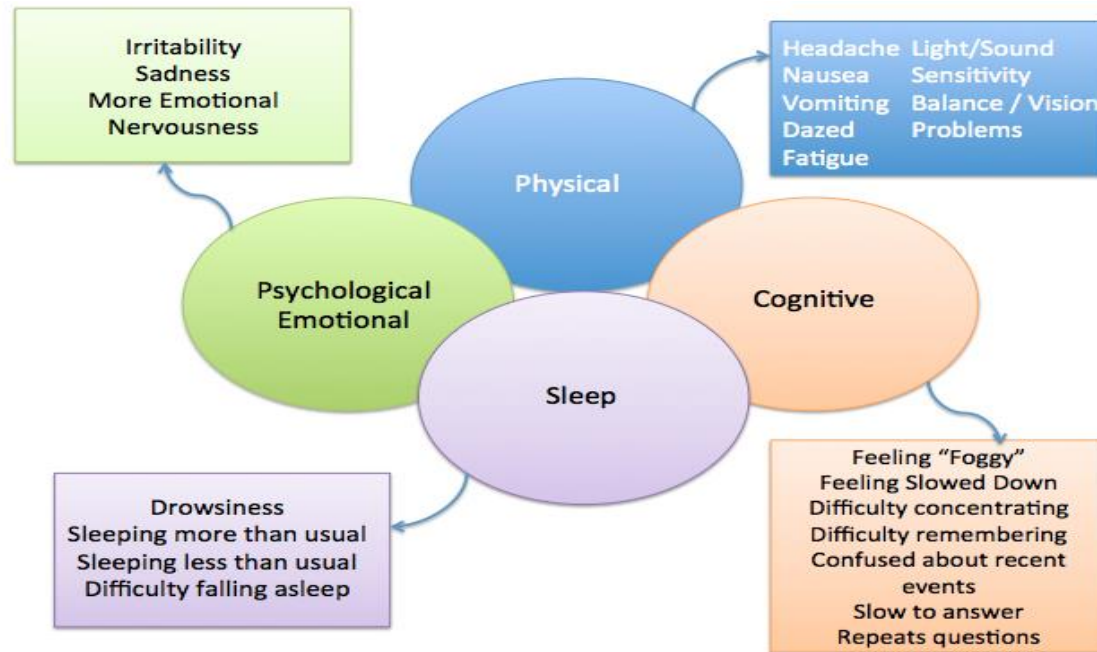
Data on incidence limited:

1 in 4 - 10 people seek medical attention i.e. under-reported

Recent NZ study 790/ 100,000

Indicates 180,000pa in Australia

Concussion and Post-Concussion Syndrome: Symptoms



Adapted from Halstead et al., (2010) *Pediatrics*, 126(3), 597-615.

PCS: prolonged concussion symptoms, 1 – 3 months or longer, up to 20%

Who will go on to develop PCS?

Current Procedures in the ED

[Log in](#) [SIGN UP \(/SIGNUP\)](#)

Paging all new residents!

Check out our guide for PGY-1s.



Go!

Canadian CT Head Injury/Trauma Rule ☆

Clears head injury without imaging.

INSTRUCTIONS

Only apply to:

- [Glasgow Coma Scale \(GCS\)](https://www.mdcalc.com/glasgow-coma-scale-score-qcs) (<https://www.mdcalc.com/glasgow-coma-scale-score-qcs>) 13-15 with LOC
- Amnesia to the head injury event
- Confusion

Exclusion Criteria:

- Age <16
- Blood thinners
- Seizure after injury

When to Use ▼

Pearls/Pitfalls ▼

Why Use ▼

High Risk Criteria: Rules out need for neurosurgical intervention

GCS <15 at 2 hours post-injury

No 0

Yes +1

Suspected open or depressed skull fracture

No 0

Yes +1

Neurosurgical problem?
CT scan?



Follow-up...

Mild brain injury discharge advice (for adults)

You have had a mild brain injury, often called a concussion.

Most people will make a full recovery. You should start to feel better in a few days and be back to normal in a few weeks. In a very small number of cases, serious complications can develop in the first 24 hours after the injury.

**Make sure you
go home in the
care of an adult.**

Warning signs: the first 24 hours after injury

If you or your carer notices any of these symptoms, see your local doctor immediately, go to the hospital's emergency department or call triple zero (000):

- feeling faint or drowsy
- cannot be woken up
- acting strangely, saying things that do not make sense
- have a constant severe headache or a headache that gets worse
- cannot remember new events, recognise people or places
- pass out or have a blackout or a seizure
- cannot move parts of your body
- clumsiness
- have blurred vision or slurred speech
- have fluid or bleeding from the ear or nose
- have loss of hearing
- vomiting more than twice

When should I return to the hospital emergency department?

Sometimes serious problems develop after a head injury. Return immediately to the emergency department if you experience any of the following symptoms:

- Repeated vomiting
- Headache that gets worse and does not go away
- Loss of consciousness or unable to stay awake during times you would normally be awake
- Getting more confused, restless, or agitated
- Convulsions or seizures
- Difficulty walking or difficulty with balance
- Weakness or numbness
- Difficulty with your vision

Most of all, if you have any symptom that concerns you, your family members, or friends,
don't delay, see a doctor right away.

Prediction of Outcome

Prediction of PCS in the ED would be helpful:

- reduce redundant imaging

- enable individualised patient prognosis

- focus on neurorehabilitation strategies to enhance outcomes

- indicate need for more intensive monitoring

Pilot Study to Predict PCS

Prof Daniel Fatovich, A/ Prof Carmela Pestell, A/Prof Mike Bynevelt, Dr Melissa Licari, PhD candidate Ola Gozt

Recruited 62 patients from RPH ED, and age/gender matched controls for baseline

No one outcome likely to be predictive

- demographic information, symptom assessment
- neuropsychological tests, blood biomarkers, MRI at T0

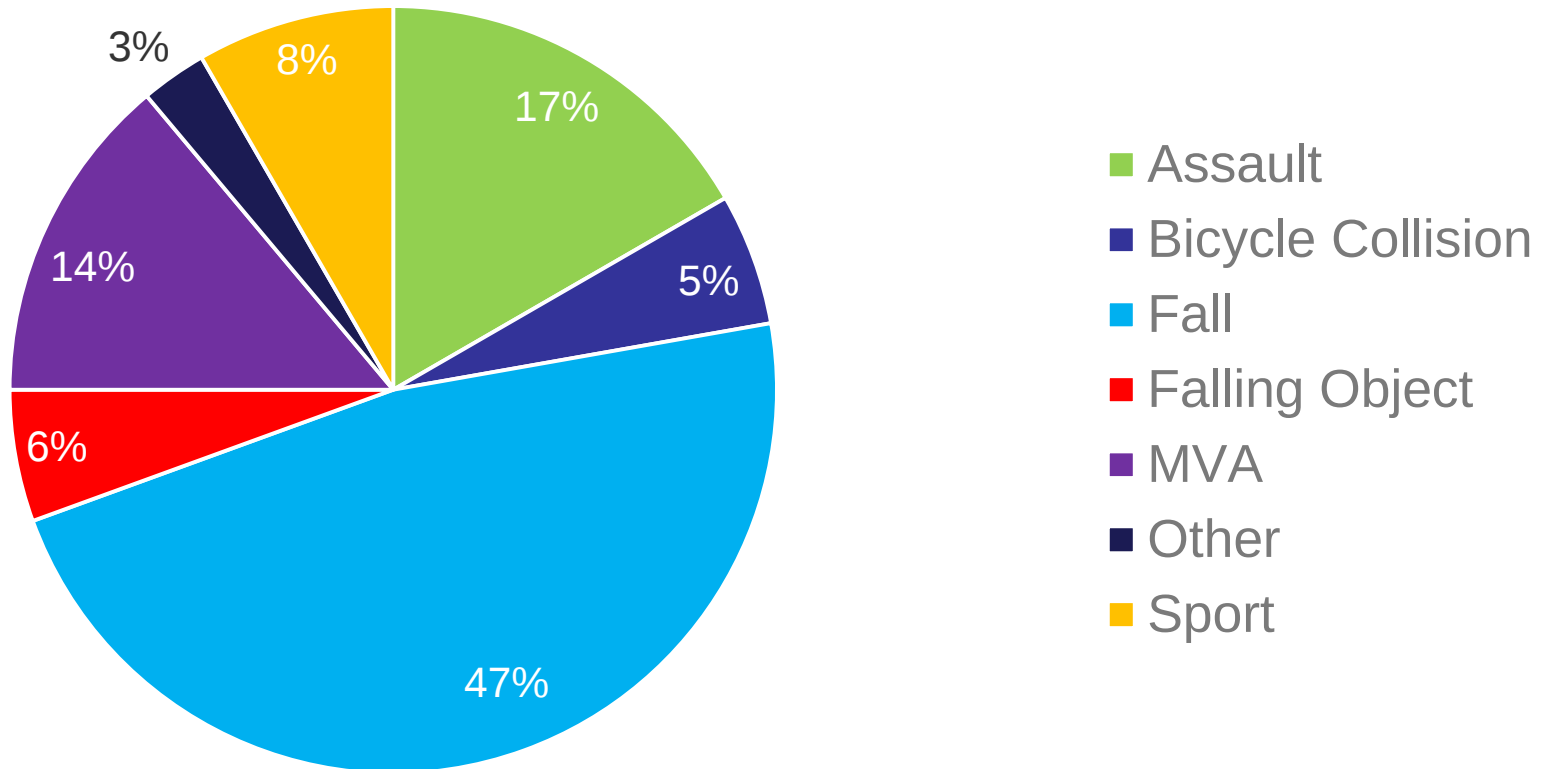
Follow-up one month later: assess for PCS (T1); final N = 36

Inclusion criteria:

- Patients between 18 and 50 years of age
- Presenting to ED within 48 hours of head injury with symptoms that may be attributable to that injury
- Cranial CT scan shows no intracranial injury, or CT was not performed
- GCS score >13

Pilot Study to Predict PCS

mTBI Injury by Type



Diagnosis of PCS

PCS was diagnosed at T₁ (28 days) according to the following criteria:

Patient scores in the moderate-to-severe range (25+) on the Rivermead Post-Concussion Symptoms Questionnaire

OR

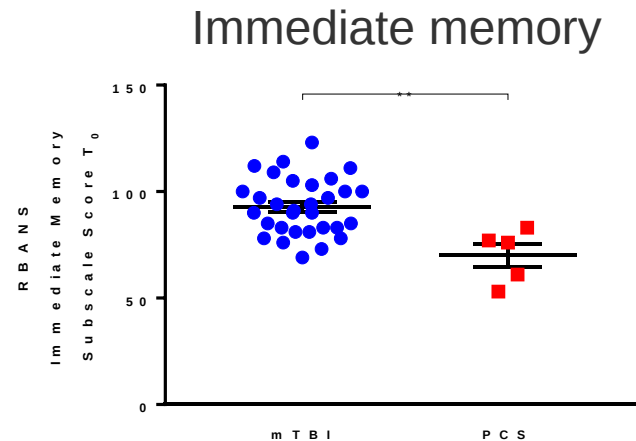
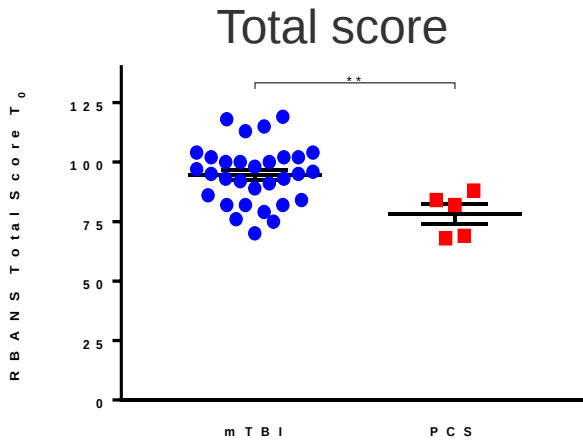
Scores ≥ 1.5 SD than mTBI group mean on two or more total neuropsychological test scores

5 participants developed PCS

Neuropsychological Test Outcomes

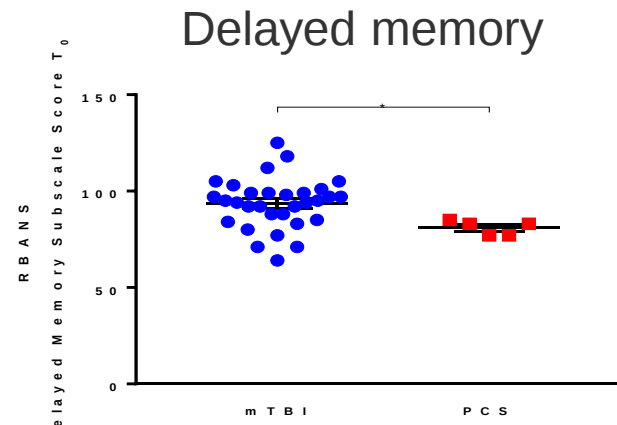
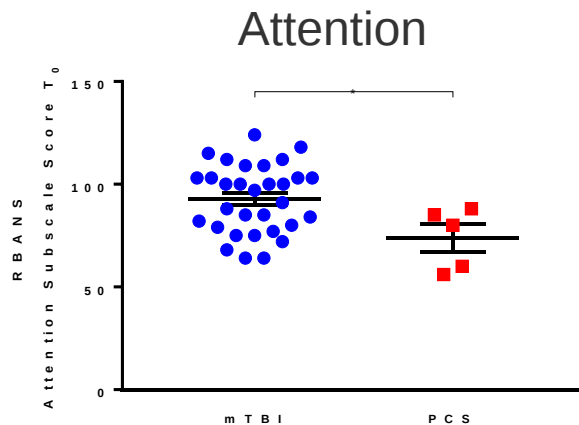
Repeatable Battery for the Assessment of Neuropsychological Status (RBANS)

Cognition – analysis compared mTBI to PCS, hypothesis driven



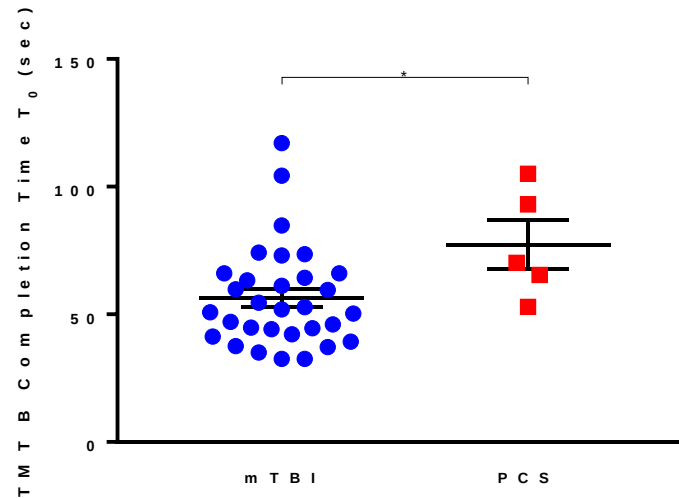
Overlap between groups

No one measure predictive

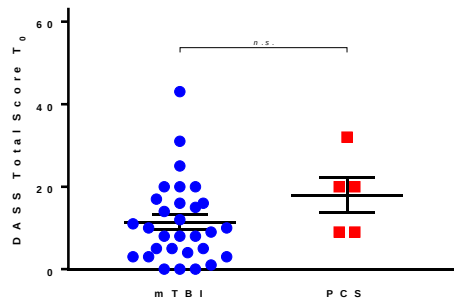


Neuropsychological Test Outcomes

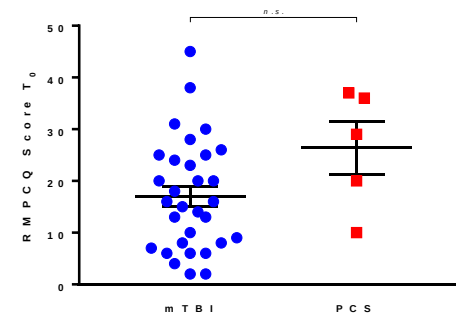
Trail Making Task (version B)
Visual attention, task switching



Depression, anxiety, stress
(DASS) total score



Rivermead



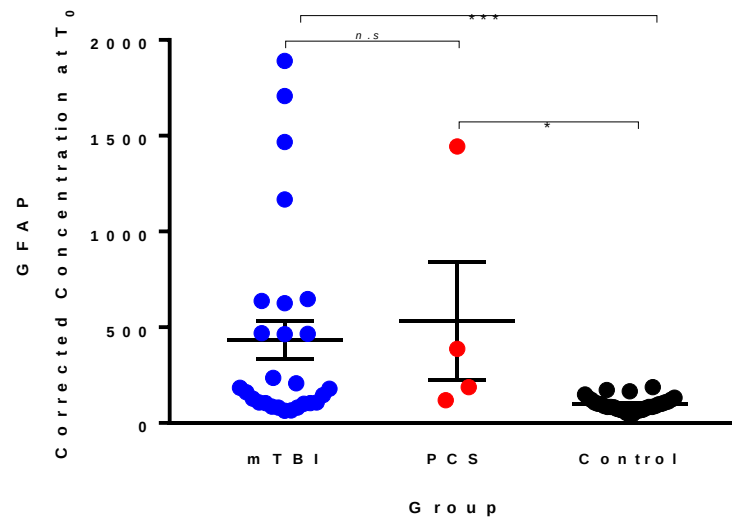
Blood Biomarkers: High Sensitivity

Requires release of markers from the injured brain:
breach of blood brain barrier
range of possibilities: proteins, miRNA, cell free DNA



Ultrasensitive analyses Quanterix Simoa
HD-1 Analyser™ system

Blood Biomarker: GFAP

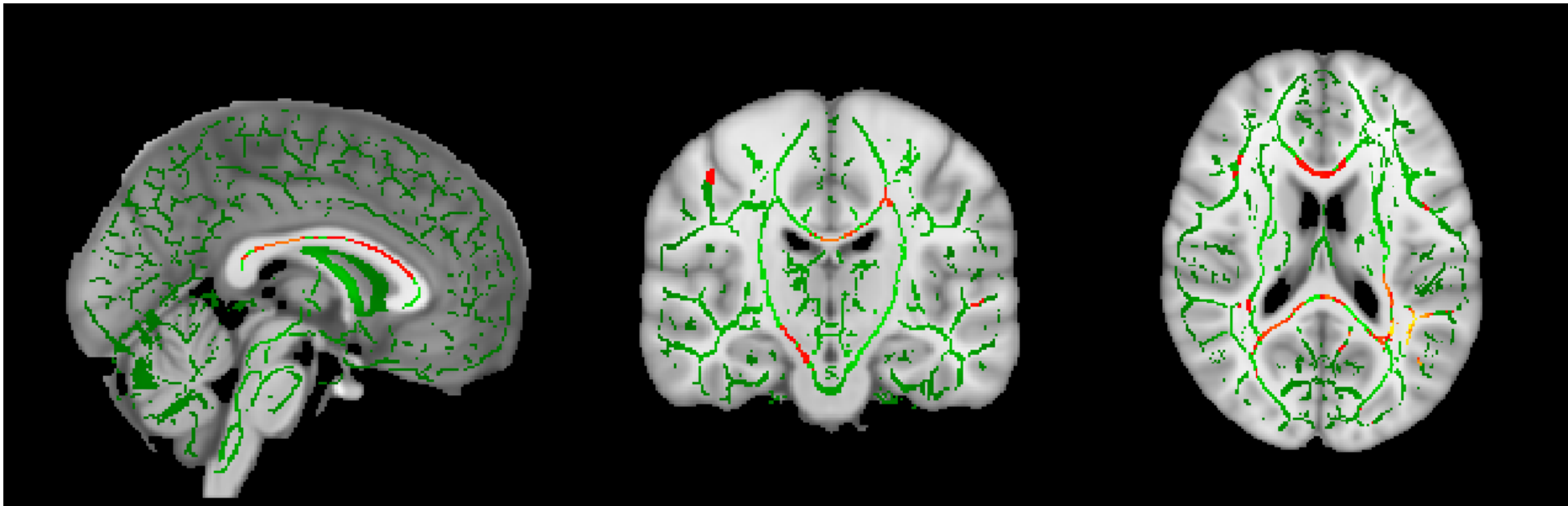


Also assessed neuron specific enolase (NSE) and neurofilament light chain (NFL)
No significant differences

MRI Outcomes

Subset of participants: N=15 mTBI (3 with PCS), N=8 controls

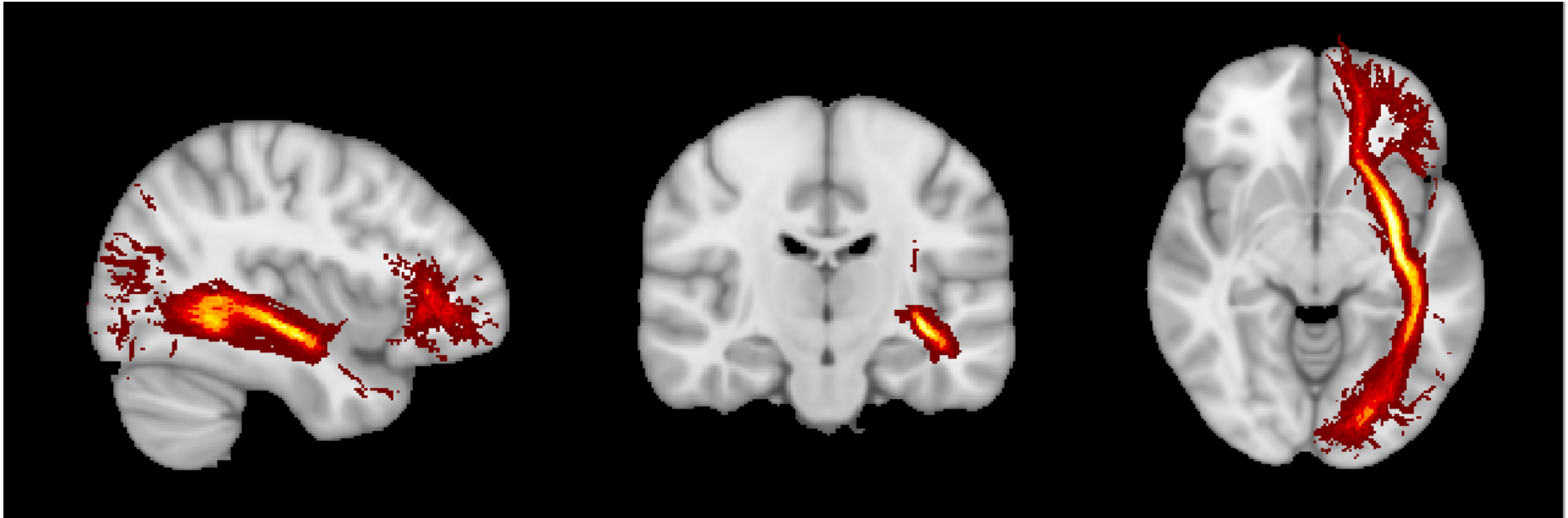
Tract based spatial statistics: mTBI compared to control, no significant differences



Red - areas of the brain in which mTBI patients had lower FA values than healthy, uninjured age and gender-matched controls within the mean FA skeleton (green).

MRI Outcomes

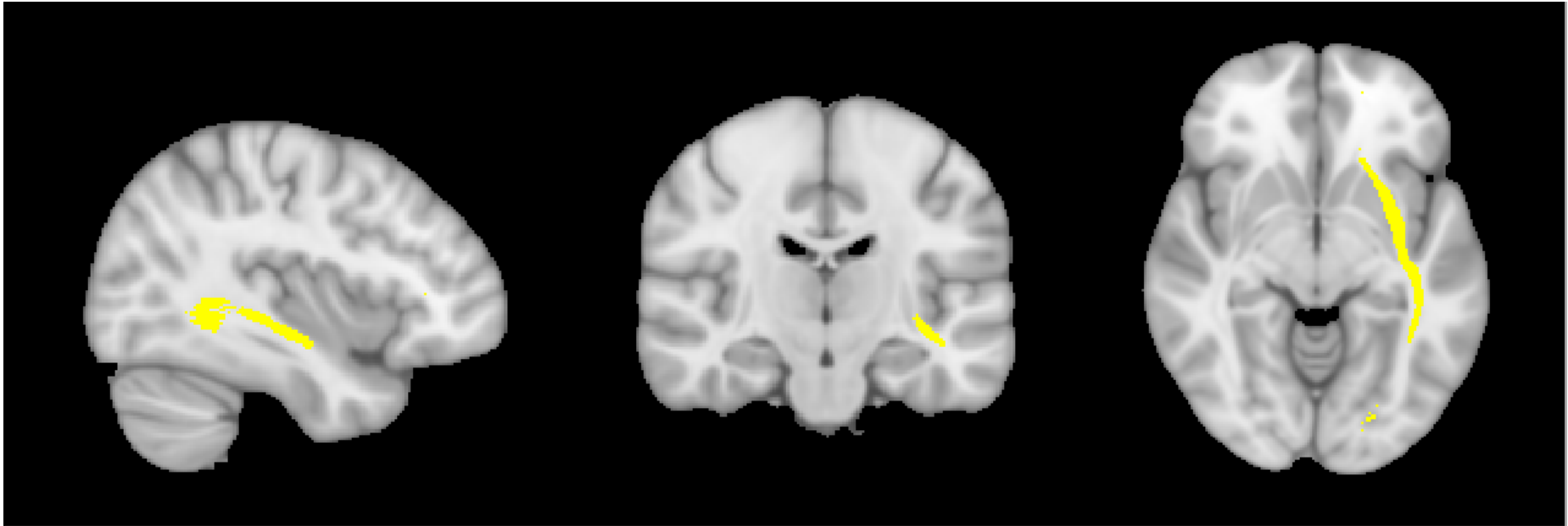
Region of interest analyses: multiple regions assessed



Left Inferior Fronto-Occipital Fasciculus

Probabilistic Map Johns Hopkins University White Matter Tractography Atlas
FSL Eyes

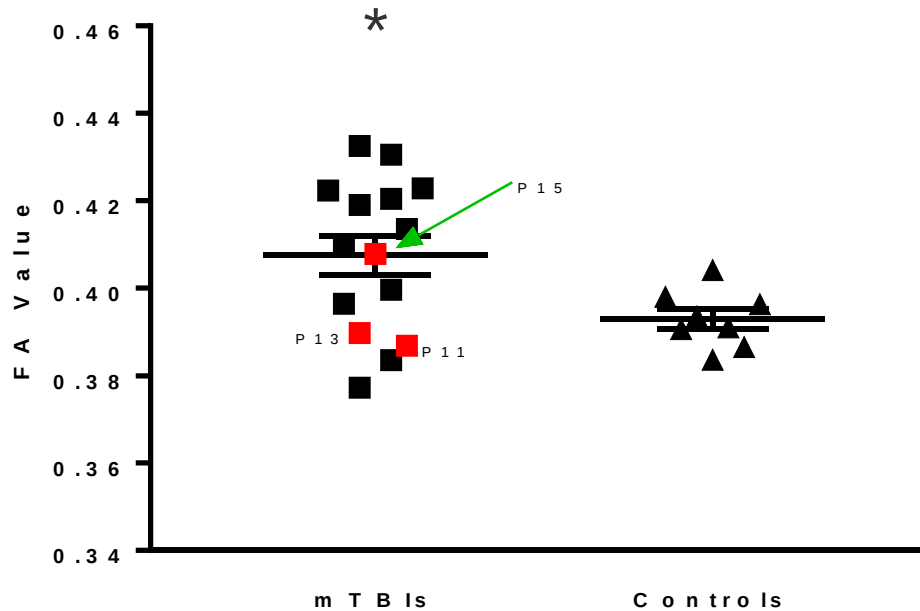
MRI Outcomes



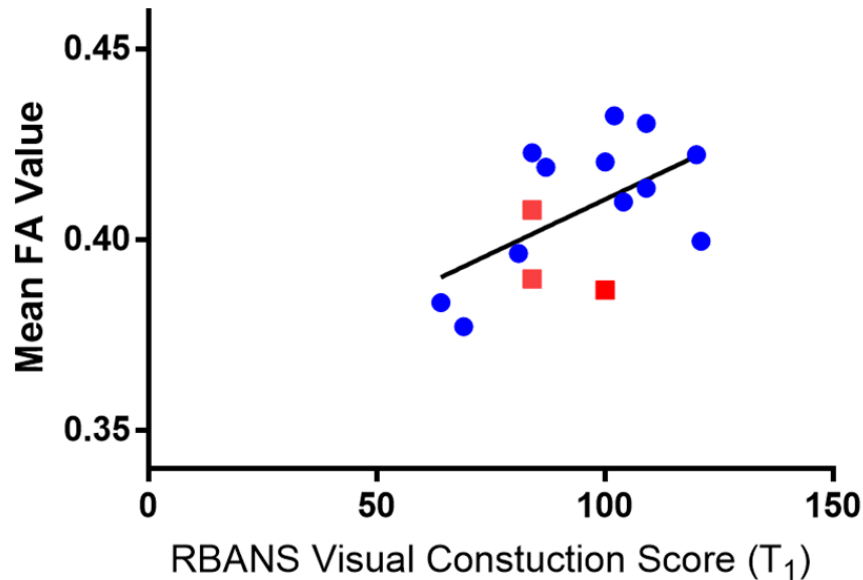
Left Inferior Fronto-Occipital Fasciculus **Threshold 30**

MRI Outcomes

Mean FA for the whole Left Inferior Fronto-Occipital Fasciculus tract,
threshold of 30 on FSL Eyes



Correlation Between Function and MRI



Pearson $r = 0.552$, $p = 0.033$

No one measure predictive

Predictive Analyses

Univariate logistic regression analysis for all outcomes: normal recovery and PCS

- Low numbers therefore multi-variate analysis not appropriate

Provides a measure of the extent of predictive power

- odds ratio: how likely an event is to occur
- assessed all outcomes: here show those with significant differences at ANOVA level between mTBI and PCS

Measures	Odds Ratio (e^{β})	P value
Total RBANS	0.873	0.024
TMT-B	1.043	0.058
RBANS- IM	0.838	0.027
RBANS-DM	0.910	0.056
RBANS-Attention	0.924	0.043

Other Potential Predictors

Demographic Features:

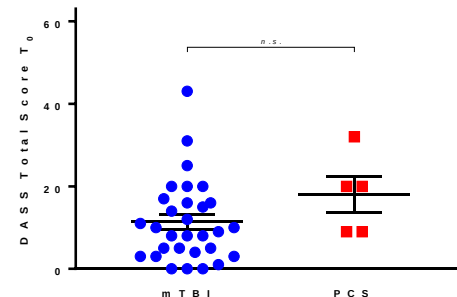
OR 4.86: The odds of PCS increase by almost five-fold for individuals with a history of concussion

OR 4.36: The odds of PCS increase by over four-fold for individuals who reported a history of a psychological disorder

Anxiety:

OR 1.37: Higher scores on the DASS-21 Anxiety Subscale generate greater odds of developing PCS

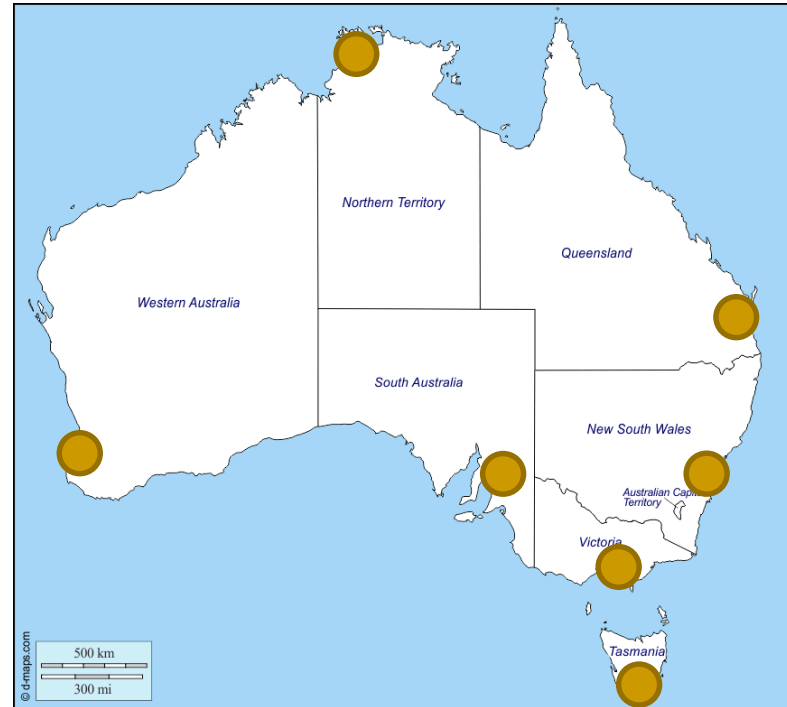
For each 1-point increase on the DASS-21 Anxiety subscale, the odds of developing PCS increase by 37.2%



Validation study to follow

Impact-TBI

A national approach to improving lives following traumatic brain injury of all severity in all ages, including concussion



Paramedics, Intensivists, Trauma specialists, Neuroscientists, Psychiatrists, Psychologists, Rehabilitation experts, Community

Impact-TBI

Some patients recover quickly and completely and others do not.

What are the predictors of poor outcome following TBI?

What interventions can improve the chances of recovery?

Many Thanks...

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NRP
Neurotrauma
Research Program



getting there together



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