

Assessment and Intervention for Patients with Mild Traumatic Brain Injury

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Methods of assessment of Post-traumatic amnesia (PTA)

- Retrospective reports
- Galveston Orientation and Amnesia Test (GOAT)
- Westmead PTA scale (Shores et al, 1989, 1995) – designed for use at 24 hour intervals

- Recent studies by Ponsford et al. (2004) and Shores et al. (2005) have called into question the accuracy with which PTA is identified in the ED and the validity of using GCS scores to screen for presence of PTA and severity of mild TBI.
- Questions assessing orientation and recall of 3 pictures, administered at hourly intervals during observation in the ED more accurately identified patients in PTA than did the GCS

WESTMEAD P.T.A. SCALE – REVISED

Name: _____

Gender: M / F DOB: / /

S = Score		Date/Time		Date/Time		Date/Time		Date/Time		Date/Time		Date & Time
		Answer	S	Answer	S	Answer	S	Answer	S	Answer	S	
Date & Time	1. What is your name?											Date & Time
	2. Where are you? (Town)											
	3. Why are you here?											
	4. What month are we in?											
	5. What year are we in?											
	6. How old are you?											
Date & Time	7. What is your DOB?											Date & Time
	8. What is the name of this place? (P: Home, hosp, hotel)											
	9. What time of day is it? (P: Morn, A/noon, night)											
	10. Picture I											
	11. Picture II											
	12. Picture III											
TOTAL												

Administration Notes: (1) If patient does not respond or says "I don't know", prompt with three options and ask them to choose (e.g. Oct, Nov, Dec for Q4); (2) For Q6 if patient responds "Hospital" ask for the name of the Hospital – if no response or unknown provide three choices (e.g. Alfred, Epworth, Royal Melbourne); (3) Provide patient with correct answers following all incorrect responses; (4) Do not change picture cards until patient has scored 12/12; (5) Discontinue once patient scores 12/12 on three consecutive occasions – patient is deemed to be "Out of PTA" at this point in time

Westmead PTA Scale – Revised




WESTMEAD P.T.A. SCALE – RE

Name: JOHN DELTA

Gender: (M) / F

DOB: 16 / 5 / 76

S = Score

Date & Time	Answer	S	Date & Time	Answer	S	Date & Time	Answer	S
10-11-06 21:00	John D.	1	10-11-06 22:00	John D.	1	10-11-06 23:00	John D.	1
2. Where are you? (Town)	Melb	1	Melb	1	Melb	1		
3. Why are you here?	Sports Injury	1	Injured	1	Injury	1		
4. What month are we in?	Nov	1	Nov	1	Nov	1		
5. What year are we in?	2006	1	2006	1	2006	1		
6. How old are you?	30	1	30	1	30	1		
7. What is your DOB?	16-5-76	1	16-5-76	1	16-5-76	1		
8. What is the name of this place? (P: Home, hosp, hotel)	Alfred	1	Alfred	1	Alfred	1		
9. What time of day is it? (P: Morn, A/noon, night)	Night	1	Night	1	Night	1		
10. Picture I		1	Pen	1	Keys	1		
11. Picture II		0	Car	0	Fork	1		
12. Picture III		1	Fork	1	Pen	1		
TOTAL		3/6		1 1/2		1 1/2		

Example of options:

Melbourne, Bendigo or Geelong – (write M/C next to answer to indicate choices provided)

Pictures not scored during first administration

Pictures not changed until after this assessment because first time 3/3 correct

Use boxes on side of page to indicate which pictures have been shown to patient and when

Westmead PTA Scale – Revised

WESTMEAD P.T.A. SCALE – REVISED

Name: JOHN DELTA

Gender: (M) / F DOB: 16 / 5 / 76

S = Score

Date/Time	Date/Time	Date/Time	Date/Time	Date/Time
10/11/06 21:00	10/11/06 22:00	10/11/06 23:00	10/11/06 24:00	11/11/06 0:00
Answer	S	Answer	S	Answer
1. What is your name?	John D. 1	John D. 1	John D. 1	John D. 1
2. Where are you? (Town)	Melb 1	Melb 1	Melb 1	Melb 1
3. Why are you here?	Sports Injury 1	Injured 1	Injury 1	Broken Arm? 1
4. What month are we in?	Nov 1	Nov 1	Nov 1	Nov 1
5. What year are we in?	2006 1	2006 1	2006 1	2006 1
6. How old are you?	30 1	30 1	30 1	30 1
7. What is your DOB?	16-5-76 1	16-5-76 1	16-5-76 1	16-5-76 1
8. What is the name of this place? (P: Home, hosp, hotel)	Alfred 1	Alfred 1	Alfred 1	Alfred 1
9. What time of day is it? (P: Morn, A/noon, night)	Night 1	Night 1	Night 1	Night 1
10. Picture I	 1	Pen 1	Keys 1	Flower 1
11. Picture II	 0	Car 0	Fork 1	Scissors 1
12. Picture III	 1	Fork 1	Pen 1	TB (mk) 1
TOTAL	9/6	11/12	12/12	12/12

* (M/c) = Multi Choice

Administration Notes: (1) If patient does not respond or says "I don't know", prompt with three options and ask them to choose (e.g. Oct, Nov, Dec for Q4); (2) For Q8 if patient responds "Hospital" ask for the name of the Hospital – if no response or unknown provide three choices (e.g. Alfred, Epworth, Royal Melbourne); (3) Provide patient with correct answers following all incorrect responses; (4) Do not change picture cards until patient has scored 12/12; (5) Discontinue once patient scores 12/12 on three consecutive occasions – patient is deemed to be 'Out of PTA' at this point in time

Westmead PTA Cards



Pathological Basis of Mild TBI

- Axonal injury
- Delayed evoked potential responses to auditory stimuli
- Biochemical changes



Mechanisms of injury

- Axonal stretching or membrane disruption causes an efflux of potassium
- This inhibits the action potential and is a likely cause of LOC
- Depolarization of neurons causes release of excitatory neurotransmitter glutamate, which activates NMDA and AMPA receptors and opens channels to increase flow of calcium, sodium and potassium into cells

Mechanisms of injury

- There is an upregulation of cellular glycolysis.
- Increased demand for glucose causes decreased cerebral blood flow, though not to ischaemic levels, lasting several days.
- In rats, after the initial period of ionic disturbance and increased glucose metabolism, the local cerebral metabolic rate for glucose and oxidative metabolism decreases significantly below baseline beginning 6 hours and lasting 5-10 days post-injury – may be related to symptoms

Mechanisms of injury

- Influx of calcium can be sequestered into mitochondria and cause metabolic dysfunction and cell damage or death. In axons it may cause dysfunction of neurofilaments and microtubules
- In milder injuries calcium levels peak in 2 days and resolve without significant cell loss in 4 days
- Lactate may also be released due to increased glycolysis. This may cause neuronal dysfunction by causing acidosis, membrane damage, altered blood-brain barrier permeability and cerebral oedema.

Criteria used to Define Mild Head Injury

(American Congress of Rehabilitation Medicine)

Traumatically induced physiological disruption of brain function, with focal neurological deficits which may or may not be transient

Severity of injury must not exceed :

- **Loss of consciousness < 30 minutes**
- **After 30 min, Glasgow Coma Scale score 13-15**
- **Post-traumatic amnesia < 24 hours**

Neuroimaging

- Lesions not generally evident on CT or MRI
- Small shear lesions may cause petechial haemorrhages that leave haemosiderin deposits which are sometimes detected by gradient echo MR sequences.
- SPECT may be useful
- Pathology may be below threshold of detection
- Lesions have been shown on MEG and qEEG that are not evident using other imaging techniques

- Outcomes following mild TBI are variable

Possible Factors Influencing Outcome Following Mild TBI

- Compensation factors
- Poor management
- Psychological trauma from injury
- Other injuries
- Genetic factors
- Previous head injury
- Pre-existing psychiatric or adjustment problems
- Demanding occupation/ student
- Presence of other stressors
- Ageing

Methodological Limitations of Mild TBI Studies

- Small sample sizes
- Retrospective data collection
- Focus on “clinical” cases
- Variable selection criteria
- Poor control for practice effects, premorbid factors or general impact of trauma
- Inaccurate estimation of post traumatic amnesia

The Coping Hypothesis

van Zomeren and Brouwer (1994)

- Post-concussional symptoms result from the chronic effort required to cope with persisting information processing deficits.
- Failure to understand the basis of ongoing difficulties may cause frustration and anxiety, thereby exacerbating cognitive difficulties.
- Provision of information in the acute stages of recovery might curtail the development of ongoing problems

Studies of Impact of Intervention following Mild TBI in Adults

- u Gronwall(1986) - rehabilitative intervention reduced reported post-concussional symptoms 3 months post injury
- u Alves, Macciocchi & Barth(1993) - no significant impact of provision of information alone, or information with reassurance, upon outcome

Mild Traumatic Brain Injury - A three-month follow-up study in adults

J. Ponsford, C. Willmott, A. Rothwell,
P. Cameron, A. M. Kelly, R. Nelms, &
C. Curran.

Bethesda Hospital, Melbourne, Australia

Study Aims

- To establish factors related to persisting symptoms three months after injury
- To examine whether patients benefit from early assessment and written information

Mild TBI Subjects

- Adults
- History of loss of consciousness < 30 minutes
- Glasgow Coma Score of 13-15 on arrival at hospital
- Post Traumatic Amnesia <24 hours
- No need for surgery requiring anaesthetic
- Able to communicate in English

Procedures

- Participants with mild TBI kept under observation in ED , with monitoring of their orientation and memory
- When fully oriented, they were discharged home with standard instructions to contact their local doctor if they experienced further problems
- Recruitment occurred at end of observation period

Prevalence of Mild TBI

- 80 percent of all head injuries
- Incidence:
 - 131 / 100,000 USA
 - 186 / 100,000 Australia
- 2-3 males injured for every female
- Most common causes falls, motor vehicle or cycling accidents, sporting injury, assault.
- Variable medical attention and management

Intervention Group: seen at one week and three months post-injury, receive information booklet

Non-Intervention Group : seen at three months post-injury only.
Receive standard Emergency Department instructions and no information booklet



Information about Mild Head Injury or Concussion ©



HEADACHES



Not everyone has headaches after being knocked out. When they do happen they can have many different causes. Two common ones are fatigue and stress. Fatigue headaches are signals that you need to sleep, and doing just that will get rid of the headache. Stress headaches are also signals. They happen when you are asking your brain to use more energy than it has, for example, by concentrating for longer than you are able to. Again, sleep should relieve the headache, or you may only need to stop what you are doing and change to something more relaxing. If the headache gets worse and cannot be relieved, see your doctor.

DIZZINESS

Occasionally, people find that they get a giddy feeling if they move or change their position quickly. Usually it is only a problem for a day or two. If you find that things seem to spin round if you sit up suddenly after lying down, or if you turn your head sharply, the only way to cope is to avoid such sudden movements, or changes in position until it clears. If the dizziness persists for more than a week or two, see your doctor.



TIREDFNESS



At first, even a little effort may make you feel very tired. Your brain has less energy to spare than it normally does. If you feel sleepy, go to bed. You will probably find that you need several hours more sleep than you usually do. Let your brain tell you when it needs to sleep, even if it is the middle of the day.

FORGETTING THINGS



You cannot expect your brain to be as good at remembering things as it usually is. Don't worry if you can't think of a name or a phone number that you ought to know, or if you go to get something, and then can't remember what it is. Your memory is only going to be a problem until you recover. In the meantime, get your family and friends to remind you of important dates and appointments, or write things down.

SLOWNESS



Some people who have been knocked out find their thinking is a bit slower. This means they might have some difficulty keeping up with conversations or following directions, and things take longer to get done. Encourage others to slow down by asking questions and having them repeat what they have said. Allow yourself extra time to complete tasks and avoid situations where you are under pressure to do things quickly.

IRRITABILITY/ BEHAVIOUR CHANGES



Some people who have been concussed find that they get annoyed easily by things that normally would not upset them. This does not last very long, but it can be difficult for you and for your family. It happens because the brain controls your emotional system as well as the rest of your body. After concussion your emotions may not be as well controlled as they usually are. There are several ways to deal with this. Some people find that going out of a room, or away from a situation as soon as it begins to get annoying is enough. Others use relaxation techniques to help them get back on an even keel. You may find that you can stop the irritability developing by using up energy with something like hitting a punch-bag, or riding an exercise bicycle, or skipping hard.

CLUMSINESS



You may find that you are a bit more clumsy than usual. Don't worry if you do find that you are a bit unsteady on your feet, or bump into furniture, or maybe drop things. Just take everything you do a little more slowly. Your brain is the control centre for your whole body. It has to make sense out of all the messages coming in from your eyes and ears and other senses, and to send the right signals to the right muscles for you to be able to do anything. So give yourself more time to do things.



POOR CONCENTRATION

No one can concentrate well when they are tired, so it is not surprising that many people have trouble concentrating for a while after they have been knocked out. Maybe you cannot even concentrate well enough to read the newspaper. If you really need to, just read for a short time, then come back to it when you have had a break. The same thing applies to other areas where concentration is needed. Leave things that need your complete concentration until you are feeling better.



Getting back to school

If you go to school or university, you may also need some time off. When you return, you will need to take things a little easy at first. You may experience some of the problems that are outlined above. For example, you may find that it is harder to concentrate on lessons in class. It's also possible that you may not be able to do things as quickly as you are used to doing them, or that you forget details. You may find that a noisy classroom makes you irritable, or that you get very tired. Let your teachers or lecturers know that you have been concussed and that you may need more time to complete school work. Pace yourself and take rest breaks.



If you would like further advice or assistance, see your doctor.

Controls

- Patients presenting to the Emergency Department with minor injuries not involving the head
- Adults aged 16 years or over
- Able to communicate in English

Measures

- ❖ Symptom Checklist 90-Revised (SCL 90-R)
- ❖ Holmes Rahe Survey of Recent Experiences
- ❖ Post Concussion Syndrome Checklist (PCSC)
- ❖ Sickness Impact Profile

Post Concussion Syndrome Checklist (PCSC)

NAME _____

DATE _____

Please rate the frequency, intensity and duration of each of the following symptoms based on how they have affected you since the injury according to the following scale

FREQUENCY

1= Not at all
2= Seldom
3= Often
4= Very often
5= All the time

INTENSITY

1= Not at all
2= Vaguely present
3= Clearly present
4= Interfering
5= Crippling

DURATION

1= Not at all
2= A few seconds
3= A few minutes
4= A few hours
5= Constant

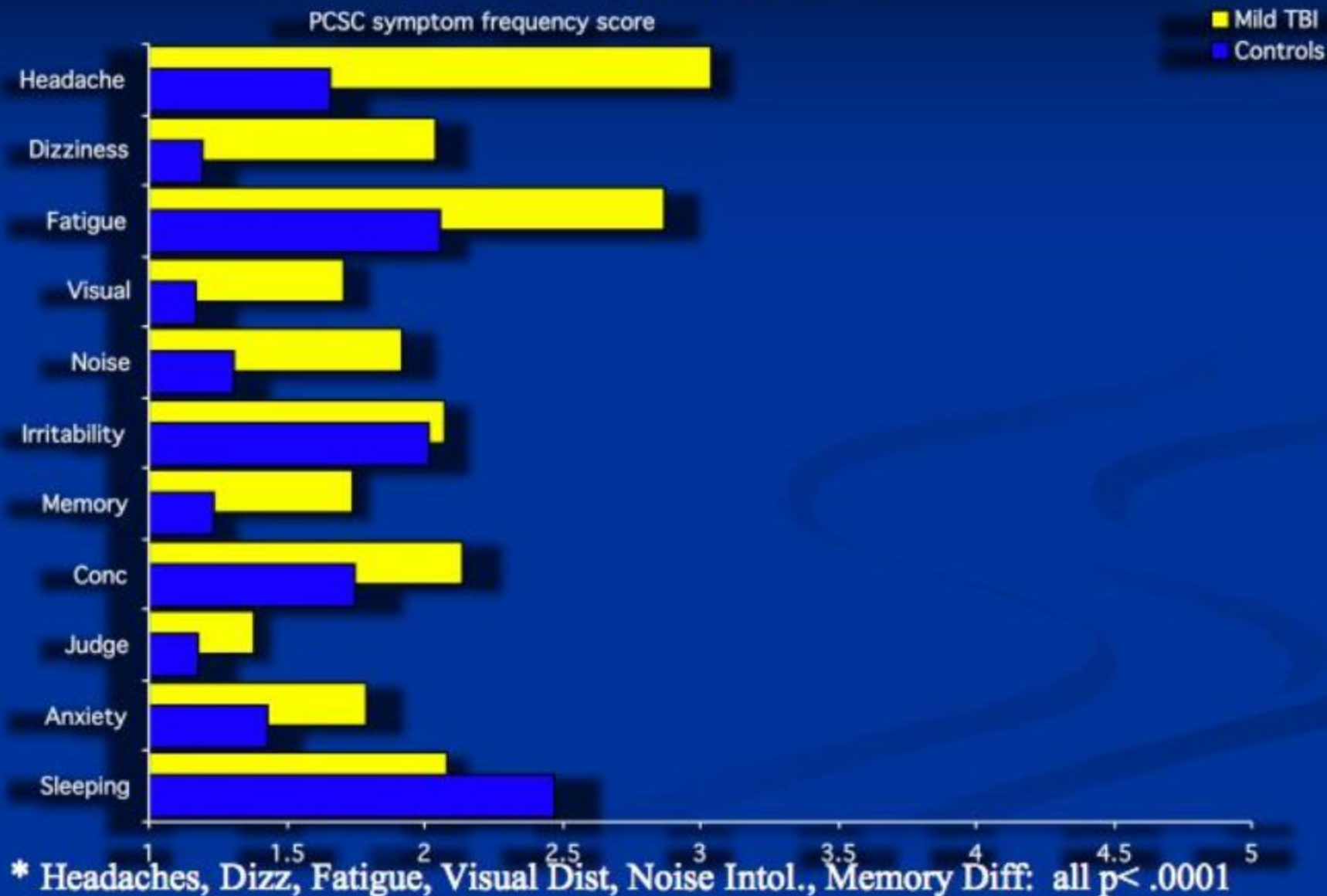
	FREQUENCY	INTENSITY	DURATION
Headaches	_____	_____	_____
Dizziness	_____	_____	_____
Irritability	_____	_____	_____
Memory Problems	_____	_____	_____
Difficulty Concentrating	_____	_____	_____
Fatigue	_____	_____	_____
Visual Disturbances	_____	_____	_____
Aggravated by Noise	_____	_____	_____
Judgement Problems	_____	_____	_____
Anxiety	_____	_____	_____
Sleeping Difficulties	_____	_____	_____

Neuropsychological Measures

- ❖ National Adult Reading Test (NART)
- ❖ Four-choice reaction time (decision time)
- ❖ Digit Span
- ❖ Digit Symbol
- ❖ PASAT 2.4 and 2.0 sec. pacings
- ❖ SCOLP Speed of Comprehension subtest
- ❖ Rey Auditory-Verbal Learning Test

**Results at one
week post-injury**

Results of Mild TBI versus Control Subjects on the PCSC at one week



Common Symptoms

- Headaches
- Dizziness
- Fatigue
- Visual Problems
- Sleep disturbance
- Intolerance of noise / lights
- Concentration difficulties
- Memory problems
- Mental slowness
- Irritability
- Anxiety & Depression

Results on Neuropsychological Measures at 1 week

	Mild TBI (n=136)		Controls (n=75)	
	mean	(sd)	mean	(sd)
Four Choice RT (DT)	334.8	(47.9)	326.1	(35.4)
Digit Symbol (age SS) *	9.5	(2.4)	10.4	(2.4)
Digit Span (age SS)	10.1	(2.8)	10.1	(2.3)
Pasat mtpcr (2 sec pacing)	4.4	(1.9)	4.5	(2.3)
Speed of Comp Total **	51.5	(17.5)	57.3	(18.6)
Rey AVLT Total 5 trials	48.1	(8.1)	46.3	(9.1)

** p<0.02 * p<0.03

Results at 3 months post- injury

Results of Mild TBI versus Control Subjects on the PCSC at 3 months



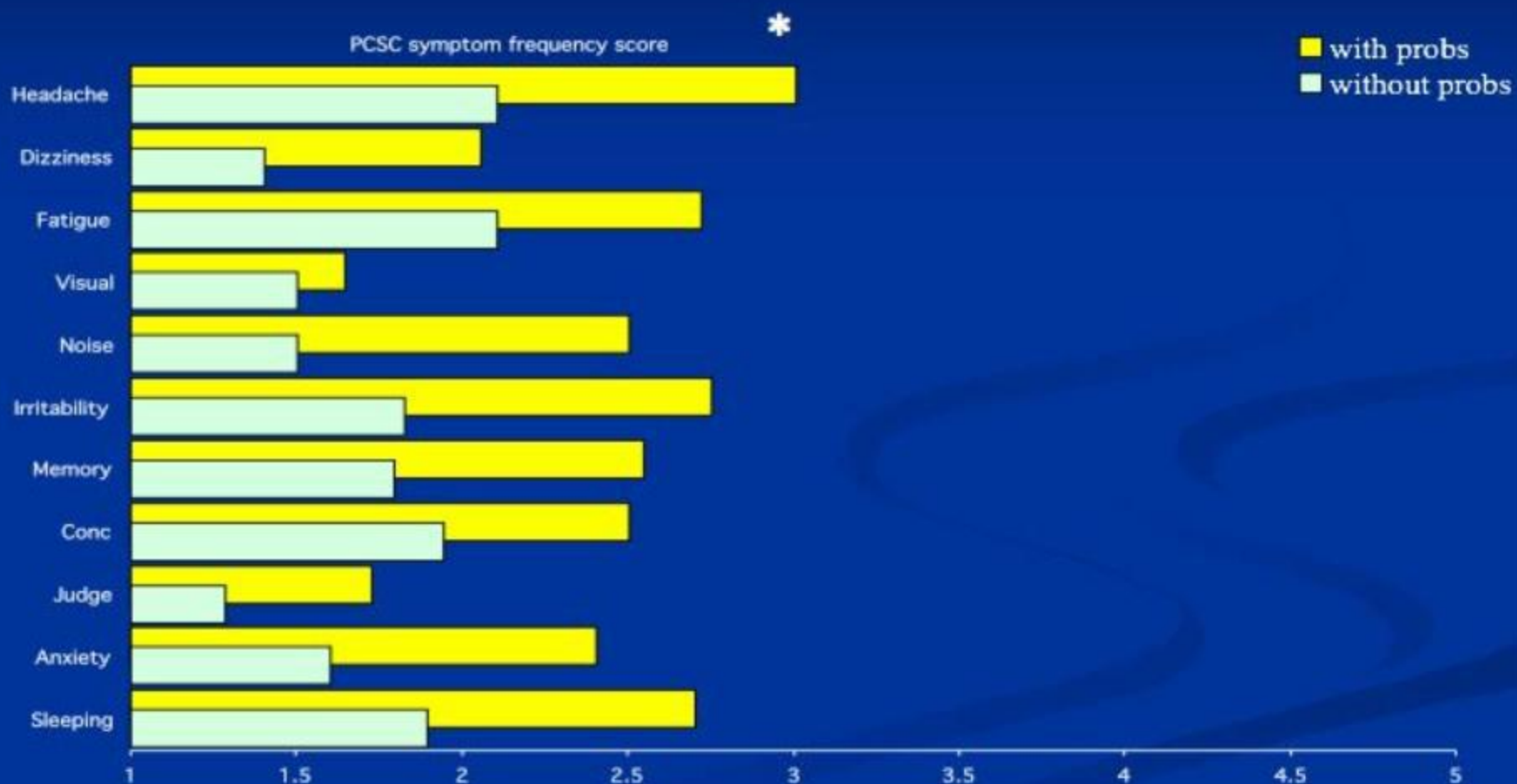
* Headaches $p = .008$; * Dizziness = .003; *Concentration $p = .03$

Results on Neuropsychological Measures at 3 months

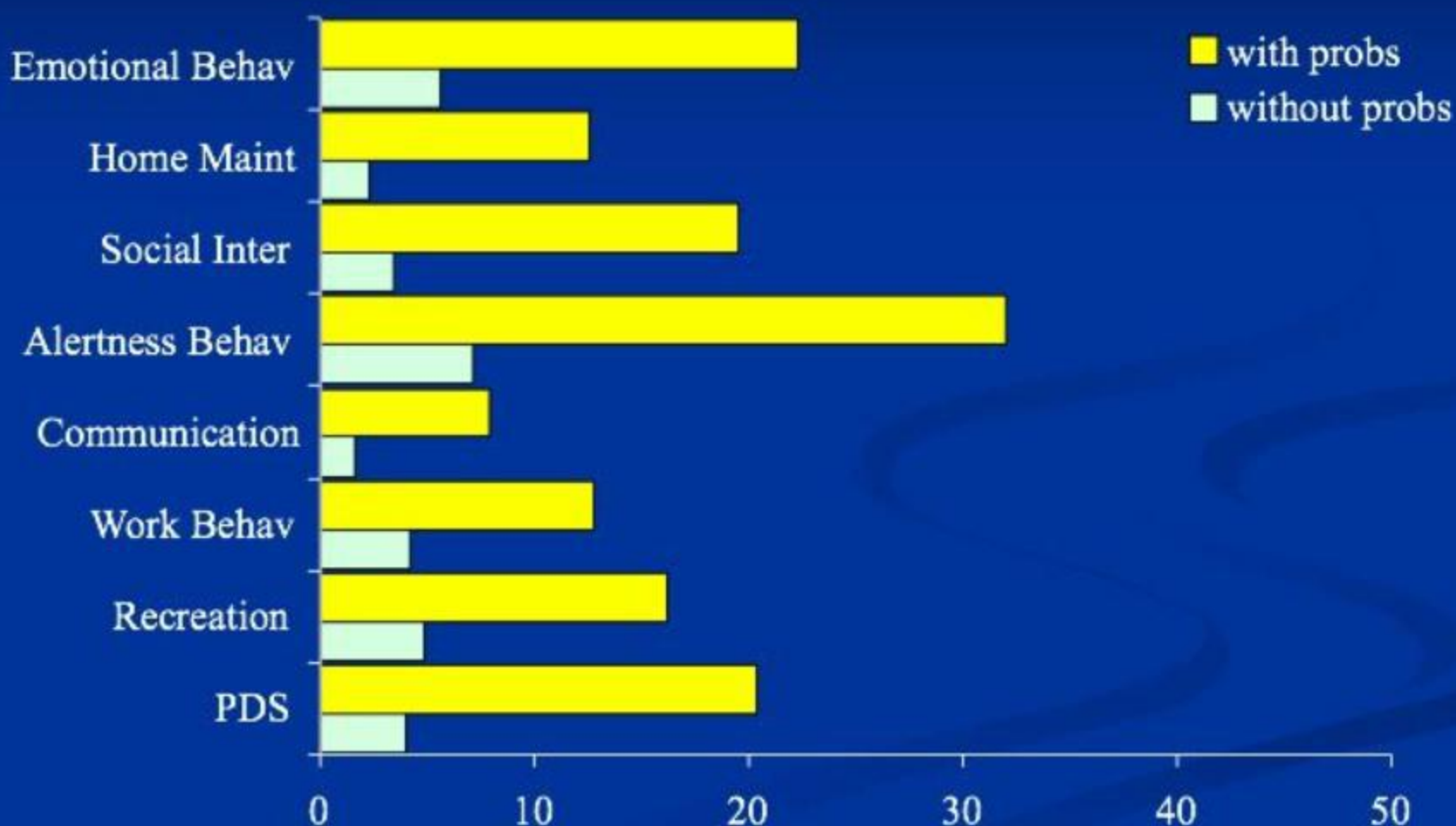
No significant differences

38 of the 210 Mild TBI participants (18.1%) had significant ongoing problems at 3 months post - injury.

Results of Mild TBI Ss with problems versus rest of Mild TBI sample on the PCSC at 3 months



Results of Mild TBI participants with problems vs rest of Mild TBI sample on the Sickness Impact Profile at 3 months



$P < .001$ for all subscales

Mild TBI Ss with problems versus rest of Mild TBI sample

	Problem People (n=38)		Mild TBI (n=171)	
	mean	(sd)	mean	(sd)
Age	24.6	(10.3)	28.6	(14.4)
Education	11.6	(1.4)	11.3	(2.1)
SES rank	5	(0.9)	4.8	(1.1)
PTA (min)*	136.3	(173.5)	91.7	(198)

Mild TBI Ss with problems versus rest of Mild TBI sample

	Problem People (n=38) %	Mild TBI (n=171) %
Gender **	45(males)	67(males)
Students	37	29
Learning Difficulties	11	9
History of HI	53	44
Psych/Neuro problems	34	24
MVA *	40	23
Other Stresses ***	55	31

* p<0.03 **p<0.01 *** p<0.005

Impact of Intervention

Neuropsychological Studies

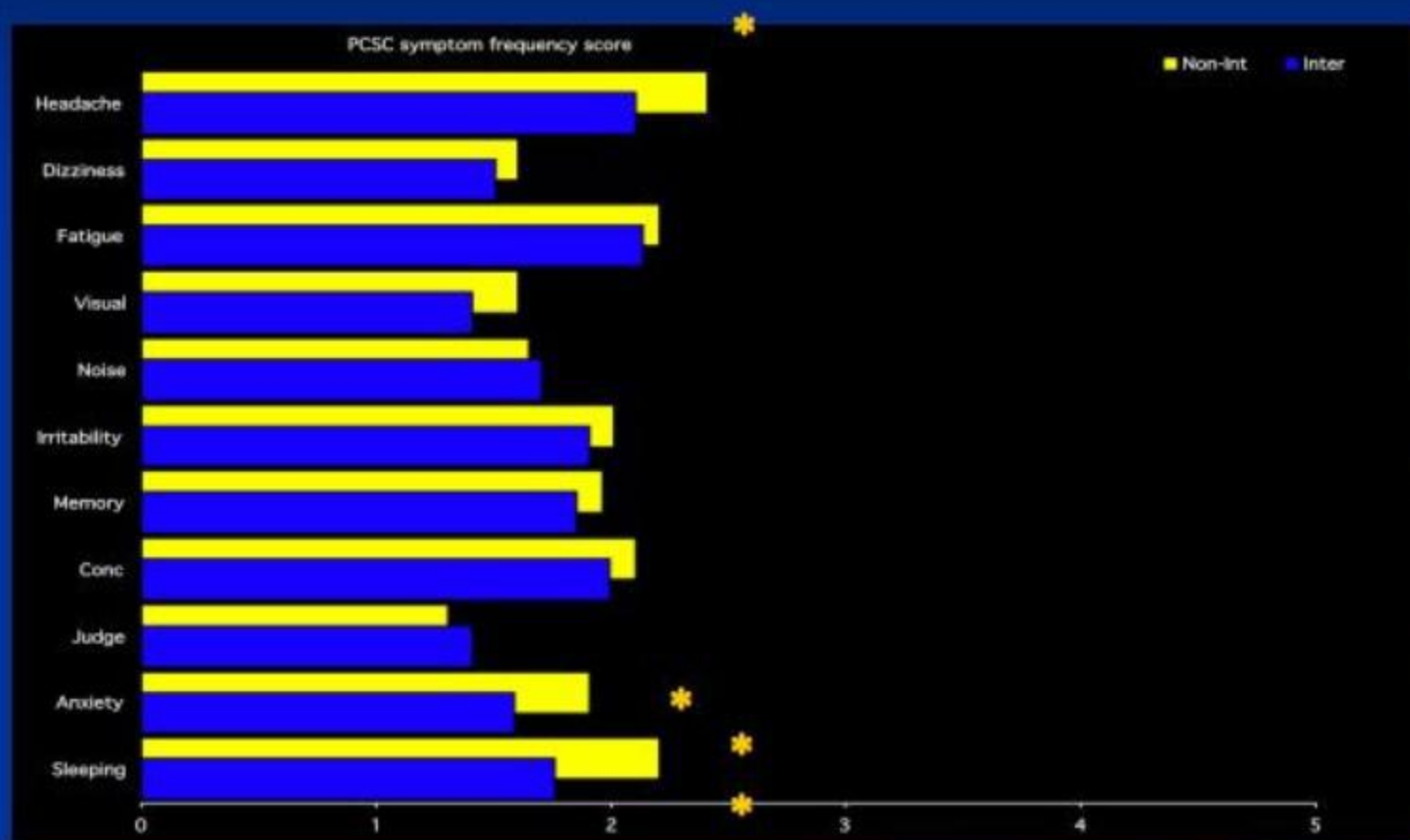
- **Decreased Speed of Information Processing**

(Gronwall et al., 1981; Hinton-Bayre et al., 1997; Maddocks & Saling, 1996; Ponsford et al., 2000)

- **Memory Impairment** *(Levin et al. 1987)*

- **Symptoms and cognitive problems resolve by one month post-injury in the majority of cases**

Results of Mild TBI adults Intervention vs Non-Intervention on the PCSC at 3 Months

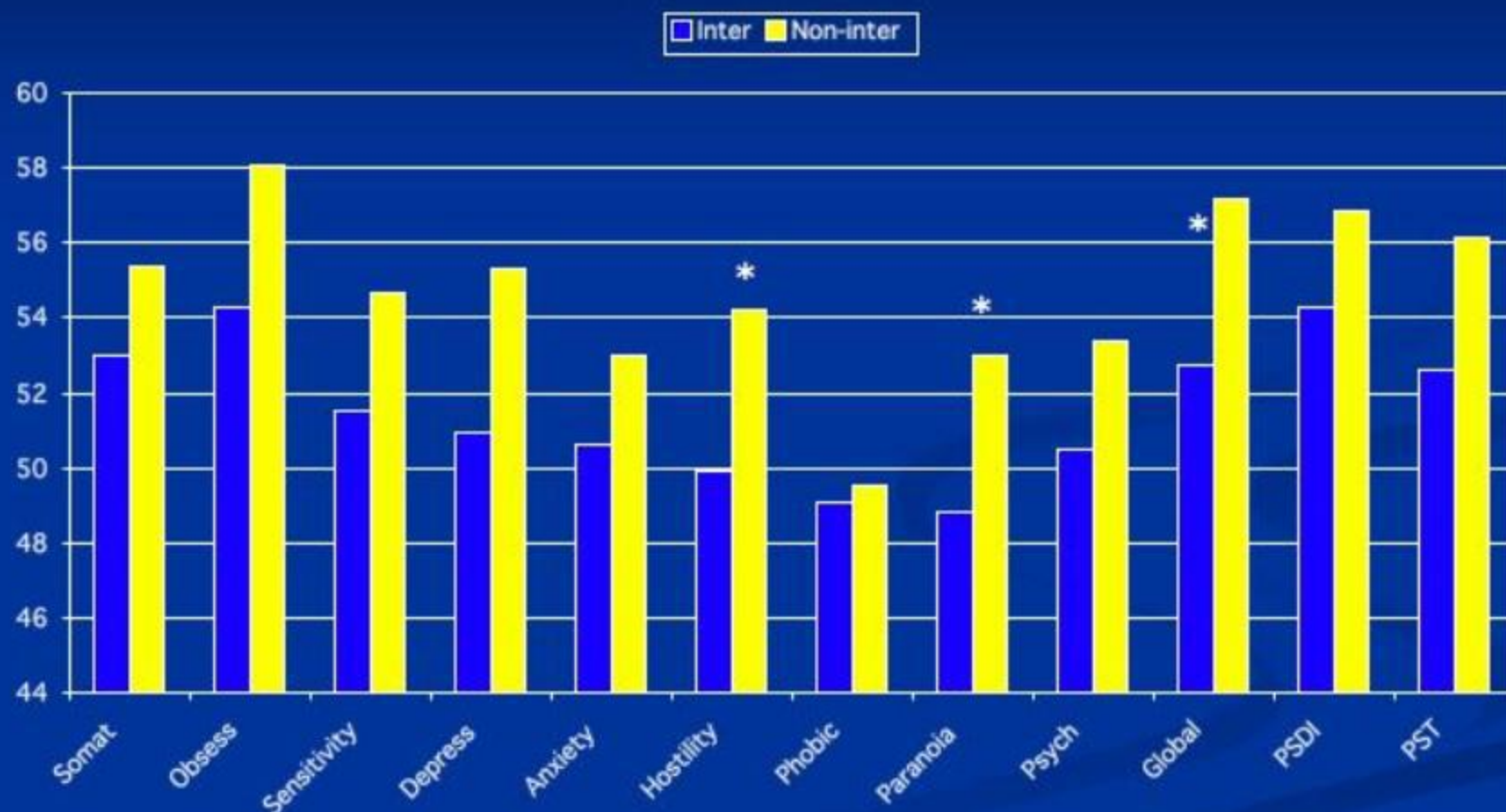


Sleeping: $F(1)=6.09, p<0.01$; Anxiety: $F(1)=4.32, p<0.04$

** $p<0.01$

* $p<0.04$

Symptom Checklist 90-R Scores for Mild TBI Intervention Versus Non-Intervention Groups at 3 Months



* SCL-R GSI Scale: $p < 0.01$; * Paranoia: $p < 0.01$; * Hostility: $p < 0.01$

Summary of Findings

- Mild TBI subjects reported symptoms at one week post-injury, particularly headaches and dizziness
- Mild slowing of information processing was evident on the WAIS-R Digit Symbol subtest and the Speed of Comprehension Test at one week post-injury

Summary of Findings(cont)

- By three months post-injury, most Mild TBI subjects had recovered, although some had ongoing symptoms
- 18% of Mild TBI subjects still had many symptoms and were highly distressed
- These individuals tended to have a longer PTA duration, and been injured in a MVA, have other stresses in their lives and showed high levels of psychopathology. A relatively higher proportion of women and students had ongoing difficulties

Summary of Findings(cont)

- Those seen at one week post-injury and given an information booklet were less distressed than those seen for the first time at 3 months

Impact of Early Intervention on Outcome Following Mild Traumatic Brain Injury in Children

J. Ponsford, C. Willmott, A. Rothwell,
G. Ayton, P. Cameron, R. Nelms, & C. Curran.

Epworth, Western and Royal Melbourne Hospitals,
Melbourne, Australia

Provision of information may ensure that :

- 1 Parents and children are adequately informed regarding what to expect and how to minimize stress on the injured child
- 2 Pre-existing problems are not attributed to the injury

Conclusions

- Most children recover quickly following mild TBI
- 20% of children with ongoing problems
- Those with ongoing problems tend to have a history of previous head injury, learning difficulties, other neurological or psychiatric disturbance, or family stressors

Conclusions (continued)

- Children with ongoing problems did not necessarily perform more poorly on neuropsychological measures
- Assessment and intervention should focus on behavioural and adjustment issues as well as cognitive impairments

Conclusions (continued)

- Provision of information and suggested coping strategies results in some reduction in reporting of symptoms and behavioural changes 3 months post-injury
- This may reduce stress on the child and attribution of pre-existing problems to the injury

Indicators of head injury severity

- Glasgow Coma Scale score
- Duration of post-traumatic amnesia (PTA)

New Study

- Study Aims
- To examine the validity and utility of the revised Westmead PTA scale in identifying presence of PTA and/or cognitive impairment in patients presenting to the Emergency Department with mild TBI, as compared with age and gender-matched trauma controls without head injuries.
- To examine the association of scores on this scale with outcome at one week and three months post-injury; and
- To evaluate the impact of receiving an information booklet on symptoms reported and levels of anxiety and depression three months post-injury.

Glasgow Coma Scale

- Measures patients' best eye opening, best motor and best verbal response to commands
- Patients with mild TBI usually show adequate eye opening and motor responses
- They may be confused and/or amnesic in their verbal responses, because they are in PTA and typically score between 13 and 15 on the GCS
- Use of the GCS in screening mild TBI has been criticised

Post-traumatic amnesia (PTA)

- Period of disorientation and/or inability to lay down new memories
- Duration of PTA dates from time of injury until return of continuous memory

Post-traumatic amnesia (PTA)

- Duration of PTA is frequently used as an index of severity of head injury
- Significant association between PTA duration and outcome (Bishara et al., 1972; Brooks & Aughton, 1979; Ponsford et al., 1995; Russell & Smith, 1961; van Zomeren & van den Burg, 1985)