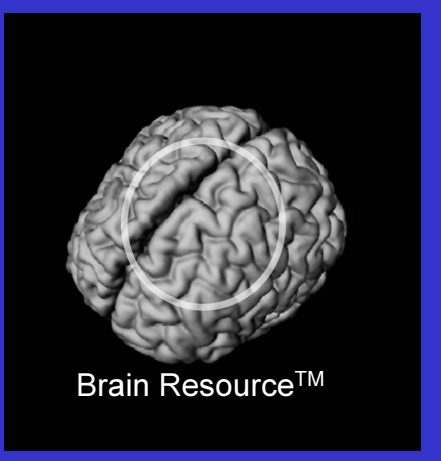
Evidence-based neuropsychological and psychophysiological profiles in mild traumatic brain injury cases presenting for medico-legal evaluation



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Summary

- Mild traumatic brain injury (MTBI) reflects a diversity of cognitive and electrical brain function deficits.
- Psychophysiological and neuropsychological performance in 14 MTBI subjects and 65 normative matched controls were examined.
- MTBI subjects showed the most severe deficits in executive function (neuropsychological: choice reaction and maze; psychophysiological: working memory).
- Complementary cognitive measures, backed by an integrated normative database for comparison, yield evidence based cognitive profiles for MTBI subjects, suitable for both clinical and medico-legal purposes.

Objective

- To identify the profile of disturbances which defines MTBI relative to healthy normative controls,using a complementary neuropsychological and psychophysiological profile of measures.

Methods

- MTBI adults (n=14, 7 female, 7 male; age range 21-52 years, *M=43, SD=10.51)* were referred to Brain Resource Company's (BRC's) New York and South Australian labs for medico-legal investigation. Subjects' results were compared against a normative sample of healthy, age and sex matched peers from BRC's International Brain Database (n=65, 35 males, 30 females, age range 20-55 years, *M=42.25, SD = 9.97).* No past history of head trauma or psychiatric illness was reported. No significant differences were found in years of education between the two groups.
- All subjects underwent BRC's NeuroMarker assessment in which a standardised, automated profile of neuropsychological and psychophysiological tasks were completed. Each subject's results were acquired during the one assessment session. Results were analysed using Statistical Package for the Social Sciences (SPSS, Windows Version 12).
- NeuroMarker examines a profile of cognitive (memory, attention, language, sensory-motor-spatial and executive functioning) and psychophysiological (eyes open and closed EEG, auditory oddball, and working memory ERP) functioning. The cognitive profile data was obtained via an IBM touchscreen computer and the psychophysiological data obtained using a NuAmps system (Neuroscan, USA). An electrode cap (Quik-cap) was used to acquire data from 32 electrode sites, corresponding to the International 10-20 montage system. Both profiles take 50 minutes each to complete with data uploaded via a secure website for BRC central analysis and comparison against the BRC International Brain Database.
- Analyses: A series of between group one way analyses of variances (ANOVA) was conducted for the neuropsychological and psychophysiological measures with a corrected alpha of p=.001.
- Differences in neuropsychological and psychophysiological profiles were investigated on an individual basis (compared with controls), as well as analysing between-group differences.

Results

- Psychophysiology: Reduced P300 (oddball and particularly working memory). There were no differences in the amplitude of early components.
- Neuropsychological: Significant differences were noted in all nine tasks. The most striking results were those for measures of the executive maze, choice reaction time, working memory and verbal interference (see Table 2).
- The complementary neuropsychological and psychophysiological measures highlight changes in executive function in MTBI, particularly in relation to speed of information processing.

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Results

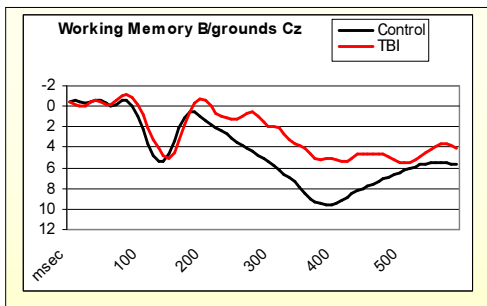


Figure 1 Examination of ERP data through Group Waveforms shows the diminished P300 amplitude for MTBI compared to controls on the working memory task (see also Figure 2).

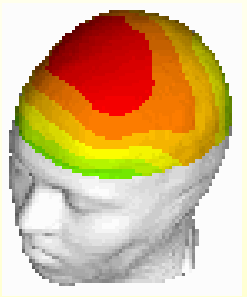


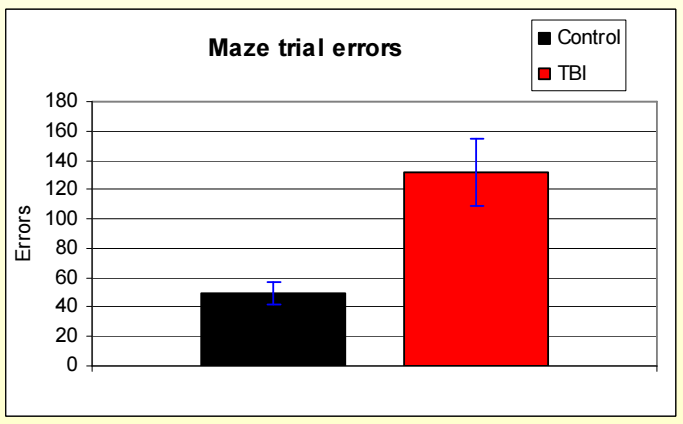
Figure 2 Topographical map showing regions of significant difference in MTBI group compared to controls on the working memory task in Figure 1.

Scale of significant differences: Blue represents significantly higher amplitude compared to controls; red represents significant lower amplitude.

Table 1: Most significant ERP differences between groups (midline sites only)

Oddball		Working Memory (P300)	
N1 target latency	F=5.58, p=.021	B/ground amp.	F=7.42, p=.008
Mean	MTBI – 124 Control – 115	Mean	MTBI - 5.62 Control - 9.23
N1 b/ground latency	F=7.31, p=.009	Distracter amp.	F=9.78, p=.003
Mean	MTBI – 127 Control – 117	Mean	MTBI -15.54 Control -4.56
P300b target amplitude	F=5.96, p=.017		
Mean	MTBI – 2.49 Control – 7.25		

Figures 3,4: Most significant differences in psychometric results between groups (p<.001)



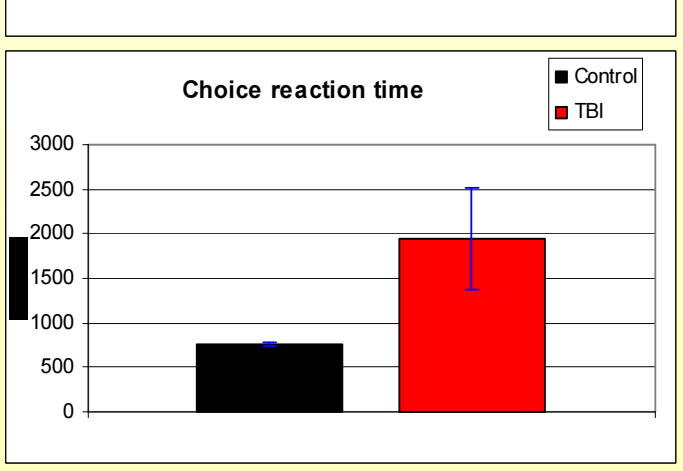


Table 2: Most significant neuropsychological differences between groups (p=<.001)

		Means	
Choice Reaction Time (ms)	F=18.05	MTBI - 1511	Control - 757
Errors over all maze trials	F=17.32	MTBI - 132.25	Control - 48.21
Maze			
•Overruns, all trials	F=12.26	MTBI - 48.17	Control - 20.79
•Av. errors per trial	F=15.46	MTBI - 12.12	Control - 5.1
•TTC first maze	F=16.95	MTBI - 180610	Control - 15030
Working Memory RT (ms)	F=11.5	MTBI - 1151	Control - 757
Verbal Interference			
•Score, part 1	F=13.72	MTBI - 13.8	Control - 17.84
•RT, part 1	F=18.73	MTBI - 1663	Control - 1096
•RT, part 2	F=15.72	MTBI - 2235	Control - 1632
•Switching of Attention			
•TTC part 1	F=11.15	MTBI - 29564	Control - 20737

TTC=Time To Completion RT = Reaction time ms = milliseconds

References

1. Grieve, K. et al. (2000). South African Journal of Psychology; 30(3):14-19
2. Sullivan, K. et al. (1997). Journal of Clinical Psychology. 53(7): 657-661
3. Cossa, FM et al. (1999). Italian Journal of Neurological Science. 20:145-153

Discussion

- Psychophysiology: The combination of P300 deficit and lack of early component significant deficit suggests that a core disturbance is in working memory and late stages of information processing (and not a lack of sensory processing).
- Neuropsychological: The maze is a composite measure of executive function and visuospatial memory[1]. Although not as widely used as other standard cognitive tests[2] the maze is able to provide information on several properties of cognitive functioning. It is likely that MTBI subjects' deficits in working memory is a core contributor to these subjects' poorer performance in all aspects of the maze.
- Choice reaction time results have been consistently impaired in subjects with TBI[3], and our results support this. Complex reaction time measures (such as one involving a choice) are more likely to show a difference than a simple reaction time index because to preserve a higher level of accuracy, the speed of response will be reduced[3].
- In a medico-legal setting, psychophysiological data has the additional benefit of being more difficult to manipulate than neuropsychological data. The current study demonstrates the concomitant disturbances in both electrical and behavioural brain function using BRC's standardised cognitive profiles.
- Having a comprehensive, standardised database of normative subjects allows for personalised and evidence based reporting. This permits distinctions to be made between the types of deficits. For example, the subject in figure a shows global deficits in neuropsychological functioning; figure b shows a subject with specific neuropsychological deficits, while the subject shown in figure c displays neurophysiological deficits only compared to normative subjects.

Conclusion

Mild TBI requires systematic and complementary profiling of brain function. Temporal data provides additional insights into brain function and may help further explain those subtle reported cognitive changes which traditional neurobehavioural assessment paradigms may fail to detect. Complementary and integrated measures of cognitive function and electrical activity demonstrated vastly more insightful and accurate results than would have been available from individual tests with isolated normative data. BRC's integrated and standardised database allows comparison of individuals, taking account of differences in age, sex and education, to provide objective, evidence based and personalised information about brain function.

Figure A

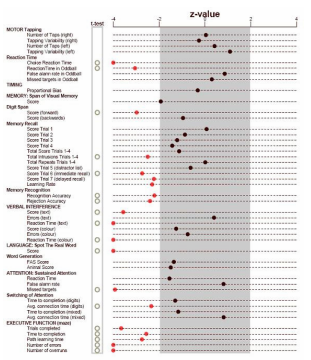


Figure B

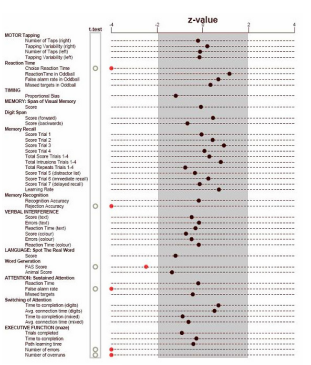


Figure C[1]

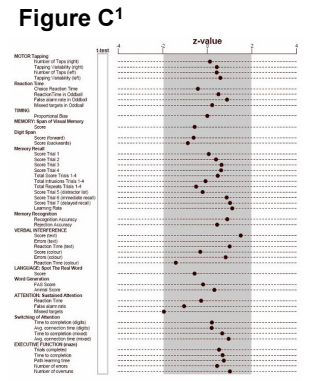


Figure C[2]

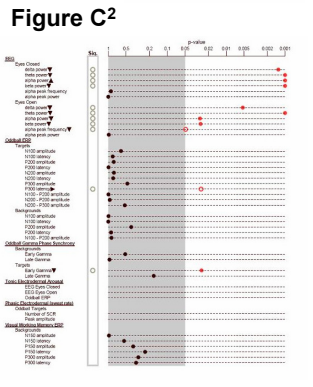


Figure C[1] & C[2] demonstrate psychophysiological deficits in the absence of neuropsychological deficits compared with the normative population, in the one subject.