



THE UNIVERSITY OF  
**WAIKATO**  
*Te Whare Wānanga o Waikato*

Research Commons

<http://researchcommons.waikato.ac.nz/>

## Research Commons at the University of Waikato

### Copyright Statement:

The digital copy of this thesis is protected by the Copyright Act 1994 (New Zealand).

The thesis may be consulted by you, provided you comply with the provisions of the Act and the following conditions of use:

- Any use you make of these documents or images must be for research or private study purposes only, and you may not make them available to any other person.
- Authors control the copyright of their thesis. You will recognise the author's right to be identified as the author of the thesis, and due acknowledgement will be made to the author where appropriate.
- You will obtain the author's permission before publishing any material from the thesis.

**Mild Traumatic Brain Injury in Childhood:  
Injury Outcomes, Teacher Perspectives and Educating Educators**

A thesis  
submitted in fulfilment  
of the requirements for the degree  
of  
**Doctor of Philosophy**  
at  
**The University of Waikato**  
by  
**ROSALIND JANE LEAMY CASE**



THE UNIVERSITY OF  
**WAIKATO**  
*Te Whare Wānanga o Waikato*

2014

## Abstract

Paediatric mild traumatic brain injury (mTBI) has the potential to impact on a wide range of developmental functions in childhood. However, the relationship between mTBI and persistent developmental difficulties is controversial, with some suggestion that children's post-injury difficulties may actually predate the injury. Regardless of cause, however, mTBI seems to be associated with developmental impairment in childhood that may impact on academic performance and overall school functioning. In spite of the high prevalence of mTBI amongst young people, educators and school services may not be aware of the implications of such injuries and how post-concussive symptoms should be managed in educational settings. It seems that the conflicting findings regarding mTBI outcomes in childhood may contribute to a lack of knowledge amongst educators about how to manage mTBI and associated difficulties in primary-school-aged students. There is a need to further clarify the existence and nature of developmental impairments after paediatric mTBI and consider their implications in educational settings. Furthermore, there is a need to understand more regarding the capacities of educators to address issues that may arise as a result of such impairments and consider how teaching practices in this area can be enhanced.

In Study 1, the emotional, behavioural, social, intellectual, neuropsychological (comprised of memory, attention, and executive function) and academic functioning of 41 children who had sustained mTBI 14-months prior was investigated. The findings of those assessments were compared with those from a non-injured cohort of children matched on age, gender, ethnicity and school decile. Assessment measures included the Strengths and Difficulties Questionnaire (SDQ) as a measure of emotional, behavioural and social functioning, the Behavior Rating Inventory of Executive Function (BRIEF) as a measure of executive function, Woodcock Johnson Tests of Cognitive Abilities (WJ III COG) and CNS

Vital Signs (CNSVS) as measures of global neuropsychological functioning, a short-form version of the Wechsler Intelligence Scale for Children (WISC-IV) as a measure of intelligence, the brief battery of the Woodcock Johnson Tests of Academic Achievement (WJ III ACH) as measure of academic achievement, and a teacher questionnaire regarding school functioning. Information obtained from parents and teachers regarding pre-injury diagnoses and learning problems did not reveal significant premorbid difficulties amongst the clinical group. The results of Study 1 showed that children who have sustained mTBI demonstrate higher rates of emotional and behavioural problems than those in a matched cohort, while executive function and social functioning was found to be similar across the two groups. Children with mTBI evidence significantly lower intellectual functioning and academic achievement, and are more likely to demonstrate learning disorders. Given the developmental impairments identified in the sample and the possible implications of such difficulties in school settings, it was considered important to evaluate teachers' perceptions of childhood TBI and how such impairments might be managed at school.

Study 2 looked at the perceptions of educators regarding childhood TBI. Nineteen primary school teachers in the Waikato and Bay of Plenty regions engaged in semi-structured interviews that covered their understanding of TBI, its mechanisms and consequences. Participants also discussed the use of programme adaptations for children with persistent difficulties after mTBI and perceived barriers to uptake. The majority of participants had a limited understanding of mTBI and its implications in childhood. None of the participants had received prior education regarding paediatric TBI and identified this as an area of weakness that they perceived could be addressed by professional development. However, participants were not aware of any available professional development opportunities specifically relating to paediatric TBI. Participants perceived significant barriers to the delivery of appropriate educational approaches for children with developmental impairments,

including limited resourcing and funding for special education and poor communication between the education and health sectors, resulting in a lack of information and support for educators.

Study 3 involved the development, delivery and evaluation of a professional development workshop and written information resource for teachers. The workshop and written information resource were delivered in three local primary schools to 38 participants. A knowledge quiz regarding mTBI was administered pre- and post-workshop. Participants also completed an evaluation of the workshop and brochure rating the usefulness of and their satisfaction with the materials. A repeated-measures experiment showed that knowledge levels significantly increased following participation in the workshop. The majority of participants were satisfied with the content of the workshop and expected to make changes to their practice with children who had experienced mTBI and were evidencing emotional, behavioural and/or cognitive symptoms.

The results of this research indicate that while the cause of post-concussive difficulties may be ambiguous, children who have experienced mTBI are at higher risk of demonstrating developmental problems across a wide range of domains. These problems have the potential to impact on school functioning; however, teachers may not be aware of these issues and thus may not be well-placed to support children who are experiencing difficulties through the post-concussive period and beyond. On the other hand, teachers demonstrate insight into their limitations in this regard and appear keen to address their professional development needs in this area. A brief professional development approach that focuses on the epidemiology and possible consequences of mTBI in childhood, along with a range of programme adaptation strategies that teachers can opt to employ as necessary, may be useful in improving teacher knowledge, educational practice and, ultimately, functional outcomes for children who have experienced mTBI. The need for screening and intervention

services for children with mTBI is highlighted, along with a reconceptualisation of how special needs are addressed in school settings.

# *Geoff Case*

1940-2012

Around a year after I began this research, my father died after sustaining a severe traumatic brain injury in a car accident.

This finished work is for him.

## Foreword

In March 2010, the Brain Injury Outcomes New Zealand in the Community (BIONIC) study of traumatic brain injury (TBI) incidence and outcomes began collecting data in the Waikato region. This Health Research Council-funded collaboration between AUT, University of Auckland and University of Waikato sought to ensure full case ascertainment of TBI in both children and adults over a 12-month period. For my PhD research, I planned to conduct a longer-term follow-up on the primary-school aged children within the cohort. In particular, I wanted to examine the presence of emotional symptoms, behavioural problems and academic issues, and the possible expression of such difficulties in academic settings. This coincided with the development of a wider study of children aged 0-16 years, led by Dr Nicola Starkey and funded by a Lotteries Commission grant (Consequences of Brain Injury in Childhood or COBIC).

I began data recruitment and collection in April 2011, contacting parents of children who had consented to follow-up and inviting their participation in the COBIC study. Altogether, 49 families were approached and 41 provided consent. Unexpectedly, it emerged that all children in this particular age cohort had injuries of mild severity, effectively making this a study of concussion. The children in this study were from urban and rural schools throughout the Hamilton City and wider Waikato district.

In the course of this research, I met with parents to complete a battery of questionnaires and subsequently completed direct assessment of the children. Teachers were also asked to complete questionnaires. At the same time, a matched cohort of non-injured children was recruited via schools. The matched cohort completed the same battery of assessments as the TBI group, including the measures that were administered by the BIONIC study at the 12-month time point. The bulk of the data collection and assessment was completed by myself, however I was lucky to have support from co-researchers when needed in times of sickness or bereavement; in particular, from Dawn Willix-Payne and Kathleen Doolan.

While the initial plan for this programme of research was to continue long-term follow-up of the children and include closer assessment of executive functions as time progressed, the process of



data recruitment and collection brought me into close contact with schools. I became interested in families' experiences of the return to school after TBI, teachers' understandings of concussion and how persistent post-concussive issues might be managed in school settings. The focus of this research moved towards this issue and its implications for children. As such, the second study became a qualitative investigation of teachers' perspectives on TBI. A new cohort of teachers was recruited via local urban and rural primary schools (most of which had participated in Study 1 in some regard, e.g. via completion of a Teacher Questionnaire or facilitating a child's assessment to take place at school). However, none of the teachers reported having completed Teacher Questionnaires for a child in the initial study, so in that regard were new to the study. Participants to engaged in interviews regarding their perspectives on childhood TBI. Following from this, I designed a professional development workshop for educators regarding concussion. This was administered to a separate cohort of teachers, who then evaluated its usefulness. A new group of teachers was recruited from and workshops were delivered within three primary schools in the Waikato and Bay of Plenty regions.

The three studies took place over a two-year period. While conceptually related to one another, each study's focus and methodology was distinct and the participants for each study were novel. Together, this programme of research emphasises the how the developmental difficulties experienced by a sub-group of children in New Zealand are understood and managed in educational settings and considers an evidence-based approach to addressing issues related to mild TBI in primary-school-aged children.

## Acknowledgements

I would like to acknowledge the Health Research Council for granting me a Clinical Research Fellowship in order to undertake this research.

To all the children, families, teachers and schools who participated in this research, I give you my heartfelt thanks. It has been a privilege to work with you and hear your stories, and I am so grateful for your willingness to contribute to this work.

I have been absolutely blessed to have Dr Nicola Starkey in my corner from the outset. As a supervisor, she is unparalleled in her energy and commitment, and as an academic she is a fearsome combination of clever and efficient (a sometimes rare combination in university settings). As a human being, she is also lovely and very funny. Thus, I have had the best possible experience of completing a PhD and I attribute it all to Dr Starkey. Thank you. I honestly wouldn't have bothered otherwise.

I am also grateful to the rest of my supervisory team from the BIONIC study: Dr Kelly Jones and Professor Valery Feigin at AUT, and Associate Professor Suzanne Barker-Collo at University of Auckland, for feedback and advice throughout this process. Thanks to you all for facilitating much of this research. Thanks also to my co-researchers from the BIONIC and COBIC studies, in particular Dawn Willix-Payne and Kathleen Doolan. Your support was invaluable.

I have also been very lucky to have been mentored and supervised throughout my clinical training and beyond by Dr Carrie Cornsweet Barber and Dr John Fitzgerald. Again, I have

been honoured to have your unconditional support throughout this journey and I am so grateful for all that you have both taught me. To the staff in the School of Psychology at the University of Waikato: thank you for making the corridor so fun and interesting. Special mention should go to Allan Eaddy for his excellent taste in music and impressive collection of fine hats.

I would like to thank my mum for her endless support and encouragement and for beginning me on this journey as a very little girl running around the grounds of our family's psychogeriatric rest home in the tiny village of Motumaoho. To my dad, wherever you are, I know that you're proud of me because you always told me that. To my sister, Anne-Marie, and my brother, Sean, thanks for being quite good siblings. I need also to acknowledge my other family and best cousins, Mary Tait-Jamieson and Mike Linklater, who have provided me with a beachside writing retreat and listening ears more times than I can count. The motivation, support and cups of tea have been a lifesaver.

Finally, I need to say thank you to my husband, Geoff. You have supported me right through all these years of study and made it possible for me to do this work. To our daughters, Mia and Stella, I hope to spend less time in front of the computer now and more time riding bikes (but please note we will need to wear helmets because it will be a seriously bad look otherwise).

When I began this PhD, lots of people told me that it would be the most miserable experience of my life. I'm happy to say that, thus far, it's been one of the best things I have ever done and also one of the most enjoyable. My thanks again to all who made that possible.

## Table of Contents

	<i>Page</i>
<b>Abstract</b>	i
<b>Dedication</b>	v
<b>Foreword</b>	vi
<b>Acknowledgements</b>	viii
<b>Table of Contents</b>	x
<b>List of Tables</b>	xvi
<b>List of Figures</b>	xviii
<b>Chapter 1:                    The Epidemiology of Traumatic Brain Injury</b>	
Introduction	1
Prevalence and Incidence	3
Risk Factors for TBI	7
<b>Chapter 2:                    The Consequences of Paediatric Traumatic Brain Injury</b>	
Introduction	12
Post-Concussive Syndrome	13
Emotional Functioning	16
Behavioural Problems	17
Social Functioning	20
Cognitive Functioning	21
Intelligence	21
Attention	23
Working Memory	24

Executive Function	25
School Functioning	27
Developmental and Methodological Considerations	29
Concussion Information and Services in NZ	31
Summary and Rationale	33
<b>Chapter 3:</b>	
<b>Study 1: The Impact of Mild Traumatic Brain Injury on Children’s Developmental Functioning 14-Months Post-Injury</b>	
Aims of the Study	36
Hypotheses	37
Methodology	37
Ethics	37
Recruitment	38
Participants	39
Materials	44
Measures	44
Procedure	56
Statistical Analysis	57
Results	59
Multivariate Analysis of Covariance	59
Global Outcomes	60
Emotional, Behavioural and Social Functioning	61
Cognitive Functioning	64
Academic Functioning	68

	Teacher Questionnaire	72
	Clusters of Impairment	73
	Summary	76
	Discussion	78
	Summary	93
<b>Chapter 4:</b>	<b>Study 2: Teacher Perspectives on Traumatic Brain Injury in Childhood</b>	
	Study Rationale	95
	Literature Review	96
	New Zealand's Special Education System	96
	Managing the Return to School Following TBI	97
	Teacher Knowledge and Perspectives	98
	Teacher Education in NZ	103
	Summary	103
	Methodology	106
	Recruitment	106
	Participants	108
	Interview Schedule	109
	Procedure	109
	Coding and Analysis	110
	Results	
	Understanding of TBI and Concussion	111
	Consequences of Injury	120

	Programme Adaptations and Management Strategies	127
	Professional Needs of Teachers	131
	Barriers	138
	Summary	142
	Discussion	143
	Summary	155
<b>Chapter 5:</b>	<b>Concussion in the Classroom: Educating Educators</b>	
	Rationale and Overview	156
	Aims of the Study	159
	Methodology	160
	Participants	160
	Materials and Measures	161
	Procedure	162
	Analysis	163
	Results	165
	Quantitative Results	165
	Qualitative Results	166
	Discussion	175
	Summary	182
<b>Chapter Six:</b>	<b>Summary and Conclusions</b>	184
	Overview of Findings	184

	Conclusions	190
<b>References</b>	References	192
<i>Appendices</i>		
<b>Appendix A</b>	Introductory Letter to Parents / Guardians	221
<b>Appendix B</b>	Introductory Letter to Matched Cohort Parents / Guardians	223
<b>Appendix C</b>	Introductory Letter to Teachers	225
<b>Appendix D</b>	Parent / Guardian Information Sheet and Consent Form	227
<b>Appendix E</b>	Child Information Sheet and Consent Form	232
<b>Appendix F</b>	Case Eligibility / Ascertainment Form	237
<b>Appendix G</b>	Contact Details Form	240
<b>Appendix H</b>	Control Parent Demographic Form	245
<b>Appendix I</b>	Clinical and Control Parent Demographic Form	249
<b>Appendix J</b>	Teacher Questionnaire	253
<b>Appendix K</b>	Introductory Letter to Principals	259
<b>Appendix L</b>	Information Sheet for Teachers	261
<b>Appendix M</b>	Semi-Structured Interview Schedule	263
<b>Appendix N</b>	Teacher Consent Form	266
<b>Appendix O</b>	Email to Principals	268
<b>Appendix P</b>	Information Sheet for Principals	270
<b>Appendix Q</b>	Study 3 – Information Sheet for Teachers	273



<b>Appendix R</b>	Concussion Seminar Powerpoint Slides	276
<b>Appendix S</b>	Teacher Brochure	292
<b>Appendix T</b>	Study 3 – Background Questionnaire	295
<b>Appendix U</b>	Concussion Quiz	297
<b>Appendix V</b>	Seminar and Brochure Evaluation Form	299

## LIST OF TABLES

<i>Table</i>		<i>Page</i>
1.1	Adult Glasgow Coma Scale	2
1.2	Paediatric Glasgow Coma Scale	2
3.1	Demographic information for the TBI and control participants	42
3.2	Injury mechanisms and incident locations	43
3.3	Psychological measures	45
3.4	SDQ parent and teacher ratings – Clinical significance cut-offs	47
3.5	Description of the Clinical Scales on the BRIEF parent and teacher forms	49
3.6	MANOVA – SDQ parent and teacher Ratings	62
3.7	Fisher’s Exact Test – Parent and teacher ratings of clinical significance on the SDQ	63
3.8	Pearson correlations between parent and teacher SDQ scores	64
3.9	MANOVA: WISC-IV Subscale and Composite Scores	65
3.10	Pearson Chi-Square – Clinical vs. Control: Number of children obtaining WISC-IV scores in the below or average and above ranges	67
3.11	MANOVA: WCJ III ACH Composite Scores	69
3.12	Pearson Correlation coefficients between WCJ III ACH Academic Achievement composite score, FSIQ and parent and teacher BRIEF and SDQ composites.	70
3.13	Frequencies of Learning Strengths and Weaknesses and Pearson Chi-Square Analysis	72
3.14	Frequencies of Teacher Impressions – Reading, Spelling, Math & P.E	73

3.15	Frequencies of Teacher Impressions – Handwriting and Language Domains	73
3.16	Frequencies of Domain Impairments	74
3.17	Demographics of Children with Multiple Impairments (3+ domains of functioning)	76
3.18	Individual cases of multiple impairments with teacher information included	76
4.1	Teacher Perception of Injury mechanisms	114
4.2	Teacher Perceptions of Risk Factors (total responses)	116

**LIST OF FIGURES**

<i>Figure</i>		<i>Page</i>
1.1	Recruitment and selection of clinical group cases for the present study.	40

## CHAPTER 1

### The Epidemiology of Traumatic Brain Injury

Traumatic Brain Injury (TBI) is defined as “an acute brain injury resulting from mechanical energy to the head from external forces” (World Health Organisation, 2005). Problems of definition and classification exist throughout the literature on TBI, with many studies using the broad term ‘head injury’ to describe such an event (Kraus & Chu, 2005). Discussions of mild TBI (mTBI) are further confused by the use of multiple terms such as ‘minor closed-head injury’ and ‘concussion’ (Kirkwood et al., 2008). The use of differing terms is also complicated by disagreement within the literature regarding the criteria and classification of the level of severity in TBI, with a multitude of definitional criteria having been generated by numerous professional groups such as the American Congress of Rehabilitation Medicine (1993), American Academy of Neurology (1997), American Academy of Pediatrics (1999) and the World Health Organisation (WHO, 2005), although many of these professional groups have subsequently clarified such definitions. This is particularly salient in the case of milder traumatic brain injuries, the classification of which continues to be hotly debated in spite of significant similarities between each professional group’s suggested definitional criteria.

According to the most widely accepted definition put forward by the WHO (2005), TBI is diagnosed when immediate post-injury symptoms include one or more of the following: (1) confusion or disorientation; (2) loss of consciousness; (3) post-traumatic amnesia; (4) other neurological abnormalities (e.g., focal neurological signs, seizure, intracranial lesion) (Carroll, Cassidy, Holm, Kraus, & Coronado, 2004). The severity of TBI in adults is classified as being ‘mild’, ‘moderate’ or ‘severe’ according to scores on the Glasgow Coma Scale (GCS) (Carroll, Cassidy, Holm, et al., 2004; New Zealand Guidelines

Group, 2006). This scale is not applicable to young children, however, as it includes verbal response as a key measure of responsivity. This issue was addressed with the introduction of the Paediatric Glasgow Coma Scale (pGCS) (Murray, Tyler, Jones, Stuntz & Lemire, 1988), which included an alteration to the type of verbal responses expected from a child and provided an option to replace the verbal response assessment with one of grimace response, applicable in cases where a child is pre-verbal or unable to verbalise due to obstruction, such as intubation. Table 1.1 and 1.2 detail the scoring criteria for the adult and paediatric versions of the GCS.

Table 1.1

*Adult Glasgow Coma Scale*

BEST EYE RESPONSE	BEST VERBAL RESPONSE	BEST MOTOR RESPONSE
1. No eye opening 2. Eye opening to pain 3. Eye opening to verbal command 4. Eyes open spontaneously	1. No verbal response 2. Incomprehensible sounds 3. Inappropriate words 4. Confused 5. Orientated	1. No motor response 2. Extension to pain 3. Flexion to pain 4. Withdrawal from pain 5. Localising pain 6. Obeys command

Table 1.2

*Paediatric Glasgow Coma Scale*

BEST EYE RESPONSE	BEST VERBAL RESPONSE	BEST GRIMACE RESPONSE	BEST MOTOR RESPONSE
1. No eye opening 2. Eye opening to pain 3. Eye opening to verbal command 4. Eyes open spontaneously	1. No verbal response 2. Incomprehensible sounds 3. Inappropriate words 4. Confused 5. Orientated	1. No response to pain 2. Mild grimace to pain 3. Vigorous grimace to pain 4. Less than usual spontaneous ability or only responds to touch stimuli 5. Spontaneous normal facial/oro-motor activity	1. No motor response 2. Extension to pain 3. Flexion to pain 4. Withdrawal from pain 5. Localising pain 6. Obeys command

Scores from each of the three parameters (eye, verbal/grimace and motor) are combined to obtain the GCS score. A mild injury is reflected by a GCS score of 13-15, moderate injury by a score of 9-12 and severe injury by a score of 3-8. Additional to this criteria, it has been identified that individuals with a GCS score of 13 have significantly poorer outcomes in comparison to those with scores of 14 or 15, which has led to the suggestion that a sub-category of 'high-risk mTBI' be established in order to account for the differences in prognosis experienced within this group (Hsiang, Yeung, Yu, & Poon, 1997). Servadei, Teasdale and Merry (2001) also proposed a method of distinguishing between cases of mTBI in which individuals may be classified as having low, medium or high risk complications. According to this criteria, those with a GCS score of 15 and no history of amnesia, vomiting, diffuse headache or loss of consciousness are classified as low-risk, while medium-risk patients are those with a GCS score of 15 and some history of one or more of those symptoms. High-risk mTBI is defined as a GCS of 14 or 15 with skull fracture and / or evidence of neurological deficits. These categories are seen to be predictive of the risk of intracranial hematoma and, it is suggested, should inform assessment and treatment approaches on presentation to an emergency department.

### **Prevalence and Incidence**

WHO projections suggest that by the year 2020, TBI will be the third leading cause of death and disability in the world (WHO, 2006). The overall international incidence of TBI, regardless of severity, is approximately 200-300 per 100,000 individuals annually in developed countries such as Australia and the United Kingdom (Torner, Schootman, Rizzo, & Tranel, 1996). While there is a dearth of literature related to the incidence of TBI in developing countries, current evidence suggests that rates vary widely across such areas, from

160 per 100,000 in India to 360 per 100,000 in Brazil. In paediatric populations, TBI is a common occurrence (Feigin, Barker-Collo, Krishnamurthis, Theadom, & Starkey, 2010). It is estimated that approximately 475,000 children under the age of 14 in the United States experience TBI annually. Approximately 90% of children seen in hospital settings are treated in an Emergency Department and released with the remainder, some 37,000 of these events, resulting in hospitalisations. International incidence rates are likely to be underestimated, however, as registration of new TBI cases is notoriously poor, even in wealthy and developed countries (Feigin, Barker-Collo, Krishnamurthis, Theadom, & Starkey, 2010).

Irrespective of age, 70-90% of TBIs are mild (von Holst, 2007). When severity is unaccounted for, overall case fatality rates for TBI are approximately 3% (Waxweiler, Thurman, Sniezek, Sosin, & O'Neill, 1995). The incidence of mortality in individuals with moderate to severe TBI is high, with an estimated case fatality rate of 30-50% (Feigin, et al., 2010) within the first month post-injury. However, fatality rates for this group decline after that period and at six months post-injury are comparable to those of survivors of mTBI (Brown et al., 2004). 30-day case fatality rates in those with mTBI are much lower (below 1%), however, analysis of long-term survival in individuals with mTBI indicates a small, but significant reduction in age expectancy (Brown, et al., 2004). It is noted that TBIs resulting in death are excluded from a number of epidemiological studies, which may have contributed to an under-representation of the frequency of fatal TBI in the literature (Bruns & Hauser, 2003).

A number of methodological issues have acted as barriers to the collection of accurate data relating to the incidence and prevalence of TBI in New Zealand. These include an over-reliance on hospital data, diagnostic and coding issues (including high rates of false positives and negatives), inconsistent criteria for study inclusion and the issue of many individuals with mTBI not seeking or being able to access medical attention and thus not coming to the



attention of researchers (New Zealand Guidelines Group, 2006). The New Zealand Accident Compensation Corporation (ACC) has estimated the total incidence of TBI in New Zealand, on the basis of WHO Task Force projection data, at 660 per 100,000 annually. Closer examinations of special populations have also been conducted, such as Barnfield & Leatham's (1998) study of TBI in a prison population. They administered self-report questionnaires to 188 participants aged between 20 and 69 years in Wanganui prison. Of those sampled, 86.4% reported a previous TBI, with 56.7% reporting multiple TBI. As these were lifetime prevalence rates based upon self-report, it is difficult to compare the findings of this study to other international and local studies, which tend to employ objective measures and report on annual incidence rates. However, the results are comparable to other studies of prison populations and suggest that rates of TBI in prison are expectedly high due to the increased risk factors in this population (e.g., violence history, association with antisocial peers, socio-economic deprivation factors, and exposure to childhood abuse and neglect).

While the scarcity of New Zealand data extends to the epidemiology of paediatric TBI, one prospective study examined prevalence amongst 1265 individuals in a birth cohort. The results found that New Zealand rates of TBI for individuals under 25 are similar to those seen internationally, with incidence estimated to be between 100 and 230 per 100,000 annually (McKinlay et al., 2008). Overall lifetime prevalence rates in this cohort were approximately 30%, with approximately 30% of the injured group experiencing multiple TBI.

Several New Zealand studies of hospital data have also produced interesting findings, although these should be considered in light of the methodological problems highlighted above. In 2004, Christchurch Hospital Emergency Department recorded 2133 TBIs which accounted for 3.2% of total emergency presentations in that year. Of that sample, 554 (26%) individuals were aged 0-16 years (New Zealand Guidelines Group, 2006). In another, more

specific, examination of mTBI, Wrightson and Gronwall (1998) conducted an eight-week study of concussion presentations to four Auckland hospitals. Their findings were suggestive of an estimated annual incidence of 252 per 100,000 for individuals aged 0-15 years. However, as both of these studies focused on hospital presentations, they likely represent underestimations of TBI rates as many mTBI are not treated in hospital settings. The few studies that have used population-based methods have tended to arrive at significantly higher incidence rates (e.g., Leibson et al., 2011; Feigin et al., 2013).

In spite of efforts to address the dearth of accurate epidemiological data pertaining to TBI in New Zealand, in 2006 the New Zealand Guidelines Group stated that the true extent of TBI could not be established in the absence of prospective methodologies, consistent criteria and community-based data. In response to this highlighted need for robust data, the Brain Injury Outcomes New Zealand In the Community (BIONIC) study was developed. This prospective and retrospective population-based study of incidence and outcomes included all cases of TBI identified in Hamilton city (population 129,429) and the wider Waikato district (population 43,956) between March 2010 through February 2011. Using the WHO criteria, with reference to GCS in the majority of cases (as available), the BIONIC study aimed for complete case ascertainment via the use of multiple, overlapping sources. Participants could self-refer or be referred by a healthcare provider. Daily hospital admission checks were complemented by regular engagement with General Practitioners, rehabilitation centres, outpatient clinics, resthomes, coroners, ambulance services, prisons, and checks of the ACC injury database. Opportunities for self-referral were widely advertised and all cases were cross-checked (Theadom et al., 2011). Participants for Study 1 were drawn from a subset of the BIONIC sample.

Using this methodology, 1369 new TBI cases were identified (Feigin et al., 2013). Of those, 69% were male. Adolescents and young adults made up a large proportion of the sample; 28.3% were aged 0 to 15 years and 40.7% aged 15-34 years. The majority of cases were of mild severity (95%). The BIONIC study identified an overall incidence rate of TBI in the Waikato was 758/100,000. Incidence peaks were seen in children under five and adolescents / young adults: total incidence for those aged 0-4 years was 1111/100,000, while for those aged 15-34 years total incidence was 1128/100,000. Incidence dropped to 727/100,000 in young people aged between five and 14 years.

### **Risk Factors for TBI**

Age is considered to be a significant risk factor for TBI. As noted, the incidence of TBI peaks between the ages of 15 and 24 years; however, a smaller yet significant peak is also evident in children under 5 years. While pre-school-aged children are more likely to experience inflicted TBI or injuries related to falls, school-aged children are more at risk of TBI from transport-related mechanisms (such as bicycle crashes or pedestrian accidents) (Agran, Winn, Anderson, Trent, & Walton-Haynes, 2003; National Center for Injury Prevention and Control, 2011). As children move into middle and late childhood, their risk of injury from automobile accidents steadily increases, while the risk of pedestrian injuries declines (Agran, et al., 2003). Data from the BIONIC study suggest that falls cause the majority of TBI in young children (76%), with exposure to mechanical forces accounting for the majority of injuries in those aged 5-14 years (Feigin et al., 2013). For those aged over 15 years, transport accidents caused the majority of injuries. Maori adolescents and young adults were three to four times more likely to have an injury caused by assault than Europeans.

These epidemiological findings highlight the possible role of ethnicity, age and gender as risk factors in TBI.

However, there is some controversy surrounding the role of ethnicity in the incidence of TBI, with conflicting data contributing to disagreement in the literature. It has been reported that individuals from ethnic minorities, particularly in the United States, are more likely to experience TBI than their Caucasian counterparts (Rutland-Brown, Wallace, Faul, & Langlois, 2005; Thurman, Alverson, Dunn, Guerrero, & Snieszek, 1999). However, it has been argued that there are significant problems with the research methodologies and data quality associated with such findings, and some researchers have suggested that it is not yet possible to determine what type of relationship might exist between ethnicity/race and TBI (Kraus & Chu, 2005; Winqvist, et al., 2008). In a New Zealand context, it is reasonably well-established that the incidence of TBI is higher in Maori (indigenous peoples of Aotearoa / New Zealand) and Pasifika (individuals of Polynesian, Melanesia or Micronesian descent) populations, although it is acknowledged that current methods of collecting ethnicity data may limit the validity of such findings. The incidence of mTBI in Maori is likely to be an under-representation of true statistics, and moderate to severe head injuries are more common (22% of all injuries) than would be expected in Pakeha (individuals of European and British descent) populations (Accident Compensation Corporation, 2006). Current research indicates that Maori experience poorer outcomes and higher mortality rates than Pakeha. Such disparities have been found to be even more significant within paediatric populations (New Zealand Guidelines Group, 2006).

There is also a significant association between lower socio-economic status (SES) and an increased risk of TBI (Feigin, et al., 2010; Kraus & Chu, 2005). Furthermore, lower SES has also been found to be predictive of poorer long-term outcomes in terms of cognitive,

mental health, social, occupational and family functioning (Hawley, Ward, Magnay, & Long, 2004; Hoofien, Vakil, Gilboa, Donovan, & Barak, 2002). While it is difficult to untangle the relationship between socio-economic and ethnicity variables, it is apparent that low SES remains a significant risk factor in relation to TBI even when ethnicity variables are controlled for (Feigin, et al., 2010; New Zealand Guidelines Group, 2006).

Gender is strongly associated with the incidence of TBI. TBI occurs in males at rates that range from 1.6 to 2.8 times the incidence of injury in females; however this gender difference varies with age. Infant males and females have approximately the same level of risk, but in those over 5 years of age, the incidence increases faster in males and results in prevalence rates over double that of females by age 15. This discrepancy is most apparent during adolescence and may be explained by an increased likelihood that males will engage in risk-taking or violent behaviour during their teenage years in comparison to their female peers (Barker-Collo, Wilde, & Feigin, 2009; Bener, Omar, Ahmad, Al-Mulla, & Abdul Rahman, 2010). This was also confirmed by the finding in the BIONIC study that showed that TBI rates were significantly higher amongst male children than female and that this discrepancy increased with age (Feigin et al., 2013).

Alcohol use is a well-established risk factor for TBI. In adults and adolescents, alcohol intoxication presents a major risk factor for head injuries, the mechanisms of which commonly include events such as motor vehicle accidents, falls and episodes of violence (Kraus & Chu, 2005). In paediatric populations, parental alcohol misuse has been found to be strongly associated with child TBI (Winqvist et al., 2008). It is suggested that the relationship between parental alcohol abuse and paediatric TBI is related to the association between alcohol abuse and the physical abuse or neglect of children, which thereby increases their risk of being exposed to situations in which they are more likely to sustain a TBI (Villalba-Cota,

Trujilo-Hernandez, Vasquez, Coli-Cardenas, & Torres-Ornelas, 2004; Widum & Hiller-Sturmhofel, 2001). Additionally, parental alcohol abuse increases the likelihood that children and adolescents will also engage in hazardous drinking behaviours as modelled by their parents, further predisposing them to TBI (Winqvist, et al., 2008).

A significant marker of TBI risk can be seen in the incidence of multiple TBI. Individuals who have experienced one head injury are up to three times more likely to experience second TBI, while those experiencing a second injury have a relative risk of a third TBI which is approximately nine times that of an initial injury (Annegers, Grabow, Kurland, & Laws, 1980; Kraus & Chu, 2005). Such an increased risk is particularly associated with alcohol abuse and other environmental/internal factors (for example, a neglectful home environment or high levels of impulsivity) which increase an individual's vulnerability to injury (Kreutzer, Doherty, Harris, & Zasler, 1990; Salcido & Costich, 1992).

In summary, TBI is a widespread and relatively common occurrence in both adult and paediatric populations. Mild injuries account for the majority of incidents and affect a large proportion of the population prior to adulthood. While methodological issues have historically hindered the collection of accurate epidemiological data relating to TBI, particularly in a New Zealand context, the BIONIC study has addressed a large number of these methodological issues and provides an up-to-date and accurate insight into the actual regional and estimated national incidence rates of TBI (including non-hospitalised cases of paediatric mTBI).

This chapter has provided background regarding the epidemiology of TBI to help contextualise the studies that follow. While mTBI is vastly more common in children than moderate or severe injuries, its effects can be complex and difficult to assess. The next chapter will examine the consequences of mTBI in childhood. It will begin with an overview

of postconcussive symptoms. The chapter will then lead to a discussion on specific areas of child developmental functioning that may be impacted after concussion, which is the main focus of the first study.

## CHAPTER 2

### **The Consequences of Paediatric Traumatic Brain Injury**

As the majority of TBI are not fatal, those who sustain injuries must live and cope with the consequences that may arise. When TBI occurs at a young age, this can mean a lifetime of persistent effects. While it has been argued that young age at time of injury could be a protective factor due to neuroplasticity potentially contributing to recovery, longitudinal research has consistently demonstrated that the earlier a moderate or severe injury occurs, the more significant and persistent functioning deficits may emerge over time (Ewing-Cobbs et al., 2004).

The question of whether mTBI results in persistent complications for children is a controversial one. Conflicting research findings have been at least partially attributed to methodological problems and inconsistent use of TBI definitions discussed in the previous chapter (McKinlay, 2009). Satz, Zaucha, McCleary, & Light (1997) established a set of six criteria that they proposed were essential for methodological rigour in studies of mTBI: consistent definition of TBI severity; longitudinal design; the inclusion of a matched cohort; standardised assessment measures; inclusion of preinjury factors; and, a sample size greater than 20. The authors suggested that, when such criteria were applied to a literature review, persistent post-concussive difficulties were less likely to be identified.

In order to give an overview of the current literature base, this chapter will discuss the research relating to paediatric mTBI, including some studies that do not meet the criteria listed above. It is useful to be mindful of these methodological recommendations, however, in considering the generalisability of the research discussed here.



## **Post-Concussive Syndrome**

Post-concussive symptoms (PCS) are physiological, affective and behavioural effects that may occur in the weeks and months (and rarely, years) following mTBI. PCS are typically associated with mTBI; however, symptoms may also be present in individuals who have experienced moderate or severe injuries (Mittenberg & Strauman, 2000). Symptoms generally resolve within three months but a proportion of children experience persistent symptoms (Ponsford et al., 1999; Taylor et al., 2010). One recent study of PCS in children indicated that 11% of those seen in emergency departments after mTBI experience symptoms for longer than 3 months, with 2% of that cohort presenting with persistent symptoms past the 12-month time-point (Barlow, Crawford, Stevenson, Sandhu, Belanger, & Dewey, 2010). Physical symptoms such as headaches and dizziness occur most commonly, with headaches present in up to 90% of individuals diagnosed with PCS. Less frequently occurring symptoms include light or noise sensitivities, vision and hearing problems, sleep disorders, fatigue, nausea and vomiting (Hall, Hall, & Chapman, 2005; Jagoda & Riggio, 2000; Margulies, 2000).

A variety of psychological, behavioural and cognitive symptoms may occur in the post-concussive period. Emotional disturbances including anxiety, irritability and depression may be seen. Adding to the complexity of diagnosis, several of the physical changes that may occur in PCS mirror symptoms of psychological disorders such as depression (e.g., fatigue, insomnia) or anxiety (nausea, noise sensitivities) (Sadock & Sadock, 2003). Significant personality changes may also occur (O'Shanick & O'Shanick, 2005). Furthermore, problems of behavioural inhibition and emotion regulation, such as impulsivity, aggression, anger, restlessness and impaired social judgement can be evident (McAllister, 2005).

Such symptoms are not exclusive to TBI; the same set of symptoms may also be evident in individuals who have suffered other types of injuries not involving brain insult such as orthopaedic injuries (Yeates & Taylor, 2005). This is likely to be due to the general and multi-causal nature of many post-concussive symptoms (e.g., fatigue, headaches, low mood). However, children are significantly more likely to demonstrate such symptoms after mTBI than children with other types of injuries or their non-injured peers (Mittenburg, Wittner, & Miller, 2007; Yeates et al., 2009). While it is generally understood that most PCS symptoms resolve within three months, understanding the persistence of PCS in children has been hindered by methodological problems such as a lack of appropriate comparison groups, which has affected the conclusiveness of studies in this area (Taylor et al., 2010).

Research suggests that there are some significant differences between adults and children in post-concussive symptom expression and reporting, which likely relates to the maturational differences in terms of neuropsychological development and injury response. It is likely that the assessment of such symptoms is also impacted by the different expectations of adaptive functioning in adults and children (Kirkwood, Yeates, & Wilson, 2006). Multi-dimensional scales used in the assessment of postconcussive symptoms have consistently demonstrated high validity in their use with adults (Randolph et al., 2009); however, the validity of such symptoms and the use of post-concussive assessment scales in children remains unclear (Janusz, Sady, & Gioia, 2012). Psychometric studies investigating the reliability and validity of measures such as derivatives of the Health and Behavior Inventory (HIB; Barry, Taylor, Klein & Yeates, 1996), Head Injury Scale (HIS; Piland, Motl, Ferrara, & Peterson, 2003), the Concussion Symptom Inventory (CSI; Randolph et al., 2009), the Rivermead Post Concussion Symptoms Questionnaire (RPCSQ; King, Crawford, Wenden, Moss & Wade, 1995) and Post-Concussion Symptom Inventory (PCSI; Gioia, Janusz, Isquith, & Vincent, 2008) have demonstrated the potential applicability of these tools in child

populations (Gagnon, Swaine, Friedman, & Forget, 2005; Mailer, Valovich-McLeod, & Bay, 2008; Piland, Motl, Ferrara, & Peterson, 2003; Piland, Motl, Guskiewicz, McCrea, & Ferrara, 2006; Taylor et al., 2010). These investigations, particularly those related to construct validity and inter-rater reliability, lend support to the growing evidence that post-concussive symptoms in children are not dissimilar to those seen in adults (Hajek et al., 2011; Janusz, Sady, & Gioia, 2012).

Methodological problems (such as failures to accurately and consistently define mTBI and characterise its severity) have contributed to ongoing controversy regarding the etiological nature of post-concussive symptoms (Yeates & Taylor, 2005). Some studies have suggested a physiological basis, while others argue that ongoing PCS has psychological underpinnings (Bigler, 2008; McKinlay, 2009). For example, Giza & Hovda (2001) reviewed over 100 studies examining post-concussion pathophysiology and found that concussion may result in significant neurological impacts including “abrupt neuronal depolarization, release of excitatory neurotransmitters, ionic shifts, changes in glucose metabolism, altered cerebral blood flow, and impaired axonal function” (p.1). Other studies have highlighted the association between structural abnormalities identified via neuroimaging and longer-term cognitive outcomes after mTBI (Levin et al., 2008; Wilde et al., 2008). While studies such as these lend weight to the physiogenesis hypothesis of mTBI impairments, others suggest that a raft of psychosocial variables may be more predictive of neuropsychological outcomes (Yeates et al., 2012). These include premorbid child and parent emotional functioning, post-injury parental distress, and socioeconomic factors (Olsson et al., 2013; Yeates et al., 2012). This suggests that individual and family psychosocial functioning (and associated variables such as SES) may mediate or potentiate negative outcomes after mTBI.

## **Emotional Functioning**

There is a limited amount of literature pertaining to emotional wellbeing following paediatric mTBI, however the evidence to date suggests that children who have sustained a concussion may be more likely to experience mood and anxiety disorders (Yeates & Taylor, 2012). Earlier studies indicated that children with mild to moderate injuries were unlikely to demonstrate any psychiatric disturbance or emotional changes at 12-month follow up (Black, Blumer, Wellner, Shepard, & Walker, 1981; Brown, Chadwick, Shaffer, Rutter, & Traub, 1981). However, those studies lacked the use of an appropriate control group and standardised assessment measures (Luis & Mittenberg, 2002). More recent research has demonstrated the possibility that children will experience ongoing emotional symptoms following TBI. In a study of children with TBI in the United Kingdom (U.K.) that used the Hospital Anxiety and Depression Scale (HADS), Hawley (2003) found that the parents of those who had experienced mTBI two to six years prior perceived their children to have significantly higher anxiety levels than those in a matched cohort. Ponsford et al. (1999) investigated the role of multiple mTBI in emotional functioning and found that children who had experienced more than one injury and also had pre-existing learning, neurological, psychological and family problems, were at increased risk of experiencing persistent emotional problems and mood disorder symptoms 3-months post-injury.

In a review of the research relating to mTBI and anxiety disorders in both adult and children, Moore, Terryberry-Spohr and Hope (2006) described the evidence as “scattered but significant” (p.1). Their review highlighted research investigating the relationship between mTBI and a variety of anxiety symptoms and disorders such as Generalised Anxiety Disorder (GAD), Post-Traumatic Stress Disorder (PTSD), Obsessive Compulsive Disorder (OCD). The authors found that studies of anxiety symptoms after mTBI were rife with

methodological issues, such as inconsistent definitions and prevalence rates, which perpetuated an ongoing inconclusiveness regarding the relationship between anxiety and mTBI.

### **Behavioural Problems**

The ability to inhibit and regulate one's behaviour is a component of executive function (EF), typically associated with the frontal lobe (Barkley, 1997). This part of the brain is particularly susceptible to damage caused by injuries involving acceleration and/or deceleration (e.g., contrecoup injury) and thus it is unsurprising that behavioural problems are possible after mTBI (McKinlay, 2009). In contrast to the dearth of literature relating to emotional difficulties after mTBI, there is a relative abundance of research investigating the possible presence of behavioural problems in such individuals. However, many of the methodological issues described in earlier studies affect the robustness of data obtained from studies in this area. While Yeates and Taylor (2012) note the increased rates of Attention Deficit / Hyperactivity Disorder (ADHD) and Oppositional Defiant Disorder (ODD) seen in children who sustain mTBI, they also highlight the need for the inclusion of outcome measures with greater specificity and sensitivity in studies investigating neurobehavioural outcomes after mTBI. Kirkwood & Yeates (2010) state that there is a lack of well-designed studies utilising prospective methodologies and that this contributes to the lack of clarity relating to this issue. They also note the problem highlighted by Bijur, Golding, Haslam and Kurzon (1988), that children who sustain mTBI are more likely to have a history of developmental and behavioural problems than their non-injured peers. Assessment of premorbid functioning, thus, should be considered in research design, yet poses a significant challenge for researchers.

McKinlay (2009) conducted a review of literature relating to paediatric mTBI outcomes from 1977 to 2008. That analysis highlighted the conflicting data surrounding the notion that mTBI in childhood may have ongoing effects. McKinlay cites multiple authors who have found evidence for behavioural deficits after mTBI (e.g., McKinlay, Dalrymple-Alford, Horwood, & Fergusson, 2002; Hawley, 2003; Hessen, Nestvold, & Anderson, 2007) and contrasts this with a comparable number of investigations that have yielded quite different outcomes, in which researchers found no significant behavioural impairments in children following mTBI (e.g., Asarnow, Satz, Light, Lewis, & Neumann, 1991; Asarnow, Satz, Light, Zaucha, Lewis & McCleary, 1995; Kinsella, Ong, Murtagh, Prior, & Sawyer, 1999; Ponsford et al., 1999; Nadebaum, Anderson, & Catroppa, 2007). These mixed findings were again confounded by study design problems, the issue of premorbid functioning and a lack of clarity regarding the role of socio-economic and family factors. In order to address these methodological issues, McKinlay suggests the following: Universal research criteria and definition of mTBI, better information regarding the sensitivity of measures for use with mTBI, use of smaller age ranges that consider developmental stage (rather than including, for example, young children through to adolescents), assessment of which groups act as appropriate controls for mTBI (as it is not clear that those who have experienced orthopaedic injuries, lacerations or burns, act as suitable controls), and increased information regarding the relationships amongst psychosocial, family and environmental variables that might impact outcomes. McKinlay also suggests that research should focus beyond children's functioning at home, where demands may be reduced and problems masked by parental attendance to children's needs and difficulties, and consider how symptoms might be expressed in more complex environments with reduced supports.

In regards to premorbid functioning, there is a small body of evidence to suggest that attention deficits and hyperactivity may contribute to injury occurrence. However, few

studies have attempted to retrospectively assess for ADHD symptoms pre-injury (Pless, Taylor, & Arsenualt, 1995; Max, et al., 2004). Max et al. (2004) conducted standardised psychiatric interviews that assessed for pre-injury behavioural symptoms and identified that ADHD was present in 10% of the sample prior to injury, which is not dissimilar to agreed international and New Zealand prevalence rates (Centers for Disease Control and Prevention, 2013; Hanne, 2010)  $\beta$ . In a similar study, Bloom et al. (2001) found that 22% of participants evidenced ADHD symptoms prior to sustaining a TBI. More recently, Ornstein et al. (2013) examined response inhibition in children diagnosed with ADHD (N=92) and compared their performance with children who had sustained TBI (N = 103) along with a control group of typically developing children (N = 79). All participants were aged between six and 14 years. TBI severity ratings ranged from mild to severe. While some of those in the TBI group had been identified as showing secondary ADHD symptoms post-injury, none had a diagnosis of ADHD prior to sustaining at TBI. Children with TBI evidenced lower inhibition than those in the control group, regardless of whether they demonstrated symptoms of secondary ADHD.

There have been several recent undertakings to address methodological issues in this area with research investigating long-term behavioural outcomes following paediatric mTBI in a New Zealand context. McKinlay et al. (2008) investigated behavioural symptoms in 81 children aged seven to 13 years who had experienced a mTBI prior to age five and compared these against a matched cohort of non-injured children. They conducted diagnostic interviews that reflected ADHD, ODD and Conduct Disorder (CD) criteria with parents and teachers and found increased symptoms of each disorder in the clinical group. In another New Zealand study, Barker-Collo (2007) used the Child Behavior Checklist (CBCL; Achenbach, 1991) to examine behavioural symptoms in 74 children aged four to 13 years who had experienced mild, moderate or severe TBI in the 24 months prior. Over half (54.1%) of the sample's injuries were of mild severity. Symptoms of children in the clinical group were compared

against those in a control group of children with orthopaedic injuries (specifically, broken femur). Barker-Collo's investigation found that behavioural symptomatology in the clinical group were in the normal range on the CBCL.

In summary, the relationship between mTBI and behaviour problems remains unclear, with some evidence that post-injury symptoms are reflective of premorbid behavioural issues which in itself may predispose children to TBI, and other evidence to support the hypothesis that the relationship is causative. Further investigation into this area is warranted but particular attention needs to be paid to the issue of pre-injury symptoms in order to clarify the nature of the relationship between ADHD, conduct problems and mTBI.

### **Social Functioning**

Research suggests that poor social competence is a possible effect of TBI; however, impairments in social functioning are more likely to occur in individuals with severe injuries (Yeates et al., 2013). Interestingly, social impairments may become more pronounced rather than attenuated with time (Williams & Mateer, 1992). However, only a few studies have examined the relationship between social impairment and paediatric mTBI. While it seems reasonable to hypothesise that social competency might be impaired after mTBI in cases where children demonstrate learning or behavioural problems (due to correlations between these variables), there is in fact very little evidence to support the notion that mTBI has social consequences for children. One investigation that used a prospective, longitudinal design and assessed social functioning using the Strengths and Difficulties Questionnaire (SDQ) found no differences between children who had sustained a concussion and those in a reference group (Petersen, Scherwath, Fink, & Koch, 2008). A similar absence of significant



differences was identified in another prospective, longitudinal study examining a variety of neurobehavioural outcomes in children aged 3-7 years at the time of injury (Anderson, Catroppa, Morse, Haritou, & Rosenfeld, 2001). Social skills were assessed via the Vineland Adaptive Behavior Scale (VABS) and children in the clinical group demonstrated similar levels of functioning those in a non-injured matched cohort. The scant literature relating to social competence is further confounded by inconsistency in assessment measures utilised in the studies. While the evidence for social impairment after paediatric mTBI is currently limited, the possibility remains that other behavioural and psychological problems might impact on social functioning in children and therefore there is room for further investigation and clarification of this area.

### **Cognitive Functioning**

Cognitive functioning may refer to global neuropsychological functioning as well as specific domains, including intelligence, executive function, attention, memory and learning. As noted previously, it is not unusual for cognitive symptoms to present in the immediate post-concussive period. Whether such symptoms persist long-term, however, is a question that requires closer examination. To do so, we will look more specifically at the neurocognitive domains listed above and examine the literature relating to these areas of functioning post-mTBI in childhood.

**Intelligence.** The term intelligence is used here to refer to intellectual functioning as measured by standardised assessment tools, such as the Wechsler Intelligence Scales for Children – Fourth Edition (WISC-IV; Wechsler, 2004). The construct of intelligence is seen through this lens to reflect several aspects of cognitive functioning and educational

achievement. In the case of the WISC-IV, these can be described in terms of its four subscales: verbal comprehension, perceptual reasoning, working memory and processing speed. These components of intelligence are each comprised of many different neuropsychological abilities and also reflect environmental contributors (such as early enrichment and educational engagement). While it is acknowledged that intelligence is made up of other cognitive abilities relating to attention and memory, we will examine those constructs independently later in the piece. In the meantime it is useful to consider intelligence as a global construct that can be described in terms of a score (IQ) and, in particular, the literature pertaining to IQ scores and performance on standardised measures of intelligence assessment after mTBI.

As with many other types of functional impairment, declines in intellectual functioning are typically associated with greater injury severity (Anderson, Catroppa, Morse, Haritou, & Rosenfeld, 2000). While persistent IQ deficits are more expected after severe TBI (Anderson, Godfrey, Rosenfeld, & Catroppa, 2012), very little research has specifically investigated IQ test performance in children after mTBI and thus less is known about the impact of mTBI on intellectual functioning.

One study that looked exclusively at IQ scores after paediatric mTBI using the WISC-III included a cohort of 30 children with injuries ranging from mild to severe (Tremont, Mittenberg, & Miller, 1999). The majority of injuries (73%) were mild. Outcomes were compared against a matched cohort of children with orthopaedic injuries, with the control group matched on gender, age, ethnicity, parent education and occupation. Premorbid functioning was accounted for via screening for pre-injury diagnoses of learning disability, ADHD, psychiatric disorder and prior TBI. The results of this study showed that children with TBI achieved significantly lower scores on most subscales of the WISC-III, particularly

those that measured perceptual and processing abilities. The authors propose that, as the majority of the cohort had mild injuries, these results indicate that mTBI results in lower IQ. However, injury severity was not controlled for in the analysis and it is possible that the significantly lower scores that might be expected in children with severe TBI may have biased the mean scores for the remainder of the TBI group. Thus, it is not clear that the significant differences in IQ between the TBI and orthopaedic groups were necessarily a consequence of mild TBI. Other studies that specifically examined children with mTBI in the analysis have found no significant impairments in WISC performance when compared against a matched cohort, and particularly when viewed in comparison to same-aged peers with severe TBI (Anderson, Catroppa, Morse, Haritou, & Rosenfeld, 2000; Catroppa & Anderson, 2004; Hawley, 2004; McKinlay, Dalrymple-Alford, Horwood, & Fergusson, 2002).

**Attention.** Raskin & Mateer's (1994) model proposed five types of attention: focused (the ability to focus on an object); sustained (the ability to maintain focus for an extended period); selective (the ability to sustain attention in the presence of distracting stimuli); alternating (the ability to change set when cued); and, divided (the ability to process two pieces of information simultaneously). Few studies have examined the impact of mTBI on attentional processes in children, with mild injury groups specifically excluded from much of the previous research in this area (e.g., Wassenberg, Max, Lindgren, & Schatz, 2004).

McKinlay (2009) conducted a review of literature relating to neuropsychological outcomes in children after mTBI. In relation to attention, McKinlay identified that while attention problems are one of the more commonly reported areas of impairment after mTBI, most methodologically-sound studies show an absence of deficits at 12 or 24-month follow-up (which may suggest such deficits were not related to pre-existing ADHD). However,

McKinlay noted, few studies had included objective measures of attention. Studies that have included objective measures, such as the Continuous Performance Test as a measure of sustained attention, have not always included control groups, limiting the conclusions that can be drawn from such findings. For example, Catroppa & Anderson (2003) examined specific attention deficits in children two years after they sustained mild ( $n = 24$ ), moderate ( $n = 31$ ) or severe TBI ( $n = 14$ ). While children with severe injuries evidenced significant impairments in attentional processes, it was unclear whether those in the mild group had significant difficulties as they were only compared against those with moderate or severe injuries, rather than a non-injured cohort. This research was followed by a further investigation of a smaller cohort of children with mild ( $n = 12$ ), moderate ( $n = 24$ ) and severe ( $n = 18$ ) injuries, whose functioning was compared against a control group of 16 participants matched on age and SES at 5-year follow-up. Pre-morbid functioning was accounted for by a pre-injury assessment on the Vineland Adaptive Behavior Scale (Catroppa, Anderson, Morse, Haritou, & Rosenfeld, 2007). While significant differences in selective and sustained attention were evident between the mild and severe TBI groups, there were no significant differences between those in the mild and control groups (although it is possible that the relatively small sample size in that study may have reduced statistical power and potentially masked between-group differences). Thus, it is difficult to establish from the current research base whether attention is persistently affected after paediatric mTBI.

**Working Memory.** Working memory reflects the ability to temporarily store, manipulate and reproduce information (Baddeley, 1992). This capacity is critical to comprehension and learning (Siegel & Ryan, 1989). It has been suggested that in cases where attention problems are present after mTBI, this may be attributed in part to deficits in working memory (Cicerone, 2002). Impairments in memory can contribute to poor performance on cognitive tests, academic problems and issues with adaptive functioning.

While impaired memory has been found to be a common effect of moderate and severe TBI (Farmer et al., 1999) and has been established in adults after mTBI (Kumar, Rao, Chandramouli, & Pillai, 2013; Malojcic, Mubrin, Coric, Susnic, & Spilich, 2008), the literature relating to childhood mTBI is limited and lacks robustness.

In one such example, Loher, Fatzer and Roebbers (2012) investigated working memory in a small (N=13) sample of children aged five to 10 years, who had experienced mTBI. Children were assessed two, six and 12 weeks after their injury and their performance compared against a non-injured control group. The participants in the clinical group demonstrated subtle impairments in working memory learning tasks at all time-points and the authors suggested this might be evidence of a failure to “profit from earlier learning experiences” (p. 1), which could have significant implications for academic functioning. However, the small sample size in this instance may have impacted on the validity of the findings.

In a study that investigated memory in adults 23 years after an injury sustained in childhood or adolescence, Hessen, Nestvold & Anderson (2007) used the Wechsler Adult Intelligence Scale and Wechsler Memory Scale-Revised (WMS-R; Wechsler, 1987) to assess memory. Their findings indicated that adults who had experienced mTBI decades earlier were more likely to demonstrate memory impairment than individuals who experienced a similar injury in adulthood (lending support to the vulnerability hypothesis of age effects in TBI).

**Executive Function.** Executive Function (EF) refers to a cluster of ‘higher-order’ cognitive processes associated with the frontal lobe. It involves constructs already discussed here, such as attention. It also involves other processes such as behavioural inhibition,

organisation and planning. EF reflects the ability to act in purposeful, goal-directed ways and engage appropriate problem-solving strategies as necessary (Guy, Isquith, & Gioia, 2004).

Maillard-Wermelinger et al., (2009) examined EF in 186 children aged eight to 15 years with mTBI and compared these findings to data obtained from a control group of 99 same-aged children with mild orthopaedic injuries. The authors administered the Stockings of Cambridge and Spatial Working Memory subtests from the Cambridge Neuropsychological Testing Automated Battery (CANTAB) and obtained ratings of EF from parents using the Behavior Rating Inventory of EF (BRIEF; Gioia, Isquith, Guy & Kenworthy, 2000). While children with mTBI did not perform worse on the CANTAB measure of EF, parents of children with mTBI reported higher scores on the Metacognition Index of the BRIEF (reflective of increased difficulties in the areas of initiation, planning, and organisation, problem-solving and working memory).

The BRIEF was also used by Sesma, Slomine, Ding & McCarthy (2008) in the assessment of 330 children with head injuries of varying severities (which were defined according to an Abbreviated Injury Scale (AIS) score). They identified no significant differences in outcomes between the mild and moderate injury groups, so these were combined in the final analysis. EF was found to be significantly worse in children who had sustained severe injuries. However, it was also found that children in the mild-moderate group evidenced significantly higher Global Executive Composite (GEC) scores on the BRIEF than those in the orthopaedic injury group, suggesting poorer EF amongst that cohort. The authors also identified significant relationships between socio-economic/family factors and EF outcomes. In another study of EF utilising a neuropsychological battery that used objective measures (including a Stroop test), children with high-risk mTBI demonstrated impaired inhibition (Gerrard-Morris et al., 2010).

However, there is also evidence to suggest that persistent EF impairment is unlikely after mTBI. Nadebaum, Anderson and Catroppa (2007) also investigated 5-year EF outcomes in 54 children (mild  $n = 12$ ; moderate  $n = 24$ ; severe = 18) aged between one and seven years at the time of injury and compared their findings against a matched cohort of 17 non-injured children. Several objective measures of attentional control, cognitive and information processing were administered, and behavioural outcomes were measured using the parent BRIEF. There was little evidence of significant EF impairment in children with mild or moderate injuries, however the small size of the matched cohort may have impacted on the validity of the study's comparisons.

### **School Functioning**

While the presence of learning disorders in children is commonly associated with neuropsychological impairment (Rourke, 1985), the current literature review did not identify any studies that have examined the relationship between mTBI and learning disorders such as dyslexia. Rather, the focus of most studies related to academic functioning seems to have been regarding general academic achievement levels. Educational outcomes following TBI are typically found to be related to injury severity.

While academic impairments are a typical outcome of moderate and severe injuries, the relationship between mTBI and academic functioning remains unclear, with increasing disagreement within the literature regarding the consequences of mTBI in childhood and how this might affect school performance (Anderson, Catroppa, Morse, Haritou, & Rosenfeld, 2001). Few studies have examined academic functioning after mTBI, and most of those have found that mTBI results in normal academic functioning when children are compared to non-injured peers (Ewing-Cobbs, et al., 1998; Fay et al., 1994; Kinsella et al., 1997). For example, Light et al. (1998) used school records to investigate pre- and post-injury academic

functioning in 119 children and adolescents aged between eight and 16 years and compared their performance against an other-injury (n = 114) and non-injured (n = 106) cohort. The authors attempted to obtain mean school grades and mean achievement test scores from before and one-year post-injury. While the findings showed no significant differences between the three groups in terms of pre- and post-injury overall academic performance, only 55% of teachers provided usable data to the study, which may have impacted on the reliability of the findings.

There are several studies that have found a relationship between mTBI and academic performance. Levin & Eisenberg (1979) found that regardless of injury severity, children with TBI may have difficulties in retaining and retrieving newly learned information, which may impact on academic performance. In a New Zealand study, Wrightson, McGinn and Gronwall (1995) compared the cognitive and academic ability of 78 children who sustained mTBI before age 5 with a matched cohort of 86 children with other-injuries (described as “minor injury to another part of the body”, p. 375). At baseline, there were no significant differences between the groups; however, at six and 12 months, children with mTBI performed more poorly on tests of visual closure. At age 6.5 years, children who had sustained mTBI during their preschool years were significantly more likely to need help with reading. The authors stated that mTBI may cause “subtle but significant changes that can affect school performance” (p. 1). Other researchers have suggested that when there are subtle impairments in a child’s performance and classroom conduct, these may not be identified as being related to mTBI as teachers are often not informed of a student’s injuries and may not be aware of the possible long-term effects of TBI (Hawley, Ward, Magnay, & Mychalkiw, 2004).



## **Developmental and Methodological Considerations**

The assessment of the effects of TBI in paediatric populations is complicated by the fact that deficits may not be apparent immediately after an injury. The rapid developmental growth that occurs in childhood may contribute to the initial suppression of TBI-related impairments; however, as demands upon and expectations of a child's performance increase with age then declines in functioning may become more apparent (Taylor & Alden, 1997). This hypothesised interference with a child's developmental trajectory may not result in initial skill loss, but rather may impact on later skill acquisition. That is, a child who has learnt to read prior to sustaining a TBI may not lose the ability to read, but a child who is yet to acquire this skill may struggle with learning it later. This (sometimes hypothetical) loss of potential may be difficult to measure and can result in a child's performance appearing to be in the normal range when compared against large groups of same-aged peers; however, such a presentation may not accurately reflect the possibility that the child's ability to function at a higher level across multiple domains has been impaired by early brain insult (Taylor & Alden, 1997).

Understanding the nature of symptoms that children may present with after mTBI is also complicated by the potential relationship that such symptoms may have to the injury. Kirkwood & Yeates (2010) attempted to represent the complexity of such possible relationships by highlighting possible interactions. Six factors were highlighted as possible explanations for PCS. Firstly, the possibility that symptoms predate the injury. In this scenario, such symptoms may have been evident prior to the injury; however, it is also possible that emerging problems may not have been identified or conceptualised as problematic in the context of the child's developmental stage (particularly in younger children). This possibility was specifically highlighted by Ponsford et al's (1999) finding that

children with ongoing post-concussive symptoms were more likely to have a history of TBI, psychological problems, learning difficulties and family dysfunction. The next possible scenario highlighted is that mTBI may aggravate an already existing or emerging developmental issue. The third possibility closely relates to the second in that symptoms may be triggered in an individual with underlying problems (with the example of an underlying neurological condition highlighted by the authors). The fourth scenario is that most commonly discussed in relation to PCS; that is, that the injury is a direct cause of symptoms observed in the post-injury period. Similarly, the fifth example illustrates the possibility that symptoms may be related to secondary trauma associated with TBI (such as pain-related irritability). Finally, the authors note that symptoms that emerge in the post-injury period may be entirely unrelated to TBI (e.g., personality change as a result of social stressors emerges following an injury). In defining the various interplays between injury and symptoms, Kirkwood and Yeates (2010) emphasised the methodological and conceptual challenges which are faced by researchers attempting to examine the relationship between such symptoms and mTBI.

These types of methodological issues contribute to the often conflicting data yielded in studies of TBI. For example, studies which have utilised standardised assessment approaches have suggested that such cognitive or behavioural deficits will no longer be evident in children three months after a TBI (Kirkwood & Yeates, 2010). However, research methodologies which have included self-report or subjective ratings of post-TBI symptomatology have suggested that long-term, persistent problems and interrupted developmental trajectories may be a significant feature for a minority of children after a mild head injury or concussion (Carroll et al., 2004; Yeates & Taylor, 2005). There is also the problem of pre-injury functioning and its relationship to outcomes. The UCLA longitudinal study of neurocognitive outcomes after paediatric mTBI (Babikian et al., 2011) examined the

neurocognitive functioning of a large ( $n = 124$ ) sample of children aged eight to 17 years at the time of injury, and compared those findings against an other-injury and a non-injury group. Significant between-group differences were primarily found across the memory, processing speed and language domains. However, the authors argued that when premorbid effects were controlled for, group differences were no longer significant disappeared. This is a noteworthy finding; however, the authors' method of assessing premorbid functioning seems problematic. As evidence of having addressed premorbid functioning, they use retrospective information collected at the one-month time-point as a measure of the child's functioning pre-injury. For example, the study used the Child Behavior Checklist (Achenbach, 1991) with instructions to parents to complete it for the 6 months prior to the child's injury. However, parental recall may be subject to bias, particularly when their child has experienced injury. It may therefore and may reflect post-injury functioning rather than the months preceding the event, or alternatively idealise the pre-injury period (Bijur, Golding, Haslum, & Kurzon, 1988; Infante-Rivard & Jacques, 1999). Historical school information regarding learning and behavioural functioning was also obtained; however, the quality and validity of such information is unclear. Thus, it would seem that even though the UCLA study claimed to have addressed this significant methodological issue that continues to arise due to the accidental nature of TBI, the problem of premorbid functioning may not have been addressed in such a way that it can be argued that the variable was controlled for.

### **Concussion Information and Services in New Zealand**

Several New Zealand services offer information and support to caregivers of children who have experienced concussion. The Accident Compensation Corporation (ACC) (2013) of New Zealand publishes comprehensive concussion guidelines online and in brochure form. ACC also facilitates and funds a Concussion Service, to which care providers can contract to

deliver services in their local community to children affected by concussion (ACC, 2013). Services are available to individuals with obvious post-concussive symptoms and include medical, psychological and allied health assessment and intervention. However, limited hours are funded for each client (e.g., two hours of assessment and eight hours of therapy from an allied health clinician).

The New Zealand Ministry of Health (MOH, 2013) provides brief information on its website regarding head injury that includes several recommendations for concussion management. Most pertain to the first 24-48 hours period following a mild TBI (e.g., avoid alcohol for 24 hours, monitor individual for 48 hours). There is also a recommendation to avoid sport for three weeks following a mild TBI. The MOH recommendations do not mention the possibility that TBI symptoms may persist for longer than 48 hours.

The New Zealand Neurological Foundation (2013) provides a more in-depth discussion of the possible effects of concussion and how it should be managed, with reference to the possibility of persistent symptoms. However, some of the information provided in this instance implies patient controllability of symptom-duration: “the good news is that these unpleasant symptoms don’t last forever, and that if you manage them properly there should be no long-term ill-effects”. As seen in the current literature review, there is no well-established evidence that individuals can control symptom-duration.

The most comprehensive information available to New Zealand parents and teachers regarding concussion seems to be that provided by the Brain Injury Association of New Zealand in their brochure *Concussion in Children*. This publication discusses a range of symptoms that children may experience post-concussively, including cognitive, behavioural and emotional difficulties. Additionally, suggestions for managing the impact of such symptoms on a child’s school performance are included. No specific symptom-duration is mentioned, leaving open the possibility that persistent issues are a possibility.

While the information discussed above is available online for those able to search and access it, it is noteworthy that none of this information was encountered in hard copy by the primary researcher during the study period for this thesis (February 2011 to December 2013). Efforts were made to find and obtain such information in hospital emergency rooms and general medical wards, school receptions and GP clinics. However, none was found despite persistent efforts. Thus, it should be considered that while such information may be available to parents who have internet access and the knowledge / motivation to research the topic, parents of children from socio-economically deprived households may be less likely to seek and encounter such information online.

### **Summary and Rationale for the Current Research**

It is clear that large gaps exist in the current research base regarding mTBI and global developmental functioning in children, which has likely impacted on the quality and consistency of information available to the public regarding concussion effects. Few studies have met the criteria for methodological rigour set out by Satz, Zaucha, McLeary and Light (1997); that is to say that the vast majority of studies do not include a consistent definition of severity, longitudinal design, inclusion of a matched cohort, the use of standardised assessment measures, consideration of pre-injury factors, and a sample size greater than 20. In particular, it was noted that studies of emotional functioning are limited and tend not to include standardised measures, while studies of behavioural problems have often not included consideration of premorbid functioning or the role of SES. Previous research examining cognitive function has tended to focus on severe injuries and there has been a lack of appropriate matched cohort in those studies. Furthermore, studies of academic functioning have been almost entirely focused on severe injuries and there has been no research to date

that has examined the relationship between mTBI and learning disorders in children. The contradictory findings throughout the literature and the ongoing lack of clarity regarding the role of mTBI in later developmental functioning likely reflects these methodological problems. While there is some evidence to suggest that mTBI may have persistent consequences across emotional, social and behavioural domains, cognitive functioning and academic performance in children, conflicting findings regarding the persistence of symptoms is likely to continue in the face of such methodological issues.

A significant absence identified in the literature is that of children's functioning in school settings after mTBI. Previous research has tended to focus on parent reports of functioning at home and direct assessment of children that may not reflect their ability to function in complex, rapidly-changing environments (such as classrooms and playgrounds). The implications of this research dearth are twofold; firstly, that there is the possibility that parent / caregiver and direct assessment will not accurately reflect school performance and may overestimate a child's ability to function in academic settings (due to lowered demands and reduced stimuli in the home environment); and secondly, that when impairments are identified in children, they are not considered in light of their likely impact on a child's school functioning. The tasks that children are required to engage in at school require organisation and planning abilities, behavioural inhibition and initiation, emotion regulation, the ability to process and comprehend verbal and visual information, and intact memory and attention abilities. Where impairments exist across any of those domains, there is the possibility that children's learning and behaviour at school will be impacted. Impaired school performance in childhood is likely to impact on later academic success and career achievement, and may also influence a child's self-perception, attributions and motivations (Sylva, 1994). Early intervention for educational and psychological problems is recommended as this may enable interventions to be employed when problems are less

entrenched (Keenan & Wakschlag, 2000; Reavley & Jorm, 2010), problems may not emerge or be identified until middle childhood or beyond. Thus, the reliability and validity of assessments conducted in the preschool period may be impacted. However, the reliability of many standardised assessments significantly increases for use with children in their middle-childhood years (Sattler, 2008). The primary school years, then, reflect a period within children's development in which accurate assessment of mTBI-related impairment may be more likely and (relatively) early intervention may still be employed, particularly in school settings.

Given the limited number of studies that have used methodologically rigorous approaches to examine mTBI effects in childhood, and the lack of previous research examining how such effects might impact on school functioning, it was considered important to investigate both of these areas. The current research sought to address these issues, firstly via a rigorous method that meets the criteria recommended by Satz, Zaucha, McLeary and Light (1997), with reference to a population-based sample rather than reliance on hospitalised cases. Furthermore, an applied focus on school-related functions and academic performance following mTBI, along with contributions from educators, was considered crucial to enhancing understanding of how children's impairments might impact on their school experience. Therefore, these issues are the focus of the current programme of research.

## CHAPTER 3

### **Study 1: Developmental Functioning and School Performance Following Mild Traumatic Brain Injury.**

#### **Aims of the study**

The main aim of this study is to understand more about the impact of mTBI on children aged between five and 11 years at the time of injury and how injured children perform in school settings. In particular, it aims to establish whether children who have sustained mTBI are more likely to experience persistent developmental problems than their non-injured peers (across emotional, behavioural, social, neurocognitive and academic domains) at the 12-month time-point. This study also seeks to identify what factors are associated with higher levels of impairment and academic problems, in order to understand more about what contributes to problems in school functioning amongst this population. It is hoped that this study will address the limitations of previous work and thus clarify the effects of mTBI on child developmental and school-related functioning. In particular, it will draw its findings from a representative community sample, such as has rarely been obtained in earlier studies, and make comparisons with a non-injured cohort matched on age, gender, ethnicity and SES. The consistent use and differentiation of severity ratings throughout both the current study and its parent, BIONIC, along with a longitudinal design, use of standardised measures, consideration of preinjury functioning, and a sample size greater than 20, and the use of a population-based sample will provide a measure of rigour that has rarely been employed in paediatric mTBI research. Additionally, information from teachers were sought in order to examine children's functioning at school.



## **Hypotheses**

1. Children who have experienced mTBI will demonstrate significantly higher levels of emotional and behavioural problems compared to those in the control group at 12-months post-injury.
2. Children who have experienced mTBI will demonstrate increased difficulties associated with executive function impairment.
3. Children who have experienced mTBI will be more likely to experience academic problems and learning difficulties than comparison children free from TBI at 12-month follow-up.
4. Within the mTBI group, higher levels of emotional and behavioural problems will be correlated with higher levels of neurocognitive and academic problems.

## **Methodology**

### **Ethics**

Ethical approval for this study was obtained from the Northern Y Regional Health and Disability Ethics Committees Ref (NTY/11/02/016). Part of the ethics application involved engaging in consultation with Te Puna Oranga (Maori Health) and seeking their approval of the study. Ethical approval was also obtained from the University of Waikato School of Psychology Ethics Committee (11/08).

## **Recruitment**

Children in the TBI (clinical) group were identified via their participation in the parent study (BIONIC). As discussed in Chapter One, the population-based BIONIC study aimed for complete case ascertainment of all fatal and non-fatal TBIs in the study region. Prospective and retrospective identification systems were utilised to ensure case registration of all incidents of TBI in the study region between March 1 2010 and February 28 2011 (Theadom et al., 2011). Injuries were defined according to WHO criteria (Holder, Peden, Krug, Lund, Gururaj, & Kobusingye, 2001). The BIONIC study addressed many of the limitations of previous studies, particularly as it included mild injuries and was not limited to cases of hospitalisation. This provided a representative sample rarely captured in most TBI research. 1369 individuals with TBI were identified, with the vast majority (95%) having experienced mild injuries (Feigin et al., 2013). Of those identified, 379 were aged under 15 years. Within BIONIC, a battery of neuropsychological and health assessments were administered to participants at the baseline (within two weeks of injury), one-month, six-month and 12-month time-point. Assessments took approximately 90 minutes to complete. Participants were asked at their 12-month assessment whether they consented to being contacted for follow-up for other studies. Those that consented then had their details provided to the Consequences of Brain Injury in Childhood (COBIC) study.

The COBIC study sought to investigate 14-month developmental outcomes in the child and adolescent cohort. The current study focused on children in that cohort aged five to 11 years at the time of injury (six to 12 years at the time of assessment). This age range was selected as this reflects the primary-school-aged period with which the current research was concerned. Participants were contacted within two to six weeks of their 12-month BIONIC assessment and invited to participate in the follow-up child study. Those that consented were administered extra assessments at the 14-month time point. Further to this, a matched cohort

of non-injured children was recruited and administered all assessments. A non-injured cohort was recruited for comparison (rather than an orthopaedic group, for example) on the basis of McKinlay's (2009) recommendations that seriously injured or hospitalised children are unlikely to represent a suitable control for children with mTBI.

## **Participants**

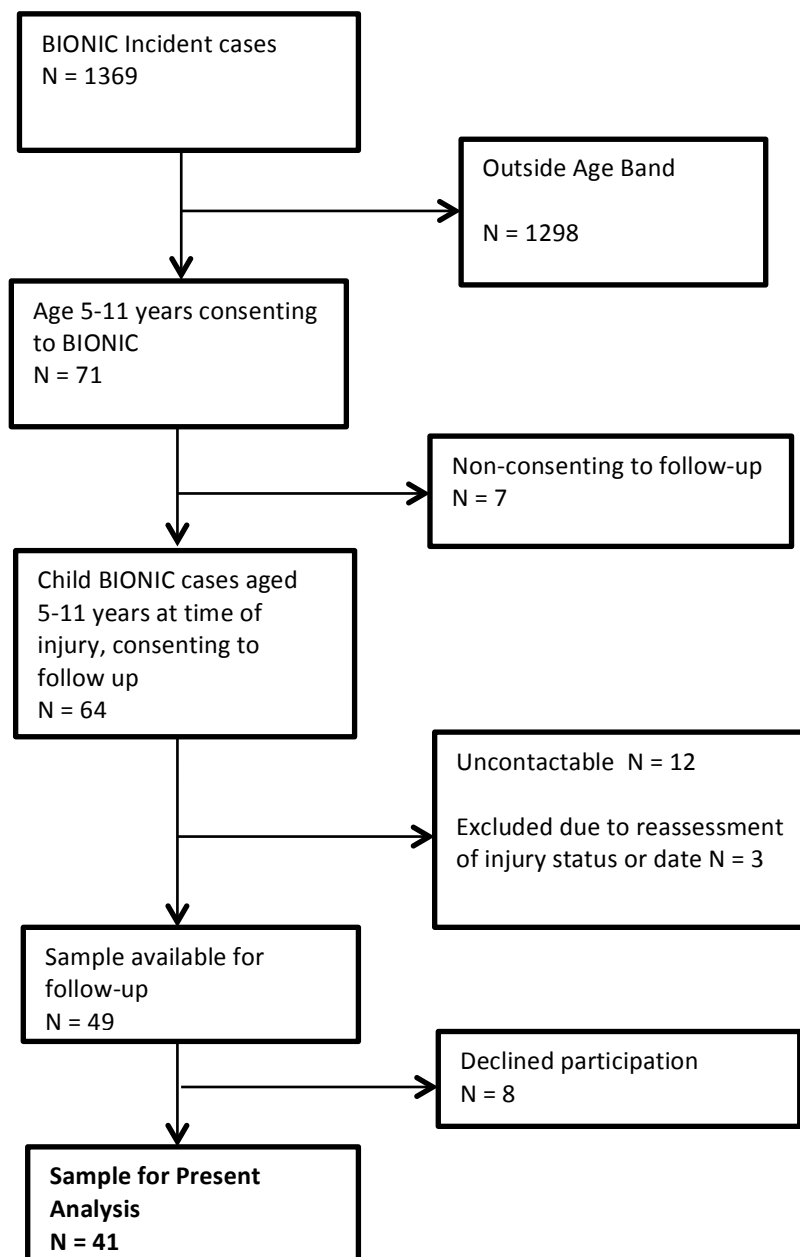
Parents / caregivers of children aged five to 11 years at the time of injury (six to 12 years at the time of the current study assessments) that consented to being contacted for future studies at their child's 12-month BIONIC assessment (for which the inclusion criteria was an incident of TBI between March 2010 and March 2011) were invited to participate in the current study (see Figure 1). Aside from being within the age band and having experienced TBI, the only other inclusion criteria was fluency in English.

In order to recruit a matched cohort of non-injured participants, it was considered appropriate to seek a volunteer sample from local schools. This would enable a non-hospitalised matched cohort to be obtained for comparison with the non-hospitalised TBI cohort, and allow for an initial matching of SES on the basis of school decile. Accordingly, schools within the COBIC study region were approached and, for those that agreed, advertisements were placed in school newsletters. Additionally, a brochure advertising the study and requesting contact was developed by the primary researcher and circulated via schools. Parents of children in the clinical group were also provided with brochures to provide to other parents of same-aged children. All advertising material provided a contact phone number and email which parents used to register their interest. Details of potential matched cohort participants were entered into a data-tracking sheet and they were sent an information pack prior to providing verbal consent.

The matched cohort was recruited on the basis that participants would be matched on age, gender and ethnicity to the TBI sample. School deciles were also matched across the groups in an attempt to equate for SES. Inclusion criteria for the matched cohort were the same as the TBI sample (aged between six and 12 years at time of assessment and fluent in English), except they had to have never experienced a TBI.

Figure 1.

Recruitment and selection of clinical group cases for the present study.



While many of the previous studies of TBI included children with orthopaedic injuries in a matched cohort, the majority of those in the clinical group had not been hospitalised and may not have accessed tertiary medical care (e.g., hospital emergency room visit). As such, it was unlikely that an orthopaedic control group would have experienced similar levels of stress associated with injury and ongoing medical care to those who had experienced mTBI (McKinlay, 2009). Thus it was deemed more appropriate to draw comparisons with a non-injury cohort.

Seventy one children aged five to 11 years at the time of injury were consented to participate in the BIONIC study. Of those, seven families declined to be contacted regarding follow-up studies, leaving a total of 64 potential participants in the study age-group. A total of 41 (64%) (22 female and 19 male) were recruited via BIONIC and consented to participate in COBIC. A further forty-one non-injured participants (22 female and 19 male) were recruited for the matched cohort. Participants in the TBI group had experienced a mTBI 12-14 months prior to their participation in the current study. These participants will hereafter be referred to as the 'clinical' group. For each participant in the clinical group and matched cohort, a parent or guardian completed a battery of questionnaires (details below). Forty (98%) of the child participants in the TBI group also completed the self-report and individually-administered battery of questionnaires and tests. The one child that did not complete the individually-administered measures was excluded from the process as she was currently undergoing developmental testing for health-care purposes and there was a possibility that the research assessment might have created additional fatigue and burden, and potentially impacted on the validity of her clinical assessment. Therefore, only parent and teacher data were collected in that particular case. All parents and children in the matched cohort completed the full battery of assessments.

Subsequently, teacher questionnaires were completed by teachers of 24 (58.5%) clinical group participants and 26 (63.4%) of the matched cohort.

Descriptive statistics regarding age, gender and ethnicities of child participants for each group are reported in Table 3.1. A total response method was employed in the coding of ethnicity information in accordance with Statistics New Zealand (2005) recommendations regarding the reporting of ethnicity data. The total number of responses generated by such a method is likely to be greater than the total number of participants. The majority of the children in both the clinical and control groups were identified as being New Zealand European, followed by Maori and Other Ethnicity. The clinical group was also comprised of participants of Indian and Niuean ethnicity. The Other Ethnicity category was made up of British, American and South East Asian.

Table 3.1

*Demographic Information for the TBI and Control participants*

	Clinical	Control	n
Age years Mean (Min-Max)	8.98 (6.36 – 12.66)	8.95 (6.07-12.68)	82
Female	22 (53.7%)	22 (53.7%)	44
Male	19 (46.3%)	19 (46.3%)	38
Ethnicity n (%)			
NZ Euro	27 (69.2%)	32 (88.9%)	75
Maori	13 (33.3%)	7 (19.4%)	75
Niuean	1 (2.6%)	0 (0%)	75
Indian	2 (5.1%)	0 (0%)	75
Other	2 (5.1%)	4 (10.8%)	75
School Decile Mean (SD)	6.24 (2.58)	6.27 (2.78)	82
Maternal Education	52.5 (20.69)	64.5 (24.2)	75

A one way ANOVA was conducted to establish whether the two groups were significantly different in SES as measured by school decile. This analysis demonstrated no significant difference between the groups,  $F(1, 80) = .002, p = .967$ .

All clinical group participants had sustained a TBI in the mild category according to WHO criteria and based on their GCS score (between 13 and 15). Furthermore, each case was classified as low, medium or high risk according to Servadei, Teasdale and Merry's (2001) mTBI risk criteria. Eleven (26.8%) injuries were mild-low, 12 (29.3%) were mild-medium and 18 (43.9%) were mild-high risk.

**Injury Characteristics.** Falls accounted for the largest proportion (46.3%) of injury mechanisms amongst the clinical group participants, while a significant proportion (29.3%) of TBIs occurred during recreational activities. Assaults were listed as the cause of injury in only four (9.8%) cases (see Table 3.2). The 'other' category included mechanisms such as crushing or sustaining injury by collapsing from fainting.

Most injuries occurred in private homes (43.9%) and at school (36.6%). The 'other' location category included: library, shopping centre, and swimming pool.

Table 3.2

*Injury Mechanisms and Incident Locations*

	n = 41	%
<b>Injury Mechanism</b>		
Fall	19	46.3
Recreational	12	29.3
Other	6	14.6
Assault	4	9.8
<b>Incident Location</b>		
Private house	18	43.9
School	15	36.6
Recreational Area	3	7.3
Other	3	7.3
Highway/Road/Street	2	4.9

## Materials

The materials used in this study were as follows:

- Introductory Letter to Clinical Group Parents / Guardians (Appendix A)
- Introductory Letter to Control Group Parents / Guardians (Appendix B)
- Introductory Letter to Teachers (Appendix C)
- Parent / Guardian Information Sheet and Consent Form (Appendix D)
- Child Information Sheet and Consent Form (Appendix E)
- Case Eligibility / Ascertainment Form (Appendix F)
- Contact Details Form (Appendix G)
- Control Parent Demographic Questionnaire (Appendix H)
- Clinical and Control (COBIC) Parent Demographic Questionnaire (Appendix I)
- Teacher Questionnaire (Appendix J)

## Measures

**Demographic Information.** A case eligibility / ascertainment form was developed to collect child demographic information and injury status, while parental demographic information was collected at the beginning of the set of parent questionnaires. This form also collected information regarding household economics, and the child's historical health information and current diagnoses/medications. Pre-injury data was systematically collected from the clinical group at the time of injury as part of the BIONIC study data collection, and subsequently for the matched cohort at baseline.



In order to complement the decile measure of SES, a further measure of SES, the Australian Socioeconomic Index 2006 (AUSE106; McMillan, Jones, & Beavis, 2009) was obtained during the assessment, in line with that used in the BIONIC study. The AUSE106 is a socioeconomic scaling index based on an algorithm that reflects education, occupation and income. It allows for codes from the Australian and New Zealand Standard Classification of Occupations to be converted into more meaningful scores (McMillan, Jones, & Beavis, 2009). This allowed for a second, more sensitive measure of SES to be considered in the current study's analysis.

Table 3.3

*Psychological Measures*

<b>DOMAIN</b>	<b>MEASURE</b>	<b>AGE RANGE</b>
<b>Behavioural, Emotional and Social Functioning</b>	Strengths and Difficulties Questionnaire (SDQ)	4+ years (parent and teacher forms)
<b>Cognitive functioning</b>	<i>Executive Function.</i> Behavior Rating Inventory of Executive Function (BRIEF)	All
	<i>Intelligence.</i> Wechsler Intelligence Scales for Children – Fourth Edition (WISC-IV) abbreviated (Similarities, Vocabulary, Matrix Reasoning, Symbol Search)	All
	<i>Global Neuropsychological Functioning</i> *CNS Vital Signs test: a computerised test of 5 core neuropsychological functions (memory, psychomotor speed, reaction time, complex attention and cognitive flexibility)	8+ years
	*Woodcock Johnson III Tests of Cognitive Abilities (WJ III COG): clinical measure of verbal and thinking abilities and cognitive efficiency	2-7 years
<b>Academic Functioning</b>	Woodcock Johnson Tests of Achievement (WJ III ACH) – Brief version (Letter Word ID, Passage Comprehension, Calculation, Applied Problems, Spelling, Writing Samples)	All

**Psychological measures.** Table 3.3 lists the assessments administered to both the TBI group and matched cohort. These are followed by detailed descriptions of each measure.

Several of the measures detailed in the table below were administered as part of the BIONIC study at the 12-month time-point, prior to the families' engagement in the current study.

These were also administered to participants in the matched cohort for purposes of comparison. Those assessments are identified in Table 3.3 by an asterisk. Where available, both parent / caregiver and teacher versions of assessments were used in order to obtain a fuller picture of each child's functioning and compare perceptions of the child.

### **Behavioural, Emotional and Social Functioning. *Strengths and Difficulties***

*Questionnaire (Goodman, 1997).* The Strengths and Difficulties Questionnaire (SDQ) is a brief, 25-item questionnaire that measures psychological adjustment in children and young people aged four to 17 years (Goodman, 1997). Parents and teachers completed the appropriate versions of the questionnaire. Positive and negative behaviours and attributes across five domains (emotional symptoms, conduct problems, hyperactivity, peer problems, and prosocial behaviour) are rated on a 3-point Likert scale, with the following responses: "certainly true" (2), "somewhat true" (1), and "not true" (0). Diagnostic hypotheses generated by the SDQ correlate highly with those made by clinicians and it is commonly used as a screening and monitoring tool in child and adolescent primary care and mental health services in Australia, New Zealand, and further abroad (Hayes, 2007; Mathai, Anderson, & Bourne, 2004; Ministry of Health, 2009). The measure has also been found to correlate highly with the Child Behavior Checklist (CBCL; Achenbach, 1991) (Goodman & Scott, 1999). The SDQ demonstrates moderate to strong internal reliability across the five subscales (ranging from 0.59 for peer problems to .080 for hyperactivity), and strong concurrent validity ( $r = 0.47, p < 0.01$ ) for the total difficulties score (Hawes & Dadds, 2004). While the capacity of the SDQ to identify psychological disorders is highest when data are collected from multiple sources, the predictive values of parent and teacher reports are approximately

equal (Goodman, Ford, Simmons, Gatward, & Meltzer, 2000). A recent study in Australia (Maybery, Reupert, Goodyear, Ritchie, & Brann, 2009) included a large (N=598) normative sample, and that sample is used for comparison with the current data. The SDQ is normed in such a way that roughly 80% of children in non-clinical populations are expected to obtain scores in the ‘normal’ range for each subscale and the overall total score, 10% in the ‘borderline’ range and 10% in the ‘high’ range (see Table 3.4 for clinical cut-offs).

Table 3.4

SDQ (Goodman, 1997) Parent and Teacher Ratings – Clinical Significance Cut-Offs

	Parent SDQ Cut-offs		Teacher SDQ Cut-offs	
	Borderline	High	Borderline	High
Emotional	4	5-10	5	6-10
Conduct	3	4-10	3	4-10
Hyperactivity	6	7-10	6	7-10
Peer	3	4-10	4	5-10
Total Difficulties	14-16	17-40	12-15	16-40

In the current study, scores from the emotional symptoms, conduct problems, hyperactivity and peer problems domains along with the total difficulties score were included from both the parent and teacher forms.

**Cognitive Functioning.** *Behavior Rating Inventory of Executive Function (BRIEF;* Gioia, Isquith, Guy, & Kenworthy, 2000; Guy, Isquith & Gioia, 2004). The BRIEF is a questionnaire that is available in two forms: as a parent or teacher rating of behaviours related to executive function; and as a self-report measure of children (over 12 years) and adolescents' self-perception as it relates to their capacity for self-regulation. The parent and teacher BRIEF were used in the current study.

It is pertinent here to briefly discuss the concept of the executive functions as they have been conceptualised by the BRIEF test developers, as there is some variability in how these are understood and discussed more generally (Friedman et al., 2008). Gioia, Isquith, Guy and Kenworthy (2000) describe the executive functions as “a collection of processes that are responsible for guiding, directing and managing cognitive, emotional and behavioral functions, particularly during active, novel problem solving” (p.1). They refer to both Welsh and Pennington's (1988) and Stuss and Benson's (1986) seminal works in this area in defining executive functions as an ability to select and achieve goals via problem solving techniques which utilise higher order cognitive processes such as anticipation, planning, judgment, monitoring and self-awareness. While the role of the frontal lobes in the development and maintenance of executive function abilities is acknowledged by the test authors, they also note that executive dysfunction may not solely reflect deficits in that specific region of the brain. Rather, the interconnectedness of brain structures and chemistry is considered, with the frontal system viewed as a potentially key mediator of this neuroanatomic connectivity.

The BRIEF parent and teacher ratings (Gioia, Isquith, Guy & Kenworthy, 2000) were designed to be administered to parents or guardians and teachers of children and adolescents aged between five and 18 years. It was developed and normed for use with young people in general and clinical populations, including those with traumatic brain injury, learning

disabilities and ADHD (Fitzpatrick, 2003). The questionnaire takes approximately 10-15 minutes to complete. Raw score totals are calculated across eight clinical domains. Two index scores are derived from the domain scores: the Behavior Regulation Index (BRI) and the Metacognition Index (MI). These two indices are summed together to obtain a Global Executive Composite (GEC) score (see Table 3.5).

Table 3.5

*Description of the Clinical Scales on the BRIEF Parent and Teacher Forms (Gioia, Isquith, Guy & Kenworthy, 2000)*

Scale	Number of Items		Description
	Parent	Teacher	
<b>Clinical Scales</b>			
Inhibit	10	10	Control impulses; appropriately stop own behaviour at the proper time.
Shift	8	10	Move freely from one situation, activity, or aspect of a problem to another as the situation demands; transition; solve problems flexibly.
Emotional Control	10	9	Modulate emotional responses appropriately
Initiate	8	7	Begin a task or activity; independently generate ideas.
Working Memory	10	10	Hold information in mind for the purpose of completing a task; stay with, or stick to, an activity.
Plan/Organize	12	10	Anticipate future events; set goals; develop appropriate steps ahead of time to carry out an associated task or action; carry out tasks in a systematic manner; understand and communicate main ideas or key concepts.
Organization of Materials	6	7	Keep workspace, play areas, and materials in an orderly manner.
Monitor	8	10	Check work; assess performance during or after finishing a task to ensure attainment of goal; keep track of the effect of own behaviour on others.
<b>COMPOSITE SCORES</b>		<b>DOMAINS INCLUDED</b>	
Metacognition Index		Initiate, Working Memory, Plan/Organize, Task Monitor, Organization of Materials.	
Behavior Regulation Index		Inhibit, Shift, Emotional Control, Self-Monitor	
Global Executive Composite		MI + BRI	

*Gioia, Isquith, Guy & Kenworthy, 2000*

The BRIEF parent form normative data were taken from a large (N=1,419) sample in the United States. The normative data for the BRIEF teacher form are somewhat weaker, taken from a smaller sample (N=720) in only one U.S. state (Maryland). The test authors report good internal consistency (.80 to .90), test-retest and inter-rater reliabilities, with higher alpha coefficients generally obtained for composite rather than domain scores (mid .90s) (Gioia, Isquith, Guy & Kenworthy, 2000; Fitzpatrick, 2003). The content and construct validity for the BRIEF appears strong (Fitzpatrick, 2003). In regards to content, items that were seen to reflect typical descriptions of behaviours related to executive functions were chosen from clinical interviews with parents and teachers. These were then independently assessed by a panel of 12 paediatric neuropsychologists and refined according to item-total correlation coefficients (Gioia, Isquith, Guy & Kenworthy, 2000).

While the ecological validity of neuropsychological tests have been called into question due to the possible lack of demand placed on executive functions during test situations (Bernstein & Waber, 1990; Tarazi, Mahone, & Zabel, 2007), parent ratings of EF such as the BRIEF are considered to be good predictors of adaptive strengths and weaknesses (Gilotty, Kenworthy, Sirian, Black & Wagner, 2002; Mangeot, Armstrong, Colvin, Yeates, & Taylor, 2002; Ries, Zabel, & Mahone, 2003). Other evidence for the ecological validity of the BRIEF include strong correlations between parent ratings and standardised academic assessments (Waber et al., 2006). There is also some evidence to suggest that parent ratings on the BRIEF might be more sensitive to neuropsychological impairment than performance-based measures (Mahone et al., 2002; Cummings, Singer, Krieger, Miller, & Mahone 2002).

Construct validity was assessed via exploratory factor analysis of the full scale which yielded two factors that explained 75% of variation in the sample data (Schraw, 2003). Those factors generated a correlation coefficient of .65 and corresponded to the Behavioral Regulation and the Metacognition Indices. Construct validity was also assessed through

correlation with the Child Behavior Checklist (Achenbach, 1991) and the Behavior Assessment System for Children-Parent Rating Scales (Reynolds & Kamphaus, 1992). The individual scales and GEC correlate well with aggressive behaviour (.50-.80), attention difficulties (.60-.90), and, to a slightly lesser extent, hyperactivity (.30-.60). In the current study, the GEC composite score was included in the analysis for both parent and teacher ratings.

*Wechsler Intelligence Scales for Children – Fourth Edition (Australian) (WISC-IV; Wechsler, 2004)*. The WISC-IV is an individually administered intelligence test for children and adolescents aged six through 16 years. The full WISC-IV is comprised of 10 core subtests and five supplementary tests that measure cognitive functioning across four domains, referred to as indices: verbal comprehension (VCI), perceptual reasoning (PRI), working memory (WMI) and processing speed (PSI). Composite scores for each index are generated, along with a Full Scale Intelligence Quotient (FSIQ) that reflects overall cognitive ability. Subscale score ranges are: 1-3 = Extremely Low; 4-5 = Borderline; 6-7 = Low Average; 8-12 = Average; 13-14 = High Average; 15-16 = Superior; 17-19 = Very Superior. FSIQ score ranges are as follows: <70 = Extremely Low; 70-79 = Borderline; 80-89 = Low Average; 90-109 = Average; 110-119 = High Average; 120-129 = Superior; 130+ = Very Superior.

A short-form version of the WISC-IV was used in the current study due to time constraints and to reduce participant burden. Sattler (2004) recommended several short-form versions of the WISC-IV that may be utilised as a rapid screen and to generate an estimated FSIQ. On the basis of this recommendation and the high predictive reliability and validity coefficients associated with the combination of these subtests (.943 and .933 respectively), four were selected for inclusion in this study's neurocognitive battery: Vocabulary (VCI), Similarities (VCI), Matrix Reasoning (PRI) and Symbol Search (PSI) (Sattler, 2004). A test corresponding to the WMI was not included on the basis of memory testing having formed a

significant component of the other BIONIC assessments administered to both clinical and matched cohort subjects; the abbreviated version of the WISC-IV used in this study took approximately 30 minutes, dependent on the test subject's level of ability. Scaled scores from the four subtests were then added together and the total matched to an estimated FSIQ, as set out by Sattler (2004).

The WISC-IV was originally standardised against a large (2200) sample in the United States. Normative data for the WISC-IV Australian version were established in 2005 from the administration of the test to 2000 individuals aged five to 21 years across Australia (Hannan, 2005). The WISC-IV subtests have been found to be valid in structure and content, and demonstrate very high levels of internal consistency and test-retest reliability (in the middle .90s) (Thompson, 2011). In the current study, the four subscales and the estimated FSIQ scores were included in the analyses.

*Woodcock Johnson Tests of Cognitive Abilities – Third Edition (WJ III; Woodcock, McGrew, & Mather 2001)*. The WJ III COG is a norm-referenced measure of cognitive functioning that can be individually administered to individuals aged between two and 90 years of age. It is commonly used as a measure of child neuropsychological functioning and is comprised of a standard (tests 1-10) and extended (tests 11-20) battery of assessments. The standard battery was used in the current study, along with three tests from the extended battery (Test 14 - Auditory Attention; Test 16 – Decision Speed; Test 20 – Paired Calculation). The WJ III COG measures seven broad abilities: Comprehension-Knowledge (Test 1 – Verbal Comprehension); Long-Term Retrieval (Test 2 – Visual Auditory Learning; Test 10 – Visual Auditory Memory-Delayed); Visual Spatial Thinking (Test 3 – Spatial Relations); Auditory Processing (Test 4 – Sound Blending; Test 8 – Incomplete Words; Test 14 – Auditory Attention); Fluid Reasoning (Test 5 – Concept Formation); Processing Speed (Test 6 – Visual Matching; Test 16 – Decision Speed; Test 20 – Paired Calculation); and,



Short-Term Memory (Test 7 – Numbers Reversed; Test 9 – Auditory Working Memory).

Scores are yielded from each subtest and combined to reflect broader abilities. Factor cluster scores are also generated for eight more narrow abilities associated with each test (lexical knowledge, language development, associative memory, visualization, spatial relations, phonetic coding synthesis and analysis, induction, perceptual speed, and working memory).

Other clinically relevant clusters are also calculated (e.g., phonemic awareness, executive processes) with reference to empirical findings from neuropsychology and educational literature. The WJ III COG yields an overall General Intellectual Ability (GIA) which acts as a norm-referenced measure of cognitive function (Woodcock, McGrew, & Mather 2001).

Standard score ranges are as follows: <70 = Very Low; 70-79 = Low; 80-89 = Low Average; 90-109 = Average; 110-119 = High Average; 120-129 = Superior; 130+ = Very Superior.

Normative data were collected from a large (8,818) United States sample of children and adults. The WJ III COG has strong psychometric properties, with good test-retest and inter-rater reliabilities in the .80s and .90s. The test is co-normed with the Woodcock Johnson Tests of Achievement (WJ III ACH) and is predictive of achievement scores, with correlations in the .70 range. Internal consistency reliability estimates are very high across all the tests (.80s and .90s) (Cizek & Sandoval, 2003).

In the current study, the WJ III COG was administered to participants <8 years of age. In the analysis, GIA score was included as an overall measure of neurocognitive functioning for participants less than 8 years.

*CNS Vital Signs (CNSVS; Gualtieri, Johnson, & Benedict, 2004)*. CNSVS is an individually administered, computerised, neuropsychological test battery suitable for use with individuals over 8 years of age. It includes an assessment platform that is comprised of 10 normed neurocognitive tests that cover Verbal and Visual Memory (immediate and delayed), Finger Tapping (motor response), Symbol Digit Coding (processing speed), Stroop Test

(executive function), Shifting Attention Test (Complex Attention), and Continuous Performance Tests (Sustained Attention and Working Memory). CNSVS generates standardised domain scores in the following areas: Composite Memory, Verbal Memory, Visual Memory, Processing Speed, Executive Function, Psychomotor Speed, Reaction Time, Complex Attention and Cognitive Flexibility. It also yields an overall Neurocognition Index (NCI) composite score.

The test battery's reliability and validity rests largely upon the psychometric properties of the conventional tests from which it is comprised, however it is considered to be most suitable when used as a screening instrument rather than diagnostically (Hanes, 2005; Gualtieri & Johnson, 2006). Good test-retest reliability (ranging from 0.55 for Stroop complex reaction time to 0.87 for the Continuous Performance reaction time) has been identified, along with concurrent and discriminant validity (Gualterri & Johnson, 2006)

In the current study, CNSVS was administered to participants >8 years in place of the WJ III. Accordingly, the NCI score was included in the analysis as a measure of overall neurocognitive function for those aged over 8 years.

Composite score ranges are as follows: <70 = Very Low; 70-79 = Low; 80-89 = Low Average; 90-109 = Average; > 110 = Above Average. It is worthwhile to note that these domain ranges are consistent (in terms of scores) across the WISC, WCJ and CNS-VS tests with only slight differences in terminology.

**Academic Functioning.** *Woodcock Johnson III Tests of Achievement (WJ III ACH;* Woodcock, McGrew, & Mather, 2001). The WJ III ACH forms the other half of the Woodcock Johnson system and sits alongside the WJ III COG. It is an individually administered, standardised measure for the assessment of academic achievement normed in Australia for use with individuals aged 2 to 90+ years. Based on the WJ-R Tests of

Achievement (Woodcock & Johnson, 1989), the WJ III ACH has been extensively normed and includes new tests, clusters and approaches to interpretation (Mather & Woodcock, 2001). The WJ III ACH is easily compared against the WJ III COG and the WISC-IV. The WJ III ACH is made up of 22 tests assessing performance across five academic domains: reading, mathematics, written language, oral language and academic knowledge.

It is against this backdrop that the Form C/Brief Battery of the WJ III ACH was developed. Form C derives four cluster scores, comprised as follows: Brief Reading (including Letter Word Identification (ID) and Passage Comprehension); Brief Math (including Calculation and Applied Problems); Brief Writing (including Spelling and Writing Samples); and Brief Achievement, a composite cluster comprised of Letter Word, Applied Problems and Spelling. Scores from all tests in the brief battery were be used in the current study. Standard score ranges are as follows: <70 = Very Low; 70-79 = Low; 80-89 = Low Average; 90-109 = Average; 110-119 = High Average; 120-129 = Superior; 130+ = Very Superior.

Each test (except Writing Samples) is scored as correct (=1) or incorrect/no response (=0) on the test record form. The ceiling for each test (except Writing Samples) is typically six incorrect answers and when this is reached, correct answers are summed to achieve a total score. Scoring of the Writing Samples test utilises a holistic procedure that requires subjective interpretation and judgement when scoring the test subject's responses. A scoring guide is provided in the WJ III ACH manual (Mathers & Woodcock, 2001). Summary and composite scores yielded from the Reading, Mathematics and Writing domains were used in the current study.

**Teacher Questionnaire.** The teacher questionnaire was adapted from that developed by Hood (2009) and was completed in addition to the teacher SDQ and BRIEF questionnaires. The teacher questionnaire gathered information regarding children's academic, behavioural

and social functioning. Firstly, teachers were asked to rate their overall impressions of the child's progress across a range of academic subjects on a 5-point Likert scale (1 = Delayed, 2 = Below Average, 3 = Average, 4 = Above Average, 5 = Advanced). Teachers were asked to rate the child's behaviour and popularity in comparison to other children of the same age, and whether there were any learning or significant health problems present. Service referral was recorded (for example, to specialist education services or occupational therapy) along with additional support services received at school, such as teacher aide. Teachers were also asked to provide standardised school assessment scores from prior to the child's injury (2010/2011 period) and subsequently (2011/2012) and their perceptions of general academic performance. Finally, teachers were asked to comment if they had any concern regarding the child's achievement and / or behaviour, and provide further additional comments if necessary.

## **Procedure**

Parent participants were sent information packs via mail. Attempts to contact families by telephone began seven to 10 days after information packs had been sent. Parents were provided with the opportunity to discuss queries or concerns related to the study and gave verbal consent or declined via telephone.

If verbal consent was obtained, an appointment time was made for the researcher to visit the parents at home or work to complete eligibility and consent forms before completing the parent assessment questionnaires. This process took approximately 30-50 minutes. Parents chose to have their child assessed either at home or school. Children over the age of 8 years old provided written assent in accordance with recommendations from the Ministry of Health Northern Y Ethics Committee. Nine (22%) of the child participants in the clinical group were seen at home and 32 (78%) at school, while 13 (32%) in the control group were

seen at school and 28 (68%) at home. Of those seen at home, this occurred either immediately following the parent assessment or was scheduled for another date subsequent to the obtaining of consent.

Child participants were then administered the battery of questionnaires. Questions were read to younger children or those who evidenced a low reading age. Subsequently, children completed the battery of individual cognitive and academic assessments. Assessments took between 60-120 minutes, dependent on the child's age and performance on the tests. If participants appeared fatigued or to be struggling to complete the assessment, another visit was arranged.

Following completion of the assessment, each child was provided with a \$20 gift voucher. In cases wherein parents had consented to teachers being contacted to contribute to the assessment, teacher questionnaires were then delivered or sent to teachers subsequent to the parent/child assessments along with a stamped, self-addressed envelope in which the questionnaire could be returned. Upon return of the completed teacher questionnaire, teachers were then provided with a \$10 gift voucher. Subsequent to the completion of each component of the parent, child and teacher assessments, the primary researcher scored all standardised and norm-referenced assessments.

### **Statistical Analysis**

Data were entered into SPSS (version 20.0) and screened for missing data, normality and outliers. The plan for the analysis was to calculate descriptive statistics to describe the characteristics of the two samples and then consider what, if any, covariates were appropriate for inclusion in multivariate analysis. As the initial attempt to match on the basis of SES using the school decile measure may not have controlled for this variable due to the

potentially inaccurate reflection of individual households that decile rankings create, the AUSE106 rating main earner's education and occupation that was obtained later in the assessment was integrated into the analysis.

Field (2013) recommends that, where possible, covariates should be independent from grouping variables. If there is a strong relationship between a covariate and grouping variable (such as between SES and membership of the TBI group), this indicates a significant degree of shared variance which suggests that the potential covariate (in this instance, SES) cannot be entirely controlled for. As SES is typically associated with TBI epidemiology and outcomes (Feigin, Barker-Collo, Krishnamurthi, & Starkey, 2010), it was possible that this may impact on the capacity of any multivariate analysis of covariance (MANCOVA) to control for this variable in the current study. However, Miller & Chapman (2001) suggest that in cases where the covariate and grouping variable are related but not "intimately" (i.e. the correlation between the two is small), it is still appropriate to include such a covariate as a strategy for data noise-reduction.

As such, the first step in the multivariate analysis plan was to identify whether there were significant differences in SES between the two groups and, if so, whether there was a significant relationship between SES and group membership in order to identify whether it was appropriate for inclusion as a covariate. Multivariate analysis was used to explore whether there were significant between-group differences in the levels of problems. Where clinical cut-offs were available, Chi-square analyses were conducted to examine whether clinically significant symptom criteria was more likely to be met by participants in the clinical group. This was followed by correlational analysis of the degree of association between parent and teacher ratings, where ratings from both were available. The final step of the analysis was to conduct case-by-case analysis of participants with multiple impairments,

investigate premorbid functioning and integrate the qualitative information obtained from teachers regarding those children.

## RESULTS

The results section will begin by presenting analyses related to each of the research questions. Analyses are organised according to the domains of functioning and measures to which they relate. The results section concludes with a single-case analysis of demographic and injury factors present in participants with functional impairments across multiple domains.

### **Multivariate Analysis of Covariance**

Before any multivariate analysis took place it was appropriate to check whether there was a significant difference in SES between the clinical and control group using the AUSE106 score. In order to assess this, an independent samples *t*-test was conducted which revealed that there was a significant difference between the two samples. On average, participants in the clinical group had a significantly lower SES ( $M = 54.67$ ,  $SD = 20.29$ ) than those in the control group ( $M = 65.62$ ,  $SD = 24.55$ ),  $t(79) = -2.186$ ,  $p = .032$ .

As such, a point-biserial (Pearson) correlation between Clinical/Control group membership and SES was computed in order to establish the degree of relationship. A small but significant correlation was identified ( $r = .24$ ,  $p = .032$ ). As the relationship between SES and TBI was small and did not account for most of the variance, it was considered appropriate to include SES as a covariate in the first multivariate analysis of global outcomes.

## Global Outcomes

The first step in the between-groups analysis was to address the question of whether there were significant differences in developmental functioning in children 14 months after mTBI when compared to their non-injured peers. To assess this, a multivariate analysis of covariance (MANCOVA) was conducted which included four composite variables as global measures of key domains of functioning: estimated FSIQ (reflective of intellectual ability); parent SDQ total difficulties score (reflective of emotional, behavioural and social functioning); parent BRIEF GEC (executive function); and, the WJ III ACH Brief Achievement composite (academic achievement). The results of this showed that SES was not significant as a covariate,  $F(4, 72) = 1.82, p = .135, \eta^2 = .092$ . The MANCOVA indicated that there was a statistically significant difference between the clinical and control groups in overall developmental functioning,  $F(4, 72) = 3.21, p = .018, \eta^2 = .151$ . Children in the clinical group had significantly lower FSIQ scores ( $M = 95.25, SD = 15.17$ ) than those in the matched cohort ( $M = 103.25, SD = 11.95$ ),  $F = 7.42, p = .008, \eta^2 = .090$ . Parent ratings on the SDQ of emotional, behavioural and social problems were significantly higher for the clinical group ( $M = 11.80, SD = 6.42$ ) than in the matched cohort ( $M = 7.03, SD = 6.36$ ),  $F(4, 72) = 7.73, p = .007, \eta^2 = .09$ . Overall academic achievement, as measured by the WJ III ACH Brief Achievement scores, was lower in the clinical group ( $M = 96.03, SD = 19.90$ ) than the matched cohort ( $M = 103.63, SD = 9.75$ ),  $F = 4.80, p = .032, \eta^2 = .060$ . The parent BRIEF GEC scores were slightly higher in the clinical group ( $M = 53.75, SD = 13.63$ ) than in the matched cohort ( $M = 48.68, SD = 14.24$ ) but the difference was only marginally significant,  $F = 2.82, p = .098, \eta^2 = .036$ .

As these results demonstrated significant differences in developmental functioning between the clinical and control groups, the next step in the analysis was to investigate each



of the relevant domains of functioning in more detail. This part of the analysis examines the emotional, behavioural and social functioning of the two cohorts (as measured by the SDQ) followed by neurocognitive and academic functioning. As SES was not significantly related to global developmental outcomes, it was removed as a covariate for the remainder of the analysis.

### **Emotional, Behavioural and Social Functioning**

**Parent and Teacher SDQ ratings.** A MANOVA was used to establish whether there were significant differences between the mean domain scores on the emotional problems, hyperactivity, conduct and peer problems subscales of the parent SDQ for the TBI and matched cohort. The overall model showed a significant difference between the two groups,  $F(4, 74) = 2.93, p = .026, \eta^2 = .132$ . The analysis indicated that children in the clinical group were rated by parents as having significantly higher scores on the emotional problems and hyperactivity, reflective of higher levels of difficulties, than those in the matched cohort. There were no significant between-group differences in conduct and peer problems (see Table 3.6).

The same approach was applied to the analysis of teacher SDQ ratings. The overall MANCOVA model showed no significant differences between the groups ( $F(4, 44) = 1.63, p = .183, \eta^2 = .129$ ), however analysis of the domain scores demonstrated that teachers of children in the clinical group rated them as having significantly higher levels of conduct problems than those in the matched cohort (see Table 3.6). The next step in the analysis was to assess the clinical significance of the SDQ scores. In order to do so, the scores were firstly

recoded and dichotomised as being in the normal or at risk / clinically significant ranges (in accordance with the SDQ cut-offs).

Table 3.6

*MANOVA – Strengths and Difficulties Questionnaire: Parent and Teacher Ratings*

Domains/Composites	Clinical (N=41)		Control (N=41)		df	F	Sig.	$\eta^2$
	$\bar{x}$	sd	$\bar{x}$	sd				
<b>Strengths and Difficulties</b>								
<b>Parent Ratings</b>								
Emotional	3.05	2.35	1.78	1.92	4,72	6.971	<b>.010</b>	.080
Conduct	2.17	1.87	1.33	2.19	4,72	2.646	.108	.032
Hyperactivity	4.00	2.25	2.46	2.68	4,72	7.932	<b>.006</b>	.090
Peer Problems	2.44	2.18	2.00	2.81	4,72	.625	.432	.008
<b>Strengths and Difficulties</b>								
<b>Teacher Ratings</b>								
Emotional	1.43	2.23	1.27	1.85	4,44	.081	.778	.002
Conduct	1.22	1.54	0.46	0.81	4,44	4.793	<b>.034</b>	.093
Hyperactivity	3.38	2.76	2.00	2.70	4,44	3.842	.056	.076
Peer Problems	2.09	2.07	1.88	2.53	4,44	.092	.763	.002

To establish whether the number of children rated by parents and teachers as having clinically significant symptoms on the SDQ significantly differed between the clinical and control groups, Pearson Chi-Square analyses would have been appropriate. However, as some cell counts were below five, it was necessary to use Fisher's Exact Test. The results of these analyses indicated that a higher proportion of parents in the clinical group rated their children's social problems as being in the clinically significant range than those in the matched cohort (see Table 3.7). Chi-square analysis of the teacher SDQ ratings indicate that only the conduct domain scores showed significant differences in clinically relevant symptoms.

Table 3.7

*Fisher's Exact Test - Parent and Teacher Ratings of Clinical Significance on the Strengths and Difficulties Questionnaire*

	Clinical n = 41	Control n = 41	df	Exact Sig. (2- sided)
<b>Parent Ratings – Clinically Significant Problems</b>				
Emotional	17 (41.5)	8 (19.5%)	1	.054
Conduct	18 (43.9%)	9 (22%)	1	.059
Hyperactivity	18 (43.9%)	9 (22%)	1	.059
Peer	19 (46.3%)	9 (22%)	1	<b>.035</b>
Total Difficulties	16 (39%)	9 (22%)	1	.149
<b>Teacher Ratings – Clinically Significant Problems</b>				
	n = 23	n=26		
Emotional	1 (4.3%)	1 (3.8%)	1	1.000
Conduct	4 (17.4%)	0 (0%)	1	<b>.042</b>
Hyperactivity	5 (20.8%)	4 (11.5%)	1	.721
Peer	5 (20.8%)	7 (26.9%)	1	.748
Total Difficulties	6 (26%)	3 (11.5%)	1	.273

**Correlations between parent and teacher SDQ ratings.** The next objective of the analysis was to examine the relationship between parent and teacher ratings of children's symptoms on the SDQ. In order to assess this, Pearson correlations between the SDQ parent and teacher scores were conducted. Parent and teacher domain scores were all significantly correlated except for on the conduct domain (see Table 3.8)

Table 3.8

*Pearson Correlations between parent and teacher SDQ scores*

	n = 49	Parent SDQ emo	Parent SDQ conduct	Parent SDQ hyper	Parent SDQ peer	Parent SDQ total diffs
Teacher SDQ emo	Pearson Sig (2-tailed)	.411** .003	-	-	-	-
Teacher SDQ conduct	Pearson Sig (2-tailed)	-	.246 .089	-	-	-
Teacher SDQ hyper	Pearson Sig (2-tailed)	-	-	.645** .001	-	-
Teacher SDQ peer	Pearson Sig (2-tailed)	-	-	-	.519** .001	-
Teacher SDQ total diffs	Pearson Sig (2-tailed)	-	-	-	-	.613** .001

\*\*Correlation is significant at the 0.01 level (2-tailed)

### Cognitive Functioning

The next stage of the analysis looked at whether children in the clinical group had significantly lower levels of cognitive functioning than those in the matched cohort. In order to examine this, scores from the BRIEF, WISC-IV, WCJ-III and CNSVS (reflective of executive function, intelligence and global neuropsychological functioning) were included in a between-groups analysis.

**Teacher BRIEF ratings.** As the overall between-groups difference in the parent BRIEF GEC score was only marginally significant in the initial MANCOVA assessing global functioning, it was not included in further analysis. However the teacher BRIEF GEC was also of interest in this analysis, so a one-way ANOVA was conducted to establish whether there were significant differences between teachers' perceptions of EF. The mean GEC score in the clinical group (M = 56.25, SD = 18.18) was compared to that of the matched cohort (M

= 49.69, SD = 10.39) and the difference was not significant,  $F(1, 48) = 2.50, p = .120, \eta^2 = .050$ .

**Intellectual Functioning.** The next step in the analysis was to examine children's intellectual functioning as measured by the WISC-IV. Descriptive statistics were generated for the four subscale scores (Similarities, Vocabulary, Matrix Reasoning and Symbol Search) and the FSIQ. Following this, a MANOVA was conducted in order to assess whether there was a significant difference in WISC subtest and composite scores between the clinical and control groups (see Table 3.9). The overall model was not significant,  $F(5, 74) = 1.58, p = .175, \eta^2 = .097$ . However, mean scaled scores on the Similarities subtest of the WISC-IV were significantly lower in the clinical group, indicative of poorer performance in that cohort,  $F(1, 78) = 4.29, p = .042, \eta^2 = .052$ . There were no significant between-groups differences in scores on the Vocabulary,  $F(1, 78) = 2.38, p = .127, \eta^2 = .030$ , Matrix Reasoning,  $F(1, 78) = 2.62, p = .110, \eta^2 = .032$ , and Symbol Search,  $F(1, 78) = 1.25, p = .106, \eta^2 = .086$  subtests. The FSIQ score was significantly lower in the clinical group,  $F(1, 78) = 7.31, p = .008, \eta^2 = .086$  (see Table 3.9 for full MANOVA results).

Table 3.9

*MANOVA – WISC-IV: Subscale and Composite Scores*

Domains/Composites	Clinical (N=40)		Control (N=41)		df	F	Sig.	$\eta^2$
<b>WISC-IV Subscales</b>	$\bar{x}$	sd	$\bar{x}$	sd				
Vocabulary	9.50	3.25	10.88	2.66	5,74	4.285	.127	.030
Similarities	9.20	3.44	10.33	3.08	5,74	2.381	<b>.042</b>	.052
Matrix Reasoning	9.88	3.34	10.98	2.71	5,74	2.617	.110	.032
Symbol Search	9.93	4.48	10.18	1.87	5,74	.106	.745	.001
<b>WISC-IV Composite</b>								
FSIQ	95.25	15.17	9.20	3.44	5,74	7.313	<b>.008</b>	.086

Given that the mean WISC scores of the participants in the matched cohort appeared higher than the population mean (Subscale M = 10, FSIQ M = 100), a one-sample T-Test was conducted in order to investigate whether those in the matched cohort were performing at higher levels than would be expected in the general population. The results indicated that the matched cohort's performance was not significantly higher than the Wechsler normative sample's mean of 100 ( $M = 103.63$ ,  $SD = 12.06$ ),  $t(41) = 1.930$ ,  $p = .061$ .

In order to elucidate the differences in intellectual functioning between the two groups, a Chi-Square analysis was conducted in order to investigate whether children in the clinical group were more likely to have below average WISC-IV subscale and FSIQ scores than children in the matched cohort. Firstly, subscale scores were recoded and dichotomised into two categories: <7 (i.e. in the low average, borderline or extremely low ranges) and 7 or above (i.e. in the average, high average, superior and very superior ranges). The same dichotomy was computed for the FSIQ score, with scores <90 reflecting those in the low average, borderline or extremely low ranges. Subsequent to recoding, Pearson Chi-Square was computed. The results showed that a significantly larger proportion of children in the clinical group demonstrated below average scores on the Similarities subscale and FSIQ than those in the matched cohort (see Table 3.10).

Table 3.10

*Pearson Chi-Square – Clinical vs. Control: Number of children obtaining WISC-IV scores in the below or average and above ranges.*

Subscale/Composite	Clinical (N=40)				Control (N=40)				df	Asymp. Sig. (2-sided)
	Below Average		Average or Above		Below Average		Average or Above			
	N	%	N	%	N	%	N	%		
Similarities	8	20.0	32	80.0	2	5.0	38	95.0	1	.087
Vocabulary	8	20.0	32	80.0	3	7.5	37	92.5	1	.193
Matrix Reasoning	4	10.0	36	90.0	3	7.5	37	92.5	1	1.000
Symbol Search	7	17.5	33	82.5	2	5.0	38	95.0	1	.154
FSIQ	13	32.5	27	67.5	5	12.2	36	87.8	1	<b>.035</b>

**Global Neuropsychological Functioning.** The next step in the analysis was to look at global neuropsychological functioning. As children under eight years completed the WJ III and those over eight completed CNSVS (as general measures of neurocognitive functioning), global composites from both measures (the GIA from the WJ III and the NCI from the CNSVS) were combined into a new variable, ‘neurocognitive functioning’ in SPSS. A univariate analysis was then conducted to examine significant differences between the groups. There was no significant difference in neurocognitive scores between the clinical group ( $M = 95.83$ ,  $SD = 13.99$ ) and the matched cohort ( $M = 97.82$ ,  $SD = 10.37$ ),  $F(1,62) = .396$ ,  $p = .532$ ,  $\eta^2 = .006$ .

**Correlations between neurocognitive and other domains of functioning.** While no group differences in neurocognitive functioning were found, it was still pertinent to investigate how neurocognitive functioning across the clinical and control groups might

relate to parent and teachers perceptions of emotional, social, behavioural functioning and executive function abilities. A Pearson correlation was computed which revealed that neurocognitive function was negatively correlated with parent ( $r = -.36$ ,  $n = 64$ ,  $p = .024$ ) and teacher ( $r = -.37$ ,  $n = 37$ ,  $p = .003$ ) scores on the SDQ Total Difficulties composite. That is, lower neurocognitive functioning was associated with higher levels of emotional, behavioural and social problems as perceived by parents and teachers. Neurocognitive function was also negatively correlated with the teacher BRIEF GEC composite score, indicating that teachers perceived that children with neurocognitive difficulties demonstrated more behavioural problems associated with executive dysfunction ( $r = -.39$ ,  $n = 38$ ,  $p = .015$ ). However, there was no significant correlation between neurocognitive functioning and parents' ratings of the BRIEF GEC composite score ( $r = -.20$ ,  $n = 64$ ,  $p = .121$ ).

### **Academic Functioning**

The next step in the analysis was to investigate the levels of academic performance amongst the clinical and control groups. Firstly, group differences in WJ III ACH scores (reflective of academic achievement) were assessed. This was followed by an ability/achievement discrepancy analysis (using the WISC-IV and WJ III ACH, the process of which is described below) in order to establish whether learning disorders (as defined in DSM-IV-TR, 2000) were present. Finally, the results of the teacher questionnaires that assessed children's academic performance were analysed and relationships amongst these variables assessed.



**Woodcock Johnson Tests of Achievement (WJ III ACH).** In order to compare children's performance on the WJ III ACH tests, descriptive statistics for the composite scores were obtained (see Table 3.10). A MANOVA was then conducted in order to compare differences in academic achievement between the clinical and control groups. The overall model was marginally significant,  $F(3, 76) = 2.22, p = .092, \eta^2 = .081$ . The dependent variables were the overall WJ III ACH Reading, Math and Writing composite scores. Statistically significant between-groups differences were evident across all three composite scores (see Table 3.10).

Table 3.11

*MANOVA: Clinical and Control Group Achievement Scores*

Subtests and Composites	Clinical (N=40)		Control (N=40)		df	F	Sig.	$\eta^2$
	$\bar{x}$	sd	$\bar{x}$	sd				
Reading Composite	95.31	18.28	103.55	9.63	3, 76	6.346	<b>.014</b>	.075
Math Composite	95.28	21.34	103.65	11.80	3, 76	4.118	<b>.046</b>	.050
Writing Composite	98.18	20.40	107.45	10.51	3, 76	6.205	<b>.015</b>	.074

**Correlation between academic achievement and other domains of functioning.**

The next step in the analysis was to investigate whether academic achievement was associated with FSIQ, and whether either of these two variables were associated with emotional, behavioural, social and executive functioning. Pearson's correlation coefficients were computed between the WCJ III ACH Achievement composite, FSIQ and the teacher BRIEF GEC and SDQ Total Difficulties scores, along with the parent BRIEF GEC and SDQ Total Difficulties scores. The results of these analyses (see Table 3.11) showed that academic achievement was strongly correlated with the FSIQ score. Academic achievement was negatively correlated with the SDQ Total Difficulties score for both parent and teacher

ratings, indicating that lower levels of academic achievement were associated with higher levels of emotional, behavioural and social problems. However, there was no significant correlation between? academic achievement and either the parent or teacher BRIEF GEC composite scores.

Table 3.12

*Pearson Correlation coefficients between WCJ III ACH Academic Achievement composite score, estimated FSIQ and parent and teacher BRIEF and SDQ composites.*

		WJ III ACH	Est. FSIQ	Teacher BRIEF GEC	Teacher SDQ TDS	Parent BRIEF GEC	Parent SDQ TDS
Academic	r		-.741**	-.280	-.355*	-.105	-.301**
Achievement	Sig (2 tailed)	-	.001	.051	.013	.354	.007
	N		80	49	48	80	80
FSIQ	Pearson Correlation	.741**		-.302*	-.272*	-.279*	-.280*
	Sig (2 tailed)	.001	-	.033	.059	.012	.011
	N	80		50	49	80	49

\*\* Correlation is significant at the 0.01 level (2-tailed)

\* Correlation is significant at the 0.05 level (2-tailed)

**Learning Disorders.** The discrepancy model of learning disorder (APA, 2000) was applied in the interpretation of the ability and achievement test outcomes for both groups. This model was employed in order to identify the likely presence of reading, mathematical and writing disabilities (e.g., dyslexia, dyscalculia and dysgraphia) in the clinical and control groups.

Firstly, ability/achievement discrepancy analyses were conducted for all participants across both groups. A step-by-step procedure for this analysis followed that suggested by Schrank, Becker & Decker (2001) in the WJ III Assessment Service Bulletin for the

comparison of cluster scores obtained on the WISC and WJ III ACH. In accordance with this procedure, each participant's FSIQ score was used to obtain a corresponding predicted achievement score, as detailed in the table of expected achievement scores described by Shrank, Becker & Decker's (2001, p.6). Predicted achievement scores were then subtracted from actual achievement scores and the values recorded as an ability/achievement standard score difference. This difference was then divided by the standard error of the estimate provided by the authors, resulting in a standard (SD) deviation score or z score. A significant discrepancy was reflected in a SD of 2.0 above or below the mean discrepancy score.

When significant discrepancies in ability and achievement in the areas of reading, math or writing were identified, these were categorised as being either a significant 'strength' or 'weakness' according to whether the direction of the discrepancy was positive or negative. For example, if a participant demonstrated a reading achievement score that was two standard deviations higher than their predicted achievement score (as predicted on the basis of their ability score) this participant would be categorised as having a reading strength. Participants with significant discrepancies were coded accordingly. Participants identified as having a significant academic weakness were also coded as demonstrating a learning disorder. Those with a significant strength were coded as demonstrating a relative strength.

Once these variables had been computed, frequency analysis was conducted in order to establish the number of participants in both groups with reading, math and writing strengths or weaknesses, learning disorders and overachievement. This was followed by a Chi-Square analysis which was used to establish whether significant differences in the presence of academic strengths and weaknesses were evident between groups. Results of this analysis demonstrated that a significantly greater proportion of the clinical group had scores indicative of a learning disorder (see Table 3.12).

Table 3.13

*Frequencies of Learning Strengths and Weaknesses and Pearson Chi-Square Analysis*

	Clinical (N=41)		Control (N=41)		df	Asymp. Sig. (2- sided)
	N	%	N	%		
Reading Strength	4	9.8%	3	7.3%	1	1.000
Reading Weakness	6	14.6%	2	4.9%	1	.264
Math Strength	8	19.5%	8	19.5%	1	1.000
Math Weakness	7	17.1%	2	4.9%	1	.155
Writing Strength	5	12.2%	9	22.0%	1	.379
Writing Weakness	6	14.6%	1	2.4%	1	.109
Learning Disorder	13	31.7%	5	12.2%	1	<b>.033</b>

**Teacher Questionnaire**

**Teacher Impressions of Academic Progress.** Teachers provided their impressions of children's achievement in the areas of reading, spelling, math, physical education (see Table 3.13), and handwriting, written language, expressive language and comprehensive language were computed (see Table 3.14). Teacher ratings of academic progress were analysed in order to identify differences between the clinical and control groups and are summarised in the tables below. The next step in the analysis was to establish whether teacher impressions of academic performance were significantly different across the two groups. In order to do so, a Fisher's Exact Test was conducted. Teacher ratings indicated that a greater proportion of children in the clinical group performed at a lower level in the areas of reading ( $p = .005$ ) and written language ( $p = .044$ ).

Table 3.14

*Frequencies of Teacher Impressions – Reading, Spelling, Math & P.E*

	READING				SPELLING				MATH				P.E			
	Clinical (N=24)		Control (N=26)		Clinical (N=23)		Control (N=26)		Clinical (N=23)		Control (N=26)		Clinical (N=24)		Control (N=26)	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Delayed	1	4.2	0	0	1	4.3	1	3.8	1	2.4	0	0	0	0	0	0
Below Average	2	8.3	4	15.4	6	26.1	8	30.8	7	30.4	4	15.4	4	16.7	3	11.5
Average	14	58.3	3	11.5	10	43.5	5	19.2	9	39.1	8	30.8	13	54.2	16	61.5
Above Average	6	25.0	13	50.0	5	21.7	10	38.5	4	17.4	12	46.2	5	20.8	6	23.1
Advanced	1	4.2	6	23.1	1	4.3	2	7.7	2	4.9	2	4.9	2	8.3	1	3.8

Table 3.15

*Frequencies of Teacher Impressions – Handwriting and Language Domains*

	HANDWRITING				WRITTEN LANGUAGE				EXPRESSIVE LANGUAGE				COMPREHENSIVE LANGUAGE			
	Clinical (N=24)		Control (N=26)		Clinical (N=24)		Control (N=26)		Clinical (N=24)		Control (N=26)		Clinical (N=24)		Control (N=26)	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Delayed	1	4.2	0	0	1	4.2	0	0	1	4.2	1	3.8	1	4.2	1	3.8
Below Average	8	33.3	4	15.4	8	33.3	7	26.9	8	33.3	5	19.2	6	25	2	7.7
Average	10	41.7	12	46.2	11	45.8	5	19.2	10	41.7	4	15.4	12	50	9	34.6
Above Average	5	20.8	8	30.8	4	16.7	10	38.5	4	16.7	12	46.2	5	20.8	10	38.5
Advanced	0	0	2	7.7	0	0	4	9.8	1	4.2	4	9.8	0	0	4	15.4

**Clusters of Impairment**

The final stage in the analysis was to identify and examine more closely the cases in which children experienced problems across a range of domains. In order to do so, several composite measures were included in the analysis: neurocognitive functioning, FSIQ, parent SDQ total difficulties score, parent BRIEF GEC scores, and the WJ III ACH Brief Academic

Achievement (BIA) composite score. Firstly, each of the variables was recoded and dichotomised to indicate whether or not the score was suggestive of a weakness. Weakness was classified as follows: neurocognitive scores < 90; FSIQ < 90; SDQ total difficulties score > 17; BRIEF GEC > 65; and, BIA < 90. These cut-offs reflect score ranges for each of the measures. Next, a frequency analysis was conducted to assess how many individuals in the clinical and control groups had one or more domains of impairment (see Table 3.15). Eighteen children in the clinical group demonstrated impairment in more than one domain of functioning, whereas only five children in the control group demonstrated multiple domains of impairment.

Table 3.16

*Frequencies of Domain Impairments*

	Clinical (N=22)		Control (N=12)	
	N	%	N	%
1 impairment	3	13.6	7	58.3
2 impairments	10	24.4	1	8.3
3 impairments	5	22.7	1	8.3
4 impairments	3	7.3	2	16.7
5 impairments	0	0.0	1	8.3
	Clinical (N=41)		Control (N=41)	
Multiple impairments	18	43.9	5	12.2

This frequency analysis was followed by a Pearson Chi-Square test which was used to establish whether there was a significant association between the number of participants with impairments across multiple domains and TBI group membership. The results of this analysis

showed that there were significantly more participants in the clinical group with problems in problems across multiple domains of functioning  $\chi^2(1) = 9.82, p = .002$ .

Finally, in order to more closely examine individual cases of TBI participants with difficulties across multiple domains, those identified as having three or domains of impairment were examined more closely. The purpose of this analysis was investigate the demographic and injury-related characteristics of the children. In particular, it sought to obtain richer information regarding the nature of childrens' difficulties and compare this with information regarding premorbid functioning and qualitative teacher comments in order to assess whether children's difficulties might have been present prior to their TBI. Eight (19.5%) children from the clinical group were included in this analysis. The demographic information pertaining to this group is described and compared against those with one to two or zero impairments in Table 3.16. Only children with mild-medium risk or mild-high risk injuries evidenced any functional impairments. Those with mild-low risk injuries did not demonstrate any impairments in neurocognitive, academic, emotional, behavioural or social functioning.

Each of the individual cases of those with impairments across three or more domains of functioning is described in Table 3.17. Included are comments from teachers, whether there were premorbid difficulties evidenced and whether educational intervention has been received. Teachers had completed and returned questionnaires for five (62.5%) of these children. No pre-injury standardised assessment scores were provided by teachers. In each of the five cases that teachers responded to, concerns regarding learning, behavioural or emotional functioning were noted. Four of the five (80%) children in these cases were of Maori ethnicity.

Table 3.17

*Demographics of Clinical Group Children with 3+ Impairments*

	3+ impairments	n	1-2 impairments	n	0 impairments	n
Mean Age (Min-Max))	8.9 yrs (6.4-12.4)	8	9.2 yrs (7.2-10.8)	11	8.9 yrs (6.3-12.7)	21
Female	5 (62.5)	8	7 (63.6)	11	9 (42.9)	21
Male	3 (37.5)	8	4 (36.4)	11	12 (57.1)	21
Major Ethnicity						
Maori	5 (62.5)	8	5 (35.7)	11	3 (14.3)	21
NZ Euro	3 (37.5)	8	9 (64.3)	11	13 (61.2)	21
Other	0 (0.0)	8	0 (0.0)	11	1 (4.8)	21
Injury Category						
Mild-low	0 (0.0)	8	0 (0.0)	11	10 (45.5)	21
Mild-medium	3 (37.5)	8	6 (54.5)	11	3 (13.6)	21
Mild-high	5 (62.5)	8	5 (45.5)	11	9 (40.9)	21
Maternal Education						
High school	4 (66.7)	6	3 (27.3)	11	2 (28.6)	7
Polytechnic	2 (33.3)	6	3 (27.3)	11	2 (28.6)	7
University	0 (0.0)	6	2 (18.2)	11	3 (42.9)	7
Educational Intervention						
Yes	3 (60.0%)	5	1 (16.7)	6	0 (0.0)	12
No	2 (40.0%)	5	5 (83.3)	6	12 (100.0)	12

Table 3.18

*Individual cases of multiple impairments with teacher information included*

M/F	Ethnicity	IQ	Age at Injury	Problems	Comments	Educational Intervention	Evidence of Premorbid Difficulties
F	Maori	71	5.17	Learning problems – concentration Often tired	(Child) needs a lot of 1-1 help to engage in and complete set work	Teacher Aide	Nil
F	Maori	84	11.43	Weight problems Referred for counselling	Her self-esteem is low and greatly affected by her perception of herself. I believe she could do so much more if her weight was controlled.	Nil	Nil
F	Maori	84	5.37	Vision problems Oral and written language problems	Takes a lot of repetition for her to remember a concept. Talks when she feels comfortable but often not related to topic.	MOE Referral  Teacher Aide	Dyslexia



<b>M/F</b>	<b>Ethnicity</b>	<b>IQ</b>	<b>Age at Injury</b>	<b>Problems</b>	<b>Comments</b>	<b>Educational Intervention</b>	<b>Evidence of Premorbid Difficulties</b>
M	NZ Euro	73	11.00	Oral, listening and written language problems	Lack of social skills. Problems interacting with peers. Lack of improvement in reading and maths	Nil	Nil
M	Maori	78	5.52	Maths and writing problems.	Tearful in unfamiliar situations. Changeable in emotions from day to day. Finds it hard to retain basic maths facts and concepts. Requires a lot of hands-on experiences.	Reading Recovery	Nil

### Summary

Participants in the current study who had sustained a mTBI 14-months prior to assessment demonstrated significantly higher levels of developmental impairments than children in a non-injured matched cohort. Areas in which these children evidenced deficits included intellectual ability, emotional and behavioural functioning and academic achievement. However, the neurocognitive and social functioning of children with mTBI seemed to be relatively intact and comparative to that of non-injured children. Case-by-case analysis of children with multiple impairments revealed that the majority did not have a premorbid diagnosis of a psychological or learning disorder that might indicate pre-injury impairment. While the majority had received education interventions at school, a significant proportion had not.

## Discussion

The main aim of the current study was to investigate the developmental functioning of children aged five to 11 years 14-months after sustaining mTBI, and compare their functioning against that of a non-injured matched cohort. This study also sought to explore the relationships amongst demographic, injury and outcome variables in children who have experienced mTBI. The results of this study indicate that children who have sustained a mTBI 14 months earlier are more likely than non-injured children to experience a range of developmental impairments across emotional, behavioural, intellectual and academic domains of functioning. However, differences in neuropsychological functioning were less common between the injured and non-injured groups. It should be highlighted that while significant group differences were evident, this does not necessarily lead to the conclusion that mTBI leads to increased difficulties. It is possible that impairments present amongst clinical group participants were not related to mTBI. However, it seems that mTBI may be an indicator or predictor for increased developmental problems, highlighting the possibility that children who experience concussion may be a more 'at-risk' group overall.

The first, overarching analysis of overall group differences in developmental functioning included measures of intellectual ability, emotional, behavioural and social functioning, academic achievement, and executive function. This was followed by closer investigation of the specifically affected domains of functioning and the relationships amongst those variables. While SES was included as a covariate in this initial analysis, it was not found to be significant as a covariate. It seems from this finding that, in spite of a small but significant difference in SES between the clinical and control groups, SES did not contribute to a significant degree to the variance in outcomes. This is not to state that SES was controlled for in this study; rather, that its inclusion as a covariate acted as a noise

reduction technique that suggests SES does not account for the differences in developmental functioning identified between the two groups (Miller & Chapman, 2001; Field, 2013).

### **Emotional, behavioural and social problems**

Children with mTBI demonstrated higher levels of psychological distress and behavioural/social issues (as measured by the SDQ total difficulties score) than their non-injured peers 14-months post-injury. This finding seems to reflect the growing evidence base to suggest that children who sustain mTBI are at significantly higher-risk of experiencing emotional and behavioural problems (Hawley, 2003; Moore, Terryberry-Spohr, & Hope, 2006; Yeates & Taylor, 2012)

Parents of children with TBI rated their children as having significantly higher levels of emotional problems than those in the matched cohort. This matches with findings from previous research that has suggested that children who have sustained mTBI are more likely to experience persistent mood and anxiety problems (Hawley, 2003; Yeates & Taylor, 2012). While Ponsford et al. (1999) highlighted the possibility that children with persistent emotional problems were likely to have had premorbid difficulties in this area, there was no evidence in this study (in the form of information from parents and teachers) that pre-existing mood and anxiety problems were a significant feature for participants in the clinical group.

Teachers did not rate children in the clinical group as having significantly higher levels of emotional problems. This difference in the perceptions of children's emotional problems may reflect previous research that has showed that teachers are less likely than parents to identify internalising problems in children and adolescents (Stanger & Lewis, 1993; Youngstrom, Loeber, & Stouthamer-Loeber, 2000).

Parents also perceived children in the clinical group to demonstrate more hyperactivity than those in the matched cohort. However, teachers of children with mTBI rated their hyperactivity levels as being similar to non-injured children. This is in line with earlier studies that have demonstrated higher rates of ADHD amongst children with mTBI (Yeates & Taylor, 2010). It is also significant that in the current study no children had received pre-injury diagnoses of ADHD, suggesting that their difficulties may not pre-date their injury. This differs from the findings of Max et. al. (1997) and Bloom et al. (2001), who identified 10-22% of the children aged between six and 15 years in their mTBI samples as having pre-injury diagnosis of ADHD. While the absence of pre-injury ADHD diagnoses does not necessarily imply good premorbid functioning, it is significant in light of previous research that has identified children with ADHD as being at higher risk of experiencing TBI. While this could reflect higher diagnostic rates in the regions of previous studies (such as the United States), meta-analyses of international prevalence rates have suggested that location plays a limited role in differing results. Instead, variations in prevalence rates are likely related to methodological differences in epidemiological studies. Further investigation of this issue is required in order to establish whether hyperactivity symptoms were present premorbidly in the children that evidenced such difficulties post-injury.

There were no significant between-group differences in parents' perceptions of children's conduct symptoms. Teachers, on the other hand, were significantly more likely to identify conduct problems in children with mTBI and rate those problems as being clinically significant. This finding suggests that while teachers were more likely to identify children with mTBI as having higher rates of conduct problems, parents may not identify such difficulties in their children. So while it would seem that the perceptions of teachers in the current study reflect previous research that suggests that persistent oppositional and conduct disorder symptoms are more prevalent in children who have experienced mTBI (McKinlay,

Grace, Horwood, Fergusson, & MacFarlane, 2009; Yeates & Taylor, 2010), parents seem to be less concerned about their children's conduct. This finding is consistent with other research that demonstrates low concordance between parent and teacher ratings of child behaviour; while parent and teacher-reports are often employed (along with self-report) in order to triangulate the view of a child, it is not unusual for there to be a lack of association between parents' and teachers' perceptions (Iizuka et al., 2010; New, Razzino, Lewin, Schlumpf, & Joseph, 2002). It is possible that parent and teacher perceptions of conduct problems may be influenced by family factors (Connolly & Vance, 2010), however further investigation of the expression and perception of conduct problems between home and school would help to further clarify such findings. It is also possible that the increased and differing demands at school including peer interaction, understanding and following instructions, and increased stimuli may impact on children's coping ability. The complexities of the school environment may affect children's functioning and thus their performance may appear worse in that setting than in at home, where demands may be lower. It may also be the case that parents and teachers have different levels of awareness or knowledge of typical child development and behaviour, which could impact on their perception of an individual child's functioning.

Both parents and teachers of children in the clinical group rated their level of peer problems as similar to those in the matched cohort. However, a higher proportion of the clinical group parents rated their children's peer problems as being in the clinically significant range. The overall finding of similar levels of functioning between the groups reflects that of Petersen, Scherwath, Fink, and Koch (2008), who found that children with mTBI did not evidence significantly higher scores on the peer problems subscale of the SDQ. It is in line with other longitudinal research which has demonstrated an absence of social problems in children with mTBI (Anderson, Catroppa, Morse, Haritou, & Rosenfeld, 2001).

However, the higher proportion of clinically significant peer problems amongst the clinical group may point to increased social problems amongst a subset of that cohort. This is worthy of further exploration in order to establish whether normal social functioning can be expected in children who have experienced mTBI in the previous year.

Overall, the findings from the current study adds weight to the developing evidence base that children who sustain mTBI are more likely than their non-injured peers to demonstrate emotional and behavioural problems. Parents perceive children with mTBI to have higher rates of emotional problems and hyperactivity, while teachers perceive with mTBI to have greater conduct problems. However, it would seem that children with mTBI are not at increased risk of experiencing problems of social functioning. Variability amongst parents' and teachers' views of children's emotional and behavioural functioning may reflect differences in the expression and identification of internalising and externalising behaviours across home and school settings.

## **Cognitive Functioning**

**Executive Function.** Parent and teacher ratings on the BRIEF were not significantly different between the two groups. This differs from previous research using the BRIEF which has shown children with mTBI to have significantly more difficulties in the areas of initiation, planning and organisation, problem solving and working memory (Maillard-Wemelinger et al., 2009), and higher GEC scores indicative of global executive function impairment (Sesma, Slomine, Ding, & McCarthy, 2008). Objective measures of EF, such as via the Stroop test, have also demonstrated impaired inhibition in paediatric mTBI cohorts (Gerard-Morris et al., 2010). It is possible that the use of the GEC composite in the current study may have masked small differences amongst some of the domains, however overall it would seem that the

functioning of the two groups was essentially similar. Teacher measures of EF have not been employed in previous research regarding mTBI, and this area may be worthy of further exploration.

**Global Neuropsychological Composite.** The combination of WJ III COG GIA scores obtained by children under 8 years and the CNSVS NCI composite scores obtained by children over 8 years yielded an overall measure of global neuropsychological functioning. Interestingly, in spite of significant between-group differences identified across other measures of neuropsychological functioning in this study, there was no evidence of significant differences in overall neurocognitive functioning between the groups. This finding is unique in that little of the previous research has looked at global neuropsychological functioning in children after mTBI via a battery such as the WJ III COG or CNSVS. It seems that to suggest that overall neurocognitive functioning is not likely to be impaired in children aged between six and 12 years, 14 months after sustaining a mTBI.

When children's overall neuropsychological functioning was correlated with their emotional, behavioural, social functioning and specific executive functions (as measured by the parent and teacher SDQ Total Difficulties and BRIEF GEC scores), significant correlations were revealed. Global neuropsychological functioning was negatively correlated with teacher BRIEF GEC and SDQ Total Difficulties scores, suggesting that lower global neuropsychological scores were associated with higher rates of emotional, behavioural and social difficulties. It was also negatively correlated with parent SDQ Total Difficulties scores, indicating that parents perceived children with low neuropsychological functioning (reflected by lower WCJ or CNSVS scores) to have higher rates of emotional and behavioural problems. However, there was no correlation between parents' perceptions of EF and the objective measure of overall neuropsychological functioning. This finding is interesting as the behaviours reflected in the BRIEF are designed to reflect the behavioural expression of

neuropsychological impairment in the form of EF deficits. However, it would seem that parent perceptions of specific EF deficits were not associated with objective measures of children's overall neuropsychological functioning. Previous studies have not compared the BRIEF with the WCJ-II COG or CNSVS, however it was expected that parent ratings of EF would be associated with neuropsychological measures of neuropsychological function and parent ratings of executive function. While it has been argued that parent ratings are potentially more sensitive to EF-related behaviours than performance-based measures (Cummings, Singer, Krieger, Miller, & Mahone, 2002; Mahone et al., 2002), there is little evidence of that in the current study as there were no significant between-group differences in the parent BRIEF ratings.

Overall, these data suggest that children do not demonstrate significant neuropsychological impairment 14 months after mTBI, as measured by either parent ratings or performance-based tests. However, it is not clear why there is a lack of relationship between such measures. It is possible that if neuropsychological impairment was to present in children after mTBI, it might emerge at a later point in their development. Further, longitudinal investigation of the association between EF, global neuropsychological functioning and the ways in which these are expressed and assessed after paediatric mTBI is warranted.

**Intelligence.** The initial MANOVA examining global outcomes showed a significant between-groups difference in intellectual ability (as measured by the estimated FSIQ score), indicating that children in the clinical group demonstrated significantly poorer performance on the WISC-IV (suggestive of lower intelligence). This finding is significant, as it is in contrast to most of the previous research regarding intellectual ability following paediatric mTBI. While the authors of one previous study argued that their results were evidence of intellectual impairment in children with mTBI, it would seem from their analysis that the



results of those with mild injuries were conflated with those who had moderate and severe injuries (Tremont, Mittenberg, & Miller, 1999). Therefore, their findings did not provide firm evidence of intellectual decline following mTBI. The remainder of previous studies that included analysis of children with mild injuries found no significant differences in IQ between those with mTBI and controls (Anderson, Catroppa, Morse, Haritou, & Rosenfeld, 2000; Catroppa & Anderson, 2004; Hawley, 2004; McKinlay, Dalrymple-Alford, Horwood, & Fergusson, 2002). In contrast, the current study identified significantly lower FSIQ scores in children who had sustained mTBI when compared against a matched cohort. Additionally, information regarding premorbid functioning indicated that only two of the children in the clinical group had received a previous diagnosis that might be relevant to their intellectual ability (in both cases, dyslexia).

It was noteworthy that children in the TBI group obtained significantly lower scores on the Similarities subtest of the WISC, reflective of lower ability in the area of verbal comprehension. This finding also differs from Tremont, Mittenberg & Miller's (1999) research that suggested that if intellectual functioning is impaired after TBI it is most likely to be in the area of perceptual reasoning, with verbal comprehension skills tending to remain intact.

It has been noted that the Similarities subtest requires a degree of abstract reasoning that is not necessarily demanded in the Vocabulary subtest (also used here to measure Verbal Comprehension). Vocabulary reflects word knowledge and verbal fluency, whereas Similarities requires children to employ less concrete conceptualisations and consider the relationships between seemingly unrelated objects. Given what is known regarding the potential for mTBI to impact on complex, higher order cognitive processes, it is possible that poor performance on the Similarities subtest reflect abstract reasoning deficits that may not be unexpected in children who have sustained an injury (Maillard-Wermelinger et al., 2009).

However, it could also be argued that this IQ difference might reflect a positive skew in the matched cohort sample that might have occurred as a result of the use of a volunteer cohort.

**Academic Performance.** The first MANOVA in the initial analysis showed that children in the clinical group demonstrated significantly lower academic achievement than those in the matched cohort. Further between-groups analysis of children's academic functioning showed that children with mTBI performed more poorly than those in the matched cohort across the areas of reading, math and writing. When discrepancy analysis was conducted between academic achievement and intellectual ability, children with clinical group were significantly more likely than those in the matched cohort to demonstrate relative learning weaknesses indicative of learning disorder. Adding to this finding, teachers of children in the clinical group were more likely to rate those children as having reading and writing difficulties than teachers of non-injured children.

This finding of overall poorer academic performance and higher rates of learning disorder in children who have sustained mTBI is in contrast to much of the literature in this area that suggests it is unlikely to see academic impairments persist after mTBI (Ewing-Cobbs, et al., 1998; Fay et al., 1994; Kinsella et al., 1997; Light et al., 1998). While one study identified significant reading deficits that emerged over time in young children who had sustained mTBI, math and writing deficits have not been highlighted in the previous literature. Furthermore, no other studies have examined whether learning disorders are more prevalent in children after mTBI. While attention must be paid to the possibility that learning problems existed pre-morbidly, information obtained in the current study indicated that only two children in the TBI group had received a premorbid diagnosis of learning disorder.

Significant negative correlations were identified between children's academic achievement and both parent and teacher SDQ total difficulties scores. This finding indicates

that parents' and teachers' lower ratings of children's emotional, social and behavioural functioning are significantly associated with children's lower academic achievement scores. As academic achievement was also significantly associated with FSIQ scores, it is possible that these variables may have confounded each other somewhat. For example, low intellectual functioning (reflected in a low FSIQ score) may contribute to both behavioural problems and academic impairments (Thaler et al., 2010). It was notable, however, that no correlation existed between children's academic achievement scores and parent or teacher BRIEF GEC scores, suggesting that there was no relationship between academic achievement and parents' or teachers' perceptions of behavioural problems related to executive dysfunction. As an association might reasonably be expected to exist between academic achievement, executive function and behaviour, this finding is puzzling. It is possible, again, that the sensitivity of the parent measure obscures its relationship to performance-based measures (Cummings, Singer, Krieger, Miller, & Mahone, 2002; Mahone et al., 2002); however, further enquiry is needed to establish whether the BRIEF (which is argued to have sound construct validity) measures similar constructs to objective measures of related abilities and behaviours.

**Cases of Multiple Impairments.** Children with mTBI were more likely than those in the matched cohort to demonstrate developmental impairments across multiple domains of functioning. Of those with functional impairments across more than three domains, the majority were Maori (62.5%). It would seem that Maori were significantly overrepresented in this small group of children with multiple impairments. However, it is possible that this overrepresentation in fact reflects the likelihood that Maori will under-perform and achieve lower scores on IQ and academic assessments (Lock & Gibson, 2008; Ogden & McFarlane-Nathan, 1997). Similarly, the finding that most of those with multiple impairments had a parent whose highest level of education was high school may not indicate that parental

education is causally related to TBI outcome. While it is possible that mTBI outcomes could be mediated by SES-related variables such as parent education (Hawley, Ward, Magnay, & Long, 2004; Hoofien, Vakil, Gilboa, Donovanick, & Barak, 2002), it is also likely that parents' low academic achievement may be a correlate of other outcome-related factors such as a family history of learning problems, which in turn may impact on child intellectual ability, academic achievement and emotional / behavioural functioning (Bradley & Corwyn, 2002; Turkheimer, Haley, Waldron, D'Onofrio, & Gottesman, 2003).

In spite of a variety of attempts to establish each participants' premorbid functioning (via baseline BIONIC assessments, educational information, qualitative information from teachers, etc.), for the majority of cases this issue remains unclear. In those with multiple difficulties, it was noted that one child in the clinical group had been diagnosed with dyslexia. However, for many there seemed to have been an absence of premorbid assessment. While school teachers were asked to provide standardised school assessment scores from prior to the child's injury, few provided meaningful scores that might serve as evidence of a child's premorbid level of achievement. The lack of premorbid assessment information may relate in part to the age of some of the children. Of the five children with multiple difficulties that teachers provided information about, three were <six years at the time of injury. It seems unlikely that much in the way of meaningful assessment information could have been gathered for participants at an emergent academic level. Young age may also affect the reliability of any parent and teacher information provided regarding a child's premorbid functioning, as it is possible that learning and behavioural difficulties would not have emerged or been identified in younger children. While it is tempting in TBI research to imagine that impairments observed post-injury are a direct result of TBI, this is only one of six potential scenarios that might explain TBI's relationship to post-injury symptoms (Kirkwood & Yeates, 2010). There is also the possibility that TBI may arise as a result of

premorbid problems, such as ADHD, which predispose children to incurring head injuries (Bloom et al., 2001; Max et al., 1997). While it was noted in this study that no children had received prior diagnoses of a mental health problem, that is not to say that sub-clinical symptoms were not present in some children or that clinically significant symptoms were present but had not come to the attention of a child mental health professional that might assess and diagnose such problems.

Another significant finding of this study was that children who sustained mild-low risk injuries did not evidence functional deficits. Only those who had sustained a mild-medium or mild-high risk injury demonstrated functional impairments. This may be evidence for the validity of Servadei's (2001) mTBI categorisations and the capacity of those criteria to predict outcomes. It might also be argued that this finding suggests that mTBI is causally related to functional outcomes. However, more investigation of this issue is needed, and premorbid functioning controlled for, in order to clarify whether this finding constitutes evidence for a causal link.

While the majority (60%) of children with impairments across three or more domains of functioning had been identified as requiring and provided with educational interventions at school, a significant proportion (40%) had not received any remedial intervention. Of those with impairments in one or two areas of functioning, only one (16.7%) had received intervention. This finding suggests that many of the children experiencing significant and persistent difficulties after sustaining mTBI were not identified by teachers as needing input. Alternatively, it may be that their need was identified but services were not provided, possibly due to resource restraints. An example of such a possibility is highlighted by the case of one participant. This 12 year old male of NZ European ethnicity had an estimated FSIQ score of 73, in the borderline range and within the confidence interval for a score in the extremely low range (indicative of intellectual disability). The teacher in this case identified

oral, listening and written language problems and reported that the child lacked social skills, had problems interacting with peers and demonstrated a lack of improvement in reading and maths. In spite of these significant difficulties, the teacher reported that no educational interventions had been provided to this child. Examples such as these raise questions as to how such children are perceived in classroom settings, what interventions are provided to them, and what barriers may impinge on a teachers' capacity to identify and obtain support for a child with significant functional impairments and a history of mTBI.

**Strengths.** A significant strength of the current research is that its design addresses all of the six criteria proposed by Satz, Zaucha, McCleary, & Light (1997) for methodologically rigorous TBI outcome research. A consistent definition of TBI severity was used which reflected the WHO (2005) criteria. The design was longitudinal, in that it observed children past the first year of injury and followed on from assessments at four earlier timepoints. Satz, Zaucha, McCleary, & Light also recommended that a clinical cohort greater than 20 be included in any studies of TBI outcomes. The current research successfully addressed this goal with 41 children in the clinical group and a further 41 non-injured children recruited for the matched cohort. Standardised assessment measures formed the majority of assessment tools and preinjury factors, such as previous diagnoses and premorbid school functioning, were included in the study. Thus, the current study methodology can be demonstrated to be rigorous, unlike much of the earlier research regarding childhood outcomes of mTBI.

The current study sample was relatively large and drawn from a population-based incidence study that aimed for complete case ascertainment. As previous research regarding childhood TBI has often relied on hospital-based data, with some studies excluding case fatalities and mild injuries, having access to a community sample is a particular strength of the current research.

The current study also drew its data from multiple sources, and via a range of assessment tools that included direct assessment, parent and teacher reports and school information. All standardised assessment measures had been used in paediatric TBI research previously and found to be reliable and valid for use with this population. Obtaining information from multiple sources allowed for comparison of this data and greater exploration of differences in children's functioning across settings. The current research also focuses on a number of domains within a single study design, with extensive data collected around the time of injury.

**Limitations.** As with much of the previous research investigating TBI outcomes, a limitation of Study One was the limited premorbid information that was able to be obtained regarding children's developmental functioning. While there were attempts to obtain premorbid information via multiple modes and measures (e.g., baseline BASC used in the BIONIC study requesting retrospective information, pre- and post-injury school assessment information, pre-injury diagnoses, and qualitative information from teachers), these assessment approaches yielded inconsistent and potentially unreliable results. The differing types of assessment used by teachers and lack of comparable, standardised assessment results provided by schools (e.g., stanine scores from before and after a child's injury) limited the interpretive capacity of the school information that was obtained. While pre-injury diagnoses were requested, these may not have fully reflected children's premorbid functioning as there may have been sub-clinical difficulties present or emerging and psychological diagnoses may not yet been sought or obtained. Study One employed numerous approaches in the attempt to evaluate premorbid functioning, however the methodological problems noted above are likely to have impacted on the reliability of those measures. It would seem that the only way to address such a problem is to investigate TBI with birth cohort samples, whose functioning can be objectively assessed via standardised measures prior to injury and reassessed

subsequently. However, the cost and complexity of this kind of population study would likely impede future investigations into this area. While premorbid functioning is difficult to control for, multiple measures can assist researchers to explore this issue and may act as noise reduction techniques within analysis.

Only families from the BIONIC study who consented to follow-up and did not have a change of contact details during the first 14 months following TBI were able to be approached for inclusion in Study One. The functioning of children from families who may have been reluctant to disclose personal information (for a myriad of possible reasons) may have been less likely to consent to follow-up or participation in the study. Furthermore, the functioning of children from more transient families with changing contact details or who moved out of the study region may also have not been captured by this research. It is possible that the needs of some children from at-risk families were not able to be evaluated, which could have led to a positive skew in the data. Additionally, a lack of sensitivity analysis might impact the generalisability of findings to the general mTBI child population.

The use of a volunteer comparison group may have introduced sample bias to the matched cohort in that this type of sample might attract volunteers with particular concerns or interest; for example, parents who are concerned about their child's functioning may be more likely to volunteer in order to access developmental assessment, while parents who consider their children to be especially gifted or talented may also be more likely to participate in order to obtain more information regarding their child's functioning. Positive or negative skews in the data may have resulted.

Measures of children's emotional, behavioural and social functioning in Study One relied on parent and teacher report. There is potential for parent and teacher responses on questionnaires to be subject to perception bias. Responses may also be skewed by either



social desirability bias or negative-reporting bias. Classroom and playground observational data may also have increased the validity and reliability of information related to children's at-school functioning.

**Future Research Directions.** It would be beneficial for future research regarding the impact of mTBI on developmental functioning to occur in the context of longitudinal birth cohort studies, if the issue of premorbid functioning is to be properly addressed. It would seem that, in spite of a variety of attempts to control for pre-injury difficulties, the possibility that children's developmental problems were present or emerging prior to their injury can not be ruled out unless children are rigorously assessed via the use of standardised instruments prior to their injury.

Future research may also look more closely at specific neuropsychological functioning in similar cohorts. For example, inclusion of more objective measures of attention, memory and executive function might enrich study findings and detect subtle changes in neurocognitive functioning.

It is possible that, given the possible developmental trajectory of mTBI-related problems, difficulties may not have yet emerged at the one-year time-point. As such, it would be useful for similar research to take place at later time-points in order to track the emergence of problems and detect disturbances in long-term developmental pathways.

## **Summary**

The findings of this study suggest that children who have sustained mTBI are more likely than non-injured children to demonstrate significant developmental problems 14-

months post-injury. In particular, children with mTBI are more likely to be perceived as demonstrating emotional and behavioural problems. They also evidence poorer performance on tests of IQ and academic functioning, and are more likely to be perceived by their teachers as experiencing academic difficulties. However, in spite of some apparent deficits across major domains of functioning, the results of the current study indicate that children who have sustained mTBI are unlikely to demonstrate persistent neuropsychological impairment. While there was concordance between parents and teachers regarding a number of aspects of children's functioning, perceptions were not always consistent. Variations in the way that children with mTBI are viewed by parents and teachers, along with evidence to suggest that (regardless of cause) children with mTBI may exhibit poorer academic functioning, raises questions regarding how individual issues might be conceptualised and addressed by educators. Furthermore, interactions with schools and teachers during the course of data collection for Study 1 anecdotally revealed a wide range of understandings amongst teachers regarding TBI and its possible effects. In order to explore the implications of Study 1 for children in school settings in light of the apparent variation in teacher perceptions of this issue, it was considered important to investigate the understandings and approaches of primary-school teachers in relation to mTBI in childhood.

## CHAPTER 4

### Study 2: Teacher Perspectives on Traumatic Brain Injury in Childhood

#### Study Rationale

Over the course of data collection for Study One, a significant amount of engagement and interaction with local schools and teachers occurred. Schools facilitated data collection by providing space and time for children from both the clinical and control groups to be assessed during school hours; many schools also assisted with recruitment of the matched cohort through publication of invitations to families to participate in the COBIC project. Furthermore, 50 teachers completed questionnaires relating to students' functioning in the school setting and returned these to the primary researcher.

These interactions led to a number of discussions between teachers and the primary researcher regarding the objectives of the study and information relating to TBI. Some teachers asked for assistance in locating recent and relevant literature pertaining to TBI's effects on child development, whilst others shared concerns regarding individual students (both current and historical) who had sustained injuries. There appeared to be a wide variation in teacher knowledge and perceptions of TBI. It seemed that some teachers were receiving inaccurate information regarding TBI, whilst many others had not encountered the topic at all.

This raised the question as to whether teachers were aware of potential problems in children who have sustained a mTBI and able to provide appropriate support to children with post-concussive effects. In light of the findings of Study 1 that children who have sustained mTBI are at higher risk of experiencing persistent emotional, behavioural and academic problems, it was established that further investigation of this issue was warranted.

## Literature Review

### The Context - New Zealand's Special Education System

The New Zealand education system is premised on principles of equality reflected in an inclusive education approach. Inclusive education is a system associated with the rights of individuals with disabilities. Historically, New Zealand excluded children with disabilities from participation in the mainstream education system (Mitchell, 1987). However, in 1989, under the banner of Tomorrow's Schools, the revised Ministry of Education Act introduced sweeping reforms to New Zealand's educational system which included a significant move away from the exclusion of disabled students from mainstream classroom settings (Department of Education, 1988; Ministry of Education, 1989). The rights of all children with special needs to access mainstream schools was established, and the responsibility for removing access barriers was located with individual schools and, in particular, Boards of Trustees (Greaves, 2003). This significant change was further entrenched following introduction of the Human Rights Act (1993) which prevented schools from blocking enrolments of students with disabilities. As Greaves (2003) points out, these legislative changes occurred in a context of neo-liberal economic reform in New Zealand. Following the election of a centre-left government in 1999, significant restructuring of the system took place again in the form of Special Education 2000 with the purpose of enhancing inclusive practices. This included the introduction of Resource Teachers of Learning and Behaviour (RTLB), who were established to act as key supports and dispense funding allocated by the Ministry of Education Special Education Service. The purpose of RTLB is to assist school in adapting systems and practices in order to help meet the needs of children with behavioural problems and learning difficulties. The principles of inclusive education have been widely

taught in the training of New Zealand teachers for several decades, although it has been acknowledged that some teachers and families continue to disagree with the practice implications of this policy (Greaves, 2003).

### **Managing the Return to School Following TBI**

The types of recommendations commonly made for managing school return post-TBI are exemplified by Keyser-Marcus et al.'s (2002) discussion of the enhancement of educational delivery for children and adolescents who have sustained such an injury. The authors discuss the need for educational assessment that draws from multiple disciplines and encompasses neuropsychological findings, educational records of premorbid functioning, academic assessment, family and teacher observations and student self-report. Training for school personnel is considered as an important aspect of improving educators' capacity to make appropriate adaptations to learning programmes. The authors highlight the lack of information entailed in typical general and special education training and suggest that specific professional development regarding TBI be available for teachers. A variety of strategies for managing common post-injury difficulties, such as executive function impairment, concentration and memory problems, are discussed. For example, the use of checklists and colour coding to ameliorate executive function impairments, using assistive technology for reading and writing, reducing in-class distractions in order to aid attention and providing breaks for fatigued students, and utilising alternative assessment techniques to reduce demands were suggested.

Glang et al. (2008) investigated the factors that influence educational service delivery for children who have sustained TBI. In this study of a sample from the United States, 56 parents of children and adolescents who had experienced a TBI completed a questionnaire

three months after their child's return to school. This was followed by a structured interview which investigated parent concerns and school supports received in greater detail.

Approximately half (51.8%) of the sample had sustained a mild or moderate TBI, with the remainder of the sample having experienced severe injuries. The study found that the provision of extra educational supports was strongly associated with injury severity, which was also associated with an increased likelihood that parents would actively request services. However, fewer than half of those with severe injuries had an Individual Education Plan put in place. Youth in this study were more likely to be identified for special education services if their transition back to school was supported and facilitated by hospital staff and the provision of TBI information to schools from medical professionals. Significantly, it was also found that the presence of academic concerns was not correlated with the provision of specialist services. Glang et al. suggested that these findings indicate that education professionals are not well-placed to recognise TBI effects and identify the need for specialist education services for such youth.

### **Teacher Knowledge and Perspectives**

While it seems that, historically at least, there has been a relative dearth of literature relating to teacher knowledge and awareness of TBI, several studies have highlighted this area in recent years and may reflect an increasing focus on the impact of teacher knowledge and perceptions of TBI on students' experiences upon return to school.

Hawley (2003) highlighted the issue of teacher perceptions in TBI with an investigation of teachers' views of one child who had sustained a moderate TBI (GCS=12) and frontal lobe damage at age eight years. Teachers (N=32) involved with the child's education were asked to report on the child's classroom behaviour and academic achievement

at four and five-year follow-up (when the child was aged 12 and 13 years old). Additionally, a comprehensive neuropsychological battery that included measures of intelligence, memory, adaptive behaviour, executive function, self-esteem, depression and anxiety was administered to the child at each timepoint.

The outcomes of this case study suggested that while intelligence appeared to be unaffected over time, the child presented with significant attention and behavioural difficulties. However, there was wide variation in how he was perceived by teachers. Differences in perception were found to be associated with the curriculum subject taught by each teacher. Teachers of subjects such as mathematics and science were more likely to perceive the child as performing, whereas teachers of less structured or 'artistic' subjects, such as art, drama and music, perceived the child as more troublesome. For example, while a science teacher's report of the child at four-year follow-up was "works well in experimental sessions, bright and enthusiastic", the same child was described by his music teacher as "disruptive and rather naughty" at the same time-point. The study highlighted the variation in how individual children who have sustained a TBI might be perceived by teachers and reflected research that suggested that children with TBI effects might benefit from structured learning environments with minimal distractions (e.g., Ylvisaker & Feeney, 1998).

Molnar (2010) investigated teachers' perceptions of childhood TBI and learning strategies that they might use with such children. Twenty-eight teachers in the United States completed qualitative surveys regarding their understandings of TBI. The results of this study suggested that teachers had limited understandings of the definition of TBI; the author highlighted that most responses to a question relating to the definition of TBI seemed to be copied verbatim from an online encyclopedia (Wikipedia). Teachers were found to be overly-inclusive in selecting characteristics of TBI from multiple-choice options; however, it was noted that ADHD tended to be omitted as a possible consequence of TBI. While many

teachers did not respond to the question regarding intervention strategies, the need for professional development and information was highlighted as important for teachers seeking to make adaptations for student with TBI. The written format of Molnar's study may have been a significant limitation in that it enabled teachers to obtain answers to questions from other sources (such as Wikipedia) and omit responses to other questions without providing the researcher with an opportunity to probe further or clarify answers. This problem may have been compounded by a low response rate (9%) and correspondingly small sample size.

Two more recent investigations of educators' understandings of TBI addressed the latter issue by incorporating much larger sample sizes; however, the written format and postal administration method was maintained. In the first of these studies, Adams, Irons, Kirk, Monk, Carlson, & Allen (2012) utilised a cross-sectional, mixed-method approach in order to examine teacher understandings of TBI characteristics and teaching strategies in a United States sample. A questionnaire covering the definition and consequences of TBI, teaching training, support and intervention strategies was posted to 294 teachers, of whom 193 (66%) responded. Participants rated 33 items on a 5-point Likert scale. The results of the quantitative component indicated that respondents who had a general education background were less equipped to work with students with TBI than those who had a special education background. Teachers indicated that they expected impulse control, social skills, cognitive functioning and communication to be most likely affected by TBI. The qualitative aspect of the study asked three open-ended questions regarding previous TBI training, recommendations for teachers and major concerns. The vast majority (85%) of respondents reported no prior formal training in TBI. A significant proportion (31%) reported that they had no knowledge of TBI. Some highlighted the need for patience, understanding and repetition as key to supporting the student with TBI, alongside communication with parents regarding educational plans. Major concerns of the respondents included their lack of



knowledge regarding TBI characteristics and the need for professional development opportunities. On the basis of these findings, the researchers recommended the delivery of professional development for teachers that should include TBI characteristics and management strategies.

The second of these studies also utilised a cross-sectional postal survey method (Linden, Braiden, & Miller, 2013). One representative from each school within a region in the United Kingdom (N=388) was asked to complete a questionnaire regarding childhood TBI. The majority of respondents demonstrated limited understandings of TBI; however, those with personal knowledge and experience of TBI evidenced more in depth knowledge of injury effects and strategies to address such difficulties in school settings. The authors concluded that limited understandings of TBI amongst educators may negatively impact on students and highlighted the need for further professional development amongst this cohort.

In another study from the United States, Mohr and Bullock (2005) investigated educators' perceptions of TBI. This was the only study identified in this review that applied a face-to-face contact methodology in the form of focus groups. Fifteen special education teachers, behaviour specialists and educational assessors participated in a focus group that investigated educator knowledge of TBI, their perceptions of their abilities to meet the needs of students with TBI, professional development needs and concerns regarding barriers and challenges. This study found that most teachers described themselves as somewhat familiar with TBI; however, only half had engaged in formal training in this area (e.g., professional development in the form of inservice or a graduate tertiary training course). None had received information regarding TBI during their undergraduate training. Educators described situations in which they found themselves responsible for accessing information on an as-needed basis, as students with TBI presented, with most using the internet to obtain such

information. Support from specialists such as neuropsychologists was identified as potentially useful by participants looking to supplement their knowledge.

Participants in this study also discussed accommodations that might be made for students returning to school post-TBI. The researchers identified that those with prior experience of TBI were able to provide specific ideas regarding management strategies (such as establishing good communication between school, family and rehabilitation providers; obtaining information regarding injury and strategies from the medical sphere; flexibility in the school routine to accommodate symptoms such as fatigue). However, teachers who were less familiar with TBI provided vague responses such as “make accommodations” (p. 3). Educators perceived themselves to be relatively well-equipped to deal with physical effects of TBI; however, understandings of how to manage cognitive or psychosocial effects were not so well established. Concerns were expressed by participants regarding a lack of information and training, improvements in student support systems and enhanced collaboration between amongst those working with children who have experienced TBI.

One Canadian study considered the issue of educational needs post-TBI from the perspective of students and their parents (Gagnon, Swaine, Champagne, & Lefebvre, 2008). The researchers conducted semi-structured interviews with 15 adolescents aged between 12 and 18 years who had experienced mTBI, and their parents. The findings of this study showed that students and parents perceived that educators needed to have better awareness of young people’s needs after sustaining a mild injury. Students and parents also identified a need for improved communication between schools and healthcare providers.

## **Teacher Education in New Zealand**

In the course of this study's development, it was considered important to understand more about what teachers are taught at university regarding TBI. Coincidentally, during the study development period and on the basis of our involvement in the wider epidemiological studies of TBI, the primary researcher and chief investigator were invited to deliver lectures to students in undergraduate teaching courses within the Faculty of Education at the University of Waikato. This facilitated discussion between staff across the education and psychology teaching programmes regarding what was already being taught to undergraduate education students regarding traumatic brain injury. It was apparent from these discussions that traumatic brain injury had not been part of the curriculum content for training teachers to date and was not included as a topic in any of the recommended textbooks available to students. Furthermore, the assessment and teaching of children with developmental or learning disabilities formed only a small part of the overall education curriculum and was comprised of a 2-week teaching period that related to special education within a professional practice paper, and the availability of an elective course on inclusive education practices.

## **Summary**

TBI has the potential to impact on student's performance and functioning in school settings, however it would seem that educators may not be well placed to support children with injuries upon their return to school. Few studies have investigated teacher understandings of TBI, but those that have indicate that teachers tend to demonstrate limited knowledge of the possible effects of TBI, particularly if they have not previously been exposed to TBI (Mohr & Bullock, 2005; Molnar, 2010; Linden, Braiden, & Miller, 2013). It seems likely that this poor understanding of the consequences of TBI is related to a lack of knowledge amongst educators regarding strategies that might be used in class to enhance

curriculum delivery to children experiencing TBI-related impairments (Molnar, 2010; Adams et al., 2012). However, teachers with a background in special education or personal experience of TBI may be more likely to understand the potential impacts of TBI and thus may be better positioned to consider curriculum and teaching adaptations for use with injured children (Adams et al, 2012; Linden, Braiden, & Miller, 2013).

Recommendations for the enhancement of students' learning and experiences when returning to school after sustaining a TBI highlight the need for teacher training and professional development with a specific focus on TBI (Keyser-Marcus et al., 2002). The purpose of such training is seen to be twofold: firstly, to enhance teacher understanding and compassion towards children who have experienced TBI and thus increase teacher readiness to make programme adaptations for such students; and secondly, to improve educators' knowledge of specific teaching approaches and strategies that might be used in-class when a child presents with neuropsychological impairment following an injury (Keyser-Marcus et al., 2002; Molnar, 2010). The importance of open communication between schools, families and health professionals is noted by both educators and families (Gagnon, Swaine, Champagne, & Lefebvre, 2008).

A major limitation of all but one of the studies reviewed here is that they employed a written, questionnaire-based format via postal surveys. This approach may have enabled some teachers to research their answers, as was suggested by Molnar's (2010) finding that a large number of responses regarding the definition of TBI had been obtained from an online encyclopedia and recorded verbatim. Thus, responses may not have accurately reflected actual teacher knowledge. A second limitation of the use of postal questionnaires in previous studies is that this research method may limit the depth of qualitative information obtained, particularly in comparison to interview formats which allow for response spontaneity, and greater exploration and discussion of meaning.

The purpose of the current study was to explore teacher perceptions and knowledge of childhood TBI. In particular, this study aims to understand in greater depth what teachers know about childhood TBI, previous education they might have received in this area, and how their knowledge might contribute to their awareness and application of educational intervention strategies. Teacher perceptions of their professional needs, in terms of both practical support and professional development, will be investigated. In order to improve on previous research in this area, a qualitative methodology including a semi-structured interview approach was employed. The semi-structured interview schedule used an open-ended questioning style which allowed the researcher to explore teacher perspectives in a more in depth manner to that which might be obtained via questionnaire methods. The interview process enabled the researcher to gather a more accurate view of participants' current knowledge of facts related to TBI, whilst also facilitating discussion of teachers' perceptions and opinions of matters relating to TBI management in school settings.

## **Methodology**

### **Ethical Approval**

Ethical approval to conduct this research was obtained from the University of Waikato School of Psychology Ethics Committee (12/29).

### **Recruitment**

Participants were recruited from primary-schools across a range of deciles. The first recruitment method sought teachers only from schools in the Hamilton City / Waikato districts, as this was the location of the researcher and where both the earlier BIONIC and COBIC studies had taken place. The second recruitment method sought teachers from further afield; specifically, in the Bay of Plenty / Tauranga region.

The first recruitment method involved emailing an introductory letter (see Appendix K) to principals in 24 Hamilton and Waikato primary schools requesting consent to contact individual teachers within the school to invite their participation in the study. The initial email included an information sheet about the study (see Appendix L). The letter advised that a follow-up phone call from the primary researcher would be made within the next two weeks to discuss possible participation. Principals were advised that they could also contact the researcher to discuss their school's possible involvement.

Fifteen (62.5%) school principals were successfully contacted via email or follow-up telephone contact. Nine (37.5%) schools were not able to be contacted by email or telephone and did not respond to requests to contact the researcher. Of those contacted, five (33.3%) declined involvement, with most declining principals reporting that they perceived their staff

to be too busy to act as research participants. Ten (66.7%) principals said that they would distribute the information to teachers and provide teachers with the primary researcher's contact details so that teachers could discuss participation directly with the study organiser.

From the initial ten schools, 13 teachers expressed further interest in participation. Their details were either provided to the primary researcher by a school principal, or the teachers emailed or phoned the researcher to give verbal consent to participation. Verbal consent was initially obtained from 13 teachers. However, as a number of schools in the Hamilton / Waikato regions had already participated in the BIONIC and COBIC head injury studies in the two years prior to the current study, it was considered that there was a possibility that principals and teachers may perceive themselves to be overburdened by ongoing research participation and that this may be impacting on recruitment. Therefore, it was decided to attempt to obtain participants from outside the BIONIC and COBIC study regions in order to protect relationships with schools who may still be asked to contribute to longitudinal studies associated with the original BIONIC and COBIC projects.

The second recruitment method involved sending the introductory letter and information sheet for principals to a primary school in the Tauranga district. The principal at that school provided consent for the school to participate and invited the primary researcher to attend the school for one day to meet with teachers who were interested in participating. That principal also offered to contact teachers associated with the local RTLB service who were based at a nearby school and provide them with the study information. It was arranged that the primary researcher would attend a full day of interviews and any interested teachers or RTLB would attend and engage in interviews at the Tauranga school. Six teachers from the Tauranga district consented to participation and subsequently engaged in interviews.

## **Participants**

Participants were 16 females and three males. Sixteen participants were currently working as primary school teachers and three were working as RTLB. Participants were aged between 20 and 59 years with a median age of 39 years. They had been employed as teachers or RTLB for between one and 40 years. The median amount of years spent teaching was nine. School deciles from which the participants were drawn ranged from one to nine with a mean decile of six.

## **The Interview Schedule**

Many of the questions in the semi-structured interview schedule (Appendix M) arose from conversations with educators that took place throughout the process of data collection the first study. Primarily, these questions were related to the researchers' anecdotal impressions that teachers held a wide variety of understandings of TBI and its effects in childhood. The interview schedule was also based upon previous research that had explored educator perspectives on traumatic brain injury and concussion.

The semi-structured interview schedule was broken into two main sections. The first section covered topics such as teachers' understandings of the definitions of traumatic brain injury and concussion, mechanisms of injury, TBI effects in children and symptom duration. The second section focused on teachers' perspectives of how TBI might impact children in a school setting, programme adaptations and classroom/playground management strategies, accessing information and training and perceived support barriers.



## **Procedure**

Ethical approval for the current study was obtained from the University of Waikato School of Psychology Ethics Committee. All participants were provided with a \$20 gift voucher at the end of the interview session.

Participants were advised that the interviews could take place in a mutually agreed location that was convenient to them. All participants opted to be interviewed in their place of work, either in their classroom before or after school hours or in another room on the school premises.

The researcher discussed the teacher information sheet with each participant and obtained written consent (see consent form in Appendix N) prior to the interview. All participants were advised of the right to refuse to answer any questions and withdraw from the study at any time. No participants expressed that they wished to withdraw or not answer particular questions at any point during or after the study. Participants were interviewed once. Interviews ranged between approximately 25 and 50 minutes in length.

All participants were asked whether the interviews could be audiotaped and all gave consent for this to occur. Each interview began with an informal talk about the participant's current work, and the origins of the current study. This served not only to inform the participant of the background of the previous COBIC study and purpose of the current study, but also to build rapport. At the completion of each recorded interview, participants were thanked and provided with a gift voucher as a token of appreciation for the participation.

## **Coding and Analysis**

In the current study, each interview was transcribed verbatim by the primary researcher and then checked for accuracy. A thematic content analysis approach was employed to analyse the qualitative data (Braun and Clarke, 2006; Herth, 1998). This firstly involved a detailed reading of each individual transcript. Significant statements were extracted and further analysed to determine their meaning. These statements and their meanings were then organised into thematic categories and assigned descriptors. Data was analysed at the semantic (i.e. surface or explicit) level. Interpretation of latent meaning was avoided in order to minimise the introduction of researcher bias. Themes were then reviewed and those with higher degrees of similarity were merged. Each transcript was then reread to ensure that no other themes could be identified. The transcripts and coding themes were then read and checked by an independent person.

## Results

The results from the qualitative analysis have been grouped according to the structure of the interview in the following categories: understanding of TBI, concussion and its effects; managing TBI in schools; teacher education and professional development; and support for schools. Under each heading are themes which describe the perspectives and experiences of the teacher participants, which is then followed by relevant quotes extracted from the interviews.

### Understanding of Traumatic Brain Injury and Concussion

Understanding of TBI and Concussion includes teachers' understandings of TBI definitions, injury mechanisms and risk factors.

**TBI definitions.** Thirteen (68.4%) described TBI as being related exclusively to external force while four (21.1%) included pathogenesis or birth trauma in their description. Two (10.5%) of the descriptions were particularly limited in content and did not elucidate the question of TBI much further than the term itself.

*"Something where a head injury affected your brain." (P10).*

The majority of participants, however, attempted to unpack the definition of TBI in some detail. Most described TBI as an injury to the brain that was likely to affect some aspect of a person's functioning. Many referred to injury mechanisms in their description of the term TBI and expressed that they were unsure or confused as to what might constitute and/or cause a TBI. While most participants identified the role of external force in the definition of TBI, many also included aspects of Acquired Brain Injury in their definition (such as prenatal

exposure to drugs and alcohol) or birth trauma (which, while often involving external force, is not typically included in definitions of TBI).

*“... A brain injury that has occurred not through natural circumstances, so they weren't born with it other than it may be something during the birth, or it is something that has happened after the birth, and it is long-term damage.” (P2)*

Seven participants referred to an outcome, such as developmental impacts or behavioural problems, when considering the definition of TBI. For example:

*“An accident that's caused some trauma to the head which has caused some sort of difficulties with that child's education understanding.” (P13).*

Five participants highlighted the word ‘trauma’ in their consideration of the term TBI and pointed out that not all head injuries might constitute a TBI.

*“‘Trauma’ is a word that comes to mind that probably needs more attention than just perhaps a knock to the head or a little bit of bruising, but I guess there's different levels of trauma and I guess different parts of the brain, so something that needs quick diagnosis and attention beyond an ice pack.” (P15).*

It was noted that some of the descriptions that focused on the term ‘trauma’ were vague and limited in content.

*“The child has had trauma, be it an accident ... there has been some damage to the brain.” (P8).*

When asked whether they thought concussion constituted a TBI, a significant proportion (68.4%) reported that they thought it may be. However, it seemed that this was not a question many had previously considered.

*“I hadn't really thought of it like that. It's probably like a mild brain trauma, because I know with concussion it can be quite delayed and can take a while for the brain to recover and sometimes it's not always noticeable to begin with. I would say yes, it is related. I would think of it as being a slightly milder, maybe recoverable brain injury, whereas maybe TBI may not be...” (P18).*

*“I would assume it would for children, just because of the growing brain. Any sort of hit to the head could have a significant impact being that it's still developing and growing. So I would presume that concussion would be a traumatic brain injury.” (P3).*

Some of those who perceived that concussion may constitute a TBI conceptualised concussion as an early symptom of a potentially more serious injury.

*“Concussion is perhaps an initial symptom, although it can be delayed. Not sure. I think it's under the umbrella as part of what happens.” (P5).*

*“Yes I think it does. It could be classed as potential which could then turn into traumatic brain injury, because of the seriousness that concussion can turn in to.” (P2).*

However several were unsure about whether a concussion was the same as a TBI, and two participants stated that it definitely was not.

**Injury Mechanisms.** Fifteen participants listed possible causes of TBI. Of those, all noted more than one potential injury mechanism. Table 4.1 details the frequency of injury mechanisms reported by participants calculated using a total response method.

Table 4.1

*Teacher Perception of Injury mechanisms (total responses)*

Possible Injury Cause	Frequency
Motor Vehicle Accident	6
Falls (from heights)	5
Recreation (walking, running, horseriding, playing, bikes)	5
Abuse	4
Sports	3
Birth Trauma	3
Prenatal Drug and Alcohol Exposure	2
Vaccines	1
Neurological 'Chemical Changes'	1
Illness / Fever	1

The vast majority of possible causes listed were accurate in that they included external force and reflected the scientific literature relating to TBI mechanisms.

*“Car accidents, falling out of trees, playground accidents, falling off bikes.” (P13).*

As noted previously, four participants described a mixture of external and internal factors, including pathogenesis, as possible causes of TBI.

*“Accidents, falling over, blows to the head, chemical changes in the body or the brain. Anything introduced foreign to the body, like vaccines, that cause a change in the brain.” (P8)*

It seemed that for those participants, anything that might cause brain damage could constitute a TBI.

*“Could mean an incident at birth, lack of oxygen or something like that. Physical injury, dropping, hitting. Drug exposure could be classified as a head injury. (P12).*

**Risk Factors.** Thirteen participants identified multiple internal (innate) and external (environmental) factors that may increase a child’s risk of sustaining a TBI. Table 4.2 details the frequency risk factors reported by participants. The most frequently reported risk factor for childhood TBI referred to innate, temperamental qualities in the child, specifically related to impulse control and a propensity for risk-taking. Children who were described as being fearless or impulsive were noted by eight participants as being at increased risk of sustaining a TBI.

*“Kids that are going to take risks more, that have no fear.” (P16)*

*“Children who have impulsivity issues, who do not think through what happens when you climb up onto the roof and may fall off. Children who are fearless, which often goes hand-in-hand with the impulsivity issue”. (P8)*

Table 4.2

*Teacher Perceptions of Risk Factors (total responses)*

Risk Factors	Frequency
Impulsivity / Fearlessness / Risk-Taking Propensity	8
Motor Skill Impairment / Poor coordination / Clumsiness	7
Active or Sporty Child	5
Abusive or Neglectful Home Environment	4
Male Gender	3
‘Overprotected’ child	2
Attention Deficity / Hyperactivity Disorder	2
Developmental Delay	2

Another commonly reported risk factor was impaired motor skills and coordination, or clumsiness. For example, when asked which children were more at risk of sustaining a head injury, P4 responded:



*“Uncoordinated ones!. You see children walking around and some are more aware of themselves and have that confidence when they’re walking and running, whereas you get certain children that are just not coordinated and they very easily fall over. That kind of unawareness of their body”.*

The ‘active’ or sporty child was also identified as being at increased risk of TBI. Several participants discussed the tendency of some children to be more involved in physical activities that might predispose them to injury.

*“Probably more active ones. That would come with the nature of it, because they can run into stuff and each other and the more sedate ones perhaps would be less prone to banging themselves into something.” (P2)*

The active child tended to be described as one who was more likely to participate in sports that were perceived to be high-risk, such as rugby, further increasing their TBI risk. One principal described being particularly worried about the impact of competitive contact sports on neurological development in childhood:

*“... Sport injuries I feel very concerned about. We don’t play rugby here at school, or soccer, because we think that they are very poor choices for the young child.” (P11).*

Four participants highlighted the role of abusive or neglectful home environments in increasing children's risk of TBI. While abuse was also noted by several as direct injury mechanism, it was also considered by some participants when considering variables that might predispose a child to injury.

*"You might have children who come from homes where there's violence, so they get an injury from that sort of thing" (P5)*

Several of the participants that mentioned abuse or neglect as a possible risk factor reported that they did not consider there to be any other variables that might increase a child's risk of TBI. For those participants, physical abuse was highlighted in the absence of other notable risk factors.

*"I don't think anyone is more at risk than anyone else. Unless you've got the abusive home, unless they're coming from an abusive background. That ups the ante." (P18).*

For others, TBI was considered to be an 'equal opportunity' injury that anyone might experience due to the accidental nature of most injuries. TBI was described as a phenomenon that could occur at any time to any person

*“I would say it would be all the same. I mean, it depends on if they’re all doing the same activities. They’re all equally at risk of being injured somehow”.* (P15)

*“I don’t know what the research is but I would have thought any child. Obviously if they’re not strapped in a car then they’re more prone to traffic accidents, or if they’re not closely supervised they might be more prone to accidents on the playground or outside. But I wouldn’t have thought that [some might be at higher risk] because if you allow a child, they should be climbing trees, any of them could fall. They could come off their bikes. So I don’t know what the research says but I wouldn’t have thought there was any group that was...”* (P13)

Socio-economic deprivation factors were not included as possible risk factors. Only one participant mentioned the possible role of such factors, but only to refute them.

*“It only needs to be a one-off, split-second – and that could just be a kid learning to walk and bumping their head on the table. That could happen to a kid whether they grew up in a very affluent home or a very poor home. I don’t see that it would make a difference.”* (P12)

Overall, participants were more likely to report innate factors rather than environmental factors as variables that might increase the likelihood of sustaining childhood TBI.

### **Consequences of Injury**

Consequences of injury included initial symptoms of concussion, longer-term post-concussive effects, and the impact of moderate to severe injuries.

**Concussion Symptoms.** Most participants were able to describe several immediate symptoms of concussion. These typically included headaches, dizziness, vomiting, and blurred vision. Many included physiological and cognitive changes in their descriptions of possible short-term effects of concussion.

*“It could be clouded thinking, confusion, irritable, headaches, not being able to sit and concentrate and read a book for a few days. It takes a while for your brain to readjust and to come down.” (P17)*

*“They may blank out a little bit, seem confused really easily ... seem like they’re listening but not picking up on things. Not able to follow more than one instruction at once.” (P5).*

Some participants described immediate cognitive and affective symptoms that might typically be associated with persistent difficulties. Problems such as learning difficulties, slow processing speed and attention deficits were highlighted alongside behavioural or mood problems such as aggression or depression as being likely to both present and resolve within several days.

*“You can get angry, so it affects your personality, but I don’t know if it goes past the first 24 hours to be honest” (P8).*

While most were able to describe some symptoms of concussion, a few participants stated they perceived themselves to have very limited knowledge regarding short-term concussion effects and that they considered this knowledge deficit to be significant and concerning.

*“I am deeply ignorant. Scarily ignorant ... I don’t know. I have no picture. I don’t even know what you would look for ... The only thing I know about concussion is a nephew who had three concussions and then smoked marijuana and now he’s bipolar. I don’t know. I just know that it’s scary.” (P11)*

Fifteen participants spoke to the topic of symptom duration and it was evident that there was wide variability in participants’ expectations regarding the length of time that

concussion symptoms might persist. Six (40%) participants said that they expected that all concussion symptoms would be resolved within three days. Several of those participants reported an expected symptom duration of 24 hours. When asked if they might expect to see ongoing symptoms in a child who had experienced a concussion two weeks earlier, one participant stated:

*“Definitely not. Probably not two days later, if I was honest.” (P19)*

Several participants referred to their own, personal experience of concussion when considering the impact and duration of symptoms. Those who referred to having previously sustained concussion in childhood expected that symptom duration would be brief.

*“I remember being concussed as a kid and I had a day or two off school. It didn’t seem like it was a big deal to me. I think you need to be aware of it and I’d say the children would be not quite themselves for a couple of days but I don’t think that it would have huge impacts on their learning ... you would need to be aware that they had been through that to make sure nothing else develops from there, but I wouldn’t imagine it being a long-term effect.” (P16).*

Several participants highlighted the possibility that incurring multiple injuries over time might have a compounding effect and lead to increased difficulties. In some instances,

the effects of multiple injuries overlapped with the perception that injury location was an important determinant of injury outcome. Multiple injuries in the same ‘part of the brain’ was highlighted by some as increasing the likelihood that long-term difficulties might occur as a result of concussion.

*“When repeated concussions happen, does it affect the same area of the brain? Is that wearing that part of the brain? Will it then have long-term effects?” (P19)*

*“My information tells me that you don’t want a brain injury in that same place again, which speaks to long-term.” (P1)*

**Persistent Problems.** While the majority of participants perceived that concussion effects would be short-term, resolving within days or weeks, seven (36.8%) said that they perceived that concussion may have longer-lasting impacts, possibly persisting for months or years. Most acknowledged, however, the uniqueness of each individual case, pointing out that it would be difficult to predict concussion effects as there are so many variables that might determine outcomes (e.g., injury severity level).

*“I don’t think it would be consistent but I think there may be times it recurs. I think perhaps there’s degrees of it; that you could have concussion where it would be major, long-term, but I think it could also just be very short-term...” (P7)*

Those that considered concussion effects to be potentially ongoing reported a number of cognitive, behavioural and affective changes that might occur as a result of such an injury. In particular, participants highlighted the possibility that behavioural and learning difficulties may arise as a result of post-injury cognitive changes (such as attentional impairments).

*“We know that if concentration is affected, you don’t know what that child is missing. You might not even realise what that child is missing. And if that’s happening several times over several days or weeks, there is a gap there which then could cause further gaps further on because you can’t scaffold ... and then if it affects behaviour, well, behaviour has a real correlation to progress in learning.” (P12)*

Two participants discussed the potential that persistent difficulties might include affective problems such as depression or anxiety. Both of those respondents referred to professional experiences of teaching children who had experienced concussion six to 12 months prior. One talked about a child appearing to lose confidence after sustaining a concussion at school.

*“She [the child] suffered a concussion and it was obviously severe enough to affect her, in fatigue especially, and anxiety things ... it was with trickier tasks, or if she was with a group and there was someone that she wasn’t sure about, you would find she would just cry or just block out the task she was doing. I saw at the start she wasn’t*



*an anxious child, she was really confident and gave things a go and then [after the injury] that's where I saw a big change.” (P15)*

Another participant discussed her perception that a student experienced depression post-injury, whilst also noting problems with fatigue and concentration that impacted on the child's ability to function in a classroom setting.

*“It was a temporary change of personality. He went from being outgoing to being quite withdrawn and it was just a temporary depression as a result of the trauma to his head. Maybe he came back to school too soon, I don't know, but he was very tired. He did have difficulty maintaining his concentration.” (P13)*

Regardless of the nature of the possibly persistent post-concussive effects (e.g., physiological, cognitive) highlighted by these participants, all were considered to have the potential to impact on classroom learning and academic performance. The possibility that social problems may arise for children experiencing post-concussive effects was also noted by several participants.

*“They could easily become withdrawn. Sometimes brain injuries can have an effect on overall personality, so it may make them less able to behave in a nice, socially*

*acceptable way. It could have an effect on their interactions in that way, simply because they're no longer able to follow the social norms.” (P13)*

*“Sometimes when children are having trouble with their learning, their peers don't respond as positively to them. It could be a child who is used to achieving well and then all of a sudden, something is gone on here – so there is the whole self-esteem thing which then could have effects on relationships. And then if there are behavioural issues, kids often don't want to be associated with the naughty kid.” (P12)*

Personality, learning, behavioural and self-concept problems were highlighted by those participants as having possible flow-on effects that might negatively impact on a child's social functioning.

**Severe Injuries and Profound Effects.** Participants spoke with greater confidence about the possible effects of moderate to severe TBI, describing a range of possible outcomes and domains of functioning that may be negatively affected by head injury. These included speech and motor deficits, and the possibility that a child's ability to engage in activities of daily living such as self-feeding and toileting might be impaired.

*“I think it could affect everything, basically. Day-to-day life, learning, sleeping, eating, drinking, everything.” (P2)*

Several participants discussed the difficulties that children with moderate to severe TBI may face when re-integrating into a classroom context. Fatigue, memory problems and information processing impairments were highlighted as difficulties that may directly affect academic performance. Individual variation was again acknowledged as an important consideration in the discussion of TBI effects.

*“I see the effects as being very different from child to child.” (P6)*

### **Programme Adaptations and Management Strategies**

Participants were asked to discuss what strategies and approaches they thought should be employed by teachers who have a child with TBI in their classroom. A variety of techniques and adaptations were suggested. Participants also highlighted teaching styles or approaches that they considered might be more or less useful in the management and support of a child who has experienced TBI.

**Innate Teacher Qualities.** Several participants referred to qualities that may be possessed by individual teachers that would assist them to meet the needs of students who had experienced TBI. One RTLB said that she perceived some teachers to be more adept than others in regards to understanding and instinctively making teaching adaptations in response to the child with a TBI.

*“Some teachers will get that there is a change in the child and might adjust their things. But others don’t get it and they still expect the child to do what everyone else is doing or what they used to be able to do.” (P17)*

Some participants discussed a type of professional caring that was compassion and empathy-driven. Those participants highlighted professional caring as an important aspect of the effective teacher's practice. They teachers referred to a desire to do their best for children and families and being passionate about assisting children with difficulties, in spite of barriers.

*“There may be a period where that child is not performing at the level that he or she previously was performing. So that child will need patience and understanding and maybe that little bit more support to get them back to where they were.” (P13)*

*“I guess patience is a really big one because these kids are capable of learning but it's at a very slow rate and you often need to repeat the same thing over and over again”. (P17)*

**Temporary Scaffolding.** While there was significant variation in the expected duration of symptoms, the majority of participants perceived that some degree of “scaffolding” would be required to support a child's learning after concussion. For some, this referred to monitoring and making adaptations in the initial days following a child's injury.

*“I think you would need to watch them carefully for 24 hours”. (P6)*

*“If I had a child with concussion I would probably give them a week of quiet activity”.*

(P2)

Most of those that discussed the need for short-term monitoring or class routine changes did so in the context of considering that such changes were important in order to minimise the risk that the child might incur a subsequent concussion whilst still recovering from an initial injury. In this regard, adaptations were framed as safety measures rather than being related to the enhancement of learning.

*“I’m not sure that I would make any teaching adjustments but I would just be more aware of what had happened and get feedback from the parents and just monitor their condition in case they deteriorated.”* (P2)

*“Just that they keep low-key, no running around, no jumping off the desks. Probably not to include them in sport”.* (P9)

*“That’s just me erring on the side of caution ... you don’t want that impact again, so I have been trying to stop that happening and hope that next time he gets concussion – because he will – it’s not in the same place”.* (P1)

Those that perceived concussion to have the potential to cause longer-term problems (months or possibly years) tended to speak more broadly about changes that could be made to teaching and assessment approaches in order to enhance performance and support recovery. Such participants also discussed a need for programme flexibility in order to accommodate physiological problems such as fatigue and headaches.

*“Just making allowances sometimes if they got tired ... adjusting the programme slightly, bringing in extra help as well. Making sure they are aware as well that if something is not feeling right for you or if you are feeling tired or if you need some more explanation or anything like that, just to make sure it is clear for them.” (P15)*

*“Because I teach the little ones, it means that if we are doing a writing exercise I would write it down so they can copy over. Just being aware that they could be a lot more tired, so getting later on in the week just letting them out to have an afternoon in the sandpit, a quiet afternoon doing something else. And not trying to push them hard doing movement things in the morning”. (P3)*

Most participants advocated here for responsivity; that is, understanding and consideration of each individual’s post-injury strengths and limitations, coupled with a reflexive teaching approach that was considerate of and adapted to each child’s needs.

## Professional Needs of Teachers

**Information.** The majority of participants discussed a need for information that could inform the way in which they might manage and adapt the curriculum to suit the needs of a post-concussive child. The need for information was mentioned in a number of regards. Many mentioned the importance of receiving information from parents regarding the nature of the child's injury, symptoms and support needs. However, most participants perceived that some parents may not inform the school of a child's injury, particularly if they did not understand the significance of the injury or if there were relationship difficulties between a family and school.

*"It depends on the parent ... I don't think people do realise quite how serious concussion can be." (P8)*

*"Sometimes the gap between home and school is huge and I think it would take a parent who was aware of the effect and what has gone on to be motivated to do that. Quite often that is not the case. And usually out of ignorance as well. They wouldn't think to inform the school." (P10)*

It was also acknowledged by several participants that the quality of information obtained from parents depended on a number of variables, including the parents' capacity to understand and communicate information they had themselves obtained from medical practitioners regarding their child's injury. Some participants suggested that, in such cases, it

would be more beneficial to receive information directly from the medical profession conveyed in either oral or written forms, but considered that there was a dearth of communication from the health sphere regarding traumatic brain injury.

*“It probably depends on the parent. Most of the time the parents are pretty well-informed but, particularly if they are quite upset if it is obviously a traumatic injury that has happened to your child, you might be a bit emotional and sitting in a doctor’s office you might not be fully absorbing, as a parent, what they were saying. So it would probably help to have pamphlets with bits circled – the really relevant stuff.”*  
(P3)

*“Some parents could be [equipped to provide teachers with information] but, again, it shouldn’t be the parents coming through ... it’s got to come from medical, as soon as that injury happens. Therefore, that child should come out of hospital already with that educational stuff coming up, with the school notified and the people put in place. As opposed to throwing them back in and saying ‘oh, go for it and see what happens’. Wait-and-see is not a game I like to play, I’m more proactive. But I know the District Health Board...”* (P18).

*“If we have got kids with crazy allergies, the teacher has to have an EpiPen (antihistamine injection) in their pocket and the public health nurse comes in twice a year and shoves these things in to bananas ... why does that not happen with brain*



*injury? If you know you have got kids in the school, maybe public health nurses could deliver stuff. They don't. That's funny. They do nits, they do Epipens, but not brain injury.” (P11)*

While many suggested that information regarding the medical aspects of a child injuries should be provided by the Ministry of Health and District Health Board services, most perceived that the responsibility for providing ongoing learning support falls to the Ministry of Education and, in particular, Group Special Education and RTLB services. Specialist education services were highlighted as being important in the development of Individual Education Plans (IEP) and programme adaptations.

*“I think the teacher would need to have information from those who specialise in extra help for children, to help them put together some sort of programme – what the child needs, what you need to do for this child, what the classroom needs to do for this child, what the school needs to do. That would be my expectation ... information so you can put a plan in place.” (P1)*

*“I used to often come down to and talk to the RTLB ladies and say ‘give me a heads up, what do I need to do?’” (P12)*

**Increasing Teacher Knowledge.** All participants reported they were not entirely satisfied with their current level of knowledge and training as it pertained to TBI, concussion effects and teaching strategies for affected children. In this regard, all participants also highlighted the need for professional development that would increase their knowledge regarding TBI and enhance their ability to deliver evidence-based teaching strategies to children experiencing neuropsychological impairment post-injury. None had received previous training or education in the area of TBI, either within their initial teacher training degree or diploma, nor subsequently via professional development opportunities. However, those who had worked in special education or RTLB services did report engaging in occupational or training activities that related to the topic of special needs more generally and considered what they had learnt in those settings could be extended to children with TBI.

*“[It came up] only because I worked at special needs school and I do know, having spoken to colleagues, that there is knowledge and there are skills that I have that people who haven’t had my teaching background don’t have because they have never come across situations like that.” (P8)*

While all participants agreed that professional development in the area of TBI was important, some differed in the time-point at which they perceived such training should be delivered. Many perceived that training should be engaged in pre-emptively, regardless of whether one was currently working with a student who had experienced TBI, so that if such a student was to present in future the teacher would have sufficient background knowledge of

possible injury effects and be immediately able to employ appropriate teaching strategies and programme adjustments.

*“I had no learning from university about it. The learning I had at the schools was on-the-job training and it was often that I found out about it after I needed to know about it.” (P8)*

*“If you had a good understanding right from the beginning you could give the child the appropriate support right from the off ... it shouldn't be trial and error, as quite often it is, because we haven't got the training and we haven't got the understanding that we need.” (P13)*

Several participants suggested as concussion may go undetected, it was especially important that teachers understand how TBI might impact on a child in case a student demonstrated unexplained difficulties.

*“It worries me that children could be in this situation in my class and I don't know. Or other children within the school. And perhaps children are being put into a category of 'lack of motivation' or some other category when perhaps they have got some brain injury.” (P14).*

*“We would really love more information, more professional development, a greater understanding. Because we do want to do our best for these children but, speaking personally, I know I haven’t got the skills I need and the understanding that I need. I know that I have been floundering a bit and going by trial and error because, without the professional development, you don’t know whether you’re doing right for that child.” (P13)*

Other participants suggested that it would be more useful for teachers to access training and information only if a child in their class experienced a TBI. Some participants perceived that accessing information on an ‘as-needed’ basis was necessary due to the extensive range of health conditions and developmental problems that could potentially present in a classroom. They acknowledged that it would be difficult to learn and retain information about a wide-range of problems that may never present in their classroom.

*“I would think that, should [a student with TBI] come my way that would be the time for me to say ‘what do I need to know about this?’. Because if I was doing it as par-for-the-course, then I probably would not retain it. Or, when it did come, I wouldn’t know if what I knew about it was still up-to-date.” (P1)*

Those that suggested that professional development may be more useful on an as-needed basis were more likely to describe professional development as a personal responsibility, rather than as a training service that should be developed and delivered to

teachers by other professionals. Some participants highlighted the potential usefulness of informal and self-driven learning methods, such as conducting a literature review outside of school hours or via connections with networks and professionals in other agencies with whom they might already have established relationships.

*“It would just be in conversation with some of the contacts and connections that we’ve got in the health sector, really. A bit like the paediatrician that we have regular connections with and we have sharing of information, so it would only be if I was alerted to it with one of my cases that I would actually go and say ‘I need some more information on this’ ... I think it’s the process of education, in that you don’t know what you don’t know. So if you have a child that has been identified as having trauma, then you’ll actually go and source it ... because they are so individualised.” (P7)*

*“I would, through my knowledge of difference agencies, go and find it ... and it would depend on the child as to where I would go and if I didn’t know where to go, I would ring up someone and say ‘ok, this is what I need, where should I go?’”. (P12)*

While participants highlighted information and further education regarding TBI as a need for teachers in their support of injured children at school, lack of information was not framed as being a barrier to appropriate service delivery. Participants perceived that once it was identified that information was required, this could be easily accessed by motivated teachers and would contribute positively to their work. However, there were several areas

relating to teacher needs that were portrayed as posing challenges to the delivery of evidence-based teaching practices that may not be easily overcome by teacher initiative and motivation alone.

## **Barriers**

Barriers included policy, process and resourcing issues that impact on teachers' ability to intervene effectively with children experiencing TBI effects.

**Funding and Resourcing.** Many participants highlighted the difficulties that teachers and schools face in attempting to meet the needs of children whose needs differ from the majority of children. In particular, practical support in the form of teacher aides, specialised intervention services and, in some cases, special equipment and teaching resources were highlighted as important for the child with TBI.

*“Obviously if it was a very significant head injury you would be hoping to have a teacher aide or volunteer to come in with you ... in terms of resourcing, there may be specific equipment that they may need.” (P3)*

*“They actually need a lot more cues and support, some really physical supports as well.” (P7)*

However, most participants who discussed the need for such resourcing perceived that this could be difficult to access. The role of the Ministry of Education Group Special Education and RTLB in the administration of such services was noted, however a number of participants described difficulties in accessing services for children whose needs did not appear high and complex, but whom still faced numerous problems in accessing the curriculum in a mainstream classroom setting.

*“Perhaps a teacher aide to help them in the classroom. Maybe a quiet space too, at times. Some kind of funding – in your dreams.” (P6)*

*“Funding [is missing]. I can not describe how frustrating it is as a teacher to know what you could give to a child to support their learning, to support their whanau, to support them as a holistic being, but not having the funding to do it.” (P8)*

*“Unless a child is in a wheelchair and they [Group Special Education] just can’t ignore it, you don’t get anything. For anything. I don’t know what they do, but it doesn’t come out way. I think special ed. are in a situation, it will be funding, but the bar is set so high that children with needs don’t get anything.” (P11)*

Participants who were currently working as RTLBs discussed the problems they had in allocating funding to schools.

*“... We (RTLB services) have had a lot of funding cut. So we can not give out so much money to schools ... And the same for special education, everything is budget cuts and people have high caseloads. I think most people are trying to do the best they can but our services aren't that well-resourced and therefore we can't put as much resourcing in as we would like to for the teachers in the classrooms.” (P17)*

The importance of in-class supports for children who had ongoing effects from TBI was highlighted by many. However, some participants posited that installing supports in mainstream classrooms was not necessarily the most ideal approach to curriculum delivery for children with higher needs.

**Problematic mainstreaming.** Several participants discussed their perception that there were problems associated with New Zealand's mainstreaming or inclusive education approach to special education that posed challenges to the teaching of children with injury-related impairments. They described multiple issues related to this approach that might negatively impact on a child who was experiencing ongoing effects from TBI. The classroom setting was portrayed as one that was not conducive to teaching children with neuropsychological impairments, such as attention deficits, information processing problems, and impulsive or externalising behavioural difficulties.

*“It is becoming more and more likely that we will have children like that in our class because the government is looking at closing down [special needs] schools and pulling funding for special needs schools and they are looking at putting everybody mainstream.” (P8)*



*“I would expect [a child] with a moderate to severe [injury] to struggle with the overwhelming nature of a classroom.” (P5)*

*“Honestly, in education it’s probably a bold statement, but I think all children who need specific help in situations, whether it’s socially or whatever, need to be taken out of traditional school and put in to some needs-based environments where they are getting their specific, individual needs met rather than being a collection of 30. The problem with being in a class of 30 and having one-on-one support is they may feel isolated and different.”(P5)*

A number of those participants conveyed a feeling of disenchantment with a system, characterised by funding cuts, that they perceived to be set up and imposed upon teaching professionals and students by consultants, managers and politicians who might themselves have limited understandings of pedagogical approaches and the problems faced by teachers “at the coalface”.

*“Incredibly frustrating and I just don’t know whether it’s because the government doesn’t understand, they have never actually come into the school and seen it as this level and seen how it does affect.” (P8)*

*“... the teachers would like to be able to support the kids more but the reality is there is just not enough hours in the day or money in the pot to do the best job that people would like to do.” (P17)*

Participants described a sense that those working within educational services, such as teachers and RTLBs, cared deeply about individual children wanted to support students and whanau who were experiencing difficulties relating to issues such as TBI, but were often battling to do so in the face of numerous systemic limitations.

### **Summary of Teacher Perspectives**

Overall, the majority of participants described their personal knowledge and training about the nature and potential effects of TBI and, more specifically, concussion as being limited. In regards to mTBI, there were a large range of views held regarding expected symptom duration and the possibility of ongoing symptoms, with some many perceiving that concussion effects would be very short-term (i.e. resolved within one week) and have no impact on school functioning. However, the potential effects of more severe injuries were acknowledged. Many participants conveyed concerns regarding the lack of professional development opportunities relating to TBI available for teachers and expressed motivation to address this perceived knowledge gap via further training and connection with expertise within the health professions. The ability of the education system, in its current state, to provide appropriate and effective support services to children in mainstream classroom settings was called into question by several participants.

## Discussion

The objective of this study was to explore levels of understanding and knowledge regarding childhood TBI amongst educators. The aims were to understand what teachers' know about the nature of TBI and its effects, particularly in relation to concussion, and their perceptions regarding management strategies and programme adaptations that might be applied with students who demonstrate ongoing problems associated with mTBI. Furthermore, this study sought to examine teachers' views of their professional needs as educators alongside the needs of students who experience persistent concussion effects, whilst also considering systemic barriers.

**Understanding of TBI and Concussion.** The current findings suggest that wide variation exists in teacher understanding of the definition of TBI. While the majority identified that TBI was likely to be associated with injury from external force, there was a significant degree of confusion amongst respondents regarding the definition of TBI. In particular, conflation with acquired brain injury (ABI) was common amongst respondents. While most participants thought concussion might be included in the definition of TBI, most responses were vague and tentative while some perceived that concussion was distinct from TBI due to its lower severity. Teachers who had prior personal or professional experience of TBI spoke in greater depth and with more accuracy about the topic, with reference to those experiences.

Most participants identified several causes of TBI. The majority of those listed reflected the epidemiological literature relating to common injury mechanisms in childhood, such as falls and recreational activities. Less common mechanisms such as abuse and motor vehicle accidents were also noted. However, a number of participants perceived that TBI was caused by other factors such as prenatal drug and alcohol exposure or birth trauma. One

participant's attribution to vaccines and "chemical changes" highlighted a possible lack of evidence-based information regarding the nature and causes of TBI. These findings reflect previous literature that suggests teachers' knowledge of TBI may be limited, particularly if they have not had personal exposure to the issue (Molnar, 2010; Adams et al., 2012). While these earlier studies utilised questionnaires in order to investigate teachers' knowledge of the definitions surrounding which enabled teachers to either select from a multiple-choice answer format or obtain information from sources such as Wikipedia whilst completing the questionnaire, the 'real-time' nature of the interviews in the current study further highlighted the variable and, at times, limited knowledge of participants regarding medical facts about TBI.

The majority of participants considered that certain children might be at increased risk of sustaining a TBI than others and were able to accurately identify risk factors reflected in the literature. Innate, developmental or temperamental factors (such as impulsivity, motor skill impairment, and higher activity levels) were most commonly noted as likely to increase a child's risk. While impulsivity and engagement in high-risk activities have been highlighted by previous researchers as potential risk factors for TBI (Barker-Collo, Wilde, & Feigin, 2009), environmental factors are also significant in the literature. In particular, socio-economic deprivation, parental alcohol abuse, neglect and physical abuse, and previous injuries have been found to be most significant in the discussion of risk factors (Feigin et al., 2010; Kraus & Chu, 2005; Winqvist et al., 2008). While abusive or neglectful domestic situations were identified by a few participants, others reported that it was overprotected children that were in fact at risk due to a lack of opportunity to develop motor skills and appropriate levels of inhibition. Parental substance abuse and socio-economic deprivation were not perceived by teachers to be relevant to a child's risk of injury. This finding again highlights that a wide range of perceptions exist amongst educators' as to the causes of TBI

and brings into question whether teachers are in a position to assess and potentially off-set injury risk in students. It seems that a lack of basic information regarding TBI would impair educators' capacity to identify students who might be at risk of sustaining an injury.

**Injury Consequences.** Most participants were familiar with the immediate effects of mTBI and able to describe numerous symptoms that might be evident in children in the initial hours or days following an injury. Teacher knowledge of the initial symptoms of concussion has not been overtly described in the previous research and this finding adds to the literature in this area. It is not unexpected that the majority of teachers would have at least a cursory level of knowledge regarding the initial effects given that information regarding immediate symptoms is readily available from GPs, via First Aid courses, the internet and media representations of mTBI. It seems likely that educators who had themselves experienced concussion or had family members who had a sustained an injury would have some knowledge of expected symptoms.

However, when asked to consider how long concussion symptoms might persist, there was much greater variability in participants' responses. Many expected symptoms to resolve within days or weeks, while others considered the effects of concussion to be ongoing for months or years. Irregularities amongst participants' responses to this issue reflect previous research that identified that teachers' knowledge of TBI effects is limited and likely to be affected by personal experiences rather than formal training in the area (Gagnon, Swaine, Champagne, & Lefebvre, 2008; Molnar, 2010; Linden, Braiden, & Miller, 2013).

Most participants did not consider that the effects of mTBI would persist for longer than two weeks. This finding is noteworthy when it is considered that post-concussive symptoms commonly persist for up to three months post-injury with some individuals experiencing effects at both the six and 12-month timepoints (Hall, Hall, & Chapman, 2005;

Jagoda & Riggio, 2000; Margulies, 2000). Participants' beliefs that mTBI symptoms would resolve within several days or weeks might impact on their capacity to notice and identify ongoing symptoms of concussion and consider the role of such symptoms in a student's functioning. This might lead to misunderstanding about the reasons for a student's impairments, lower rates of empathy and compassion amongst teachers (who might, for example, perceive the student with concentration or behavioural difficulties to be "naughty") and may decrease the likelihood that appropriate management strategies and programme adaptations might be made in response to students' symptoms. Greater awareness of mTBI effects has been highlighted by students as important in facilitating a return to school, with parents also emphasising the need for teachers to be understanding about symptoms (Gagnon, Swaine, Champagne and Lefebvre, 2008).

Those that discussed persistent effects emphasised physiological symptoms, behavioural problems and impaired attention as being most likely to pose ongoing issues after mTBI, and suggested that such problems would potentially impact on learning. This finding matches with evidence in the literature that has shown an increased likelihood of persistent post-concussive difficulties amongst these domains of functioning (McAllister, 2005; McKinlay, 2009 Mittenberg & Strauman, 2000; Yeates & Taylor 2012). The possibility of social problems arising from a student's impairments was also noted by participants who considered that students with learning and behavioural difficulties are more likely to experience social difficulties. While there is limited evidence in the literature to indicate that children are more likely to experience social difficulties after mTBI, it seems that participants who discussed the issue may have perceived an association between poor classroom performance, behavioural difficulties and social functioning. Participants discussed the impacts of severe injuries with more confidence and in greater depth, perceiving the wide variety of significant impairments that might affect any functional domain as being dependent

on injury type and severity. It is possible that the less subtle nature of severe injury impacts contributed to participants' abilities to discuss this area in more detail.

It was interesting to note that teachers who reported prior experiences of teaching children with ongoing concussion effects focused on descriptions of affective problems relating to depression and anxiety, rather than behavioural problems or cognitive impairment. Mood and anxiety problems after mTBI have been highlighted in previous research and certain post-concussive symptoms (e.g., anhedonia, tearfulness, low mood) are identical to diagnostic criteria for depression (American Psychiatric Association, 2013). The potential for such symptoms to arise in children has been established, however this finding may also point to the possibility that affective problems are more noticeable and easily identified by educators. This would be in contrast to previous literature that has shown that externalising symptoms such as behavioural problems are most easily identified by educators, rather than internalising symptoms such as depression and anxiety (Grietens, Onghena, Prinzie, Gadeyne, Van Assche, Ghesquiere, & Hellinx, 2004; Treutler & Epkins, 2003). It is also possible that, rather than a particular symptom type being more or less salient for teachers, it is dramatic change that is noted.

Earlier research into teacher understandings of TBI has not discussed teacher perceptions of the role of repeated TBI. However, several participants in this study noted the possibility that repeated TBI might increase the likelihood that a child would experience ongoing concussion effects. This reflects the wealth of neuropsychological literature that has shown significant associations between repeated injuries and persistent symptoms (Kraus & Chu, 2005). Awareness of this issue amongst educators may be enhanced by greater consistency within the literature regarding these specific findings, advice received from medical practitioners and via media representations of individuals such as sports players who

have publicly discussed their personal experiences of ongoing concussion effects related to multiple injuries.

Findings from this section of the interview that explored teacher perceptions of the consequences of TBI continue to reveal variability and limitations in educators' knowledge about the likely effects of TBI, which raises questions about the availability of information and training for teachers in this area. However, in spite of some general trends in the paediatric mTBI literature, it must also be acknowledged that there are varying and contradictory findings regarding persistent effects of childhood mTBI. The argument that teacher knowledge might be enhanced by mere exposure to increased information about mTBI seems flawed when considered in this light, as there is such variability in the research pertaining to the consequences of concussion. It seems glib, then, to suggest that exposure to previous research might enhance teacher knowledge of mTBI impacts as it is possible that confusion in the literature might only serve to further confuse the issue for educators.

**Programme Adaptations and Management Strategies.** Participants' perceptions of the likelihood of persistent difficulties seemed to inform their views regarding the need for and application of changes in curriculum delivery or content. Many participants considered that as concussion effects were unlikely to persist for more than several days and in these instances, significant programme adaptations would not be necessary. Suggested short-term strategies were instead focused on managing initial symptoms, monitoring for deterioration and minimising the risk of sustaining another injury in the immediate period following a mTBI. However, the use of a temporary scaffolding approach would extend further than monitoring and risk minimisation in the initial days following an injury and include care planning, programme adjustment and withdrawal from sport until symptoms have ceased (Dise-Lewis, 2013). Participants' focus on safety may suggest that teacher concerns about



children's risk of deterioration or subsequent injury are primary when children return to school after sustaining a mTBI. Molnar's (2010) finding that the majority of teacher respondents did not respond to the question of intervention strategies may be related to the finding here that most participants did not consider there would be a need for programme adaptation after mTBI.

Those who did perceive that persistent post-concussive effects might impact on children's school performance emphasised the individualised nature of symptoms and suggested that teachers notice and respond to students' difficulties as they present. In order to do so, participants discussed the need for underlying knowledge of TBI that would inform symptom identification, and a responsive approach to meeting students' needs. Responsivity to physiological symptoms, such as fatigue, was highlighted. Teachers suggested flexibility around schedules, allowing time for rest, and reducing demands as possible strategies to assist students in managing their return to school. It was also noted that certain personal qualities (such as compassion, understanding and patience) might enhance teachers' attention to symptoms and increase the likelihood that they would make accommodations for students. This finding reflects previous research that has shown that educators' perceive a need for patience, understanding and flexibility when dealing with children who are experiencing ongoing effects from TBI (Adams, et al., 2012; Mohr & Bullock, 2005).

**Professional Needs of Teachers.** Participants spoke in depth about the professional needs of teachers delivering educational services to children experiencing TBI-related difficulties. Accurate information regarding the nature and possible effects of TBI was highlighted as important, alongside specific, individualised information about students' injuries and symptoms. While many participants reported that they hoped to receive student-specific information from parents, it was acknowledged that some parents may be better

equipped than others to relay such information to schools. Some stated that the responsibility for conveying such information should lie with medical professionals or neuropsychologists, while others considered that special education services associated with the Ministry of Education should provide information and assistance in developing programme adaptations. While there was a clear message from participants that information was crucial in supporting teachers to support children with TBI, it was less clear via whom such information should be delivered. This finding reflects previous research that has identified the need for good communication between schools, families and the medical sphere in managing TBI at school (Mohr & Bullock, 2005; Gagnon et al., 2008).

The need for professional development was discussed at length by many participants. All of those interviewed reported that they had no exposure to the topic of TBI during their undergraduate teacher training and subsequently had not been made aware of any professional development opportunities relating to TBI. This finding reflects that of Mohr & Bullock (2005) which showed that teachers were unlikely to have received any prior education relating to TBI, especially during their undergraduate training. Participants in the current study with a background in special education services or RTLB indicated that they had knowledge regarding other disabilities that they perceived could be generalised to work with students that have experienced TBI, however all acknowledged that their knowledge of TBI was limited by a lack of training. Similar results have been found in previous studies in which educators have expressed concern about their lack of TBI knowledge (Adams et al., 2012; Linden, Braiden & Miller, 2013).

While most participants expressed a desire to engage in professional development in this area to enhance their capacity to identify students' difficulties and make relevant accommodations, there was some disagreement as to whether such training should be pre-

emptively obtained or instead accessed when a teacher is made aware that a student in their class has experienced TBI. Those who considered advance training to be important highlighted the need for increased awareness in order to identify difficulties and implement management strategies early on. This approach would seem to reflect recommendations in the literature which highlight the importance of prior TBI knowledge and increased teacher awareness in the enhancement of students' return to school (Keyser-Marcus, 2002; Linden, Braiden, & Miller, 2013). However, some participants noted that it would be unrealistically demanding and potentially unhelpful to expect teachers to gather and retain in-depth information regarding every possible medical or psychological condition that might impact on a student's learning, of which TBI is just one. Instead, it was suggested that it would be more useful for teachers to obtain information from professional networks and internet sources as it is required. Personal responsibility for one's professional development and ongoing learning was highlighted by those participants. This is similar to findings from previous research in which educators indicated that they were comfortable in taking responsibility for their learning and utilising informal training methods to address their professional development needs (Mohr & Bullock, 2005).

While information and education regarding TBI were highlighted throughout the teacher interviews as being of significant importance, this issue was not framed as being a barrier to educational service delivery. Rather, it seemed to be conceptualised as a challenge that educators' perceived themselves capable of addressing and overcoming, either by accessing professional development workshops and seminars, or through informal methods such as conducting internet-based literature reviews. However, some challenges were identified that were systemic in nature and less easily overcome.

**Barriers.** The two main barriers identified by participants as potentially impacting on educators' capacities to provide extra support to children experiencing TBI effects were funding and resourcing problems, and issues arising from the inclusion of children with disabilities in mainstream classroom settings. These issues were discussed with reference to teachers' perceptions that current government policies and recent funding cuts to special education services have perpetuated the difficulties faced by schools in providing support to such students. Some participants expressed reluctance to openly discuss their concerns regarding educational mainstreaming, due to the perception that this was a politically incorrect or unpopular view for a teacher to hold. Many were open, though, in stating that they were sceptical of the likelihood that they would receive support from special education services if a student with TBI was identified as having high or complex needs. Several participants asserted that only a small minority of children would ever receive extra funding for their difficulties. RTLB in this study, responsible for supporting teachers and dispensing special education funds, described these problems in great depth. They emphasised the significant limitations of the current system that they perceive to directly result from limited funding. Several participants also noted that a mainstream classroom setting was not likely to be conducive to the intensive, individualised teaching approach that they perceived children should receive if they were experiencing persistent effects of TBI.

Previous research regarding teacher perceptions of TBI has not focused on systemic issues such as funding limitations or problems associated with mainstreaming. This finding adds to the literature base in this regard and raises the issue of whether the current New Zealand education system is able to deliver high quality special education support services to children with learning and behaviour problems. It would seem that teachers are concerned that the intentions set out by the Ministry of Education's inclusive education reforms (Ministry of Education, 1989) may not have led to positive outcomes for all students and that

some may have in fact been disadvantaged by this change in direction. It would seem that there may be reluctance amongst educators to openly discuss their perceptions of this heavily politicised issue. In spite of these perceived barriers, however, participants also expressed a commitment to children and families with whom they work and a desire to provide those children with the best quality education that they could deliver in the face of limited resources, funding cuts and increasing classroom sizes.

**Limitations.** While the open-ended interview style and thematic content analysis approach employed in Study Two was flexible and enabled participants to discuss their opinions in their own terms, this methodology can impact on reliability in that it may be subject to interpretation and the differing perspectives of researchers. In order to address this, full interview transcripts were read and thematic codes checked by multiple researchers. However, the subjective nature of these types of interpretations is acknowledged.

Another potential limitation of the thematic analysis approach used here is that this method of identifying and extracting key themes may result in a sense of continuity and contradiction being lost from each individual's account. Use of a different approach, such as a narrative inquiry method, may reduce the amount of critical data overlooked in this respect. However, the flexibility of a thematic content analysis approach and its applicability to the types of research questions that consider issues beyond the individual's experience suggests that this type of analytic method remains appropriate for the type of investigation conducted in Study Two.

It is possible that participants prepared in advance for their interview, as they were aware of the broad study topic (teachers' perspectives on childhood TBI). As such, some may have researched the topic prior to the interview and increased their level of knowledge, which may have resulted in a positive skew in terms of teacher awareness of TBI epidemiology and

consequences. However, the use of a semi-structured interview including open-ended questions is likely to have enhanced the spontaneity of participants' responses and strengthened the reliability of the findings in comparison to the postal questionnaire method used in previous research, which enabled participants to copy their responses from online encyclopaedias (Molnar, 2010).

There was some difficulty recruiting teachers in the Waikato for Study Two. It is possible that this was in part due to high rates of school involvement in Study One, which may have contributed to a perception of study burden and research fatigue amongst Waikato teachers. The recruitment regions were thus expanded to include Bay of Plenty, which resulted in a rapid improvement in recruitment rates. The sample size in Study Two ( $n = 19$ ) was still relatively small, however, and may not be representative of the wider teacher community. While efforts were made to draw teachers from a variety of school deciles, so as to reflect diverse communities, the interview data was drawn from a selective sample who were highly motivated to share their experiences. Greater cultural diversity amongst participants may also have enriched these findings. As such, caution should be applied in generalising these findings to all wider teacher populations.

**Future Research Directions.** Future research regarding teacher perceptions of TBI would benefit from larger sample sizes and inclusion of both kindergarten and secondary school teachers. This may enhance the reliability of the findings and allow for greater generalisability. Future qualitative studies may also consider the use of a different qualitative research method, such as a narrative approach, in order to allow for more in depth analysis of teachers' discourse regarding childhood TBI.

## Summary of Study Two

The findings of Study Two highlight the limited nature of educators' professional engagement with the topic of TBI in childhood. There is wide variation in perceptions and understanding of the basic epidemiology and consequences of TBI, particularly in regards to the most commonly occurring mild injuries. While teachers demonstrate insight and seem concerned regarding their lack of professional development about TBI, many expressed that they felt unsupported by other disciplines in accessing information and education that would support their practice in this area. Teachers identified significant learning gaps that they perceive could be filled by educational opportunities such as in-service training and appeared motivated to learn more about this area. Educators also emphasised the barriers and challenges that have arisen out of New Zealand's mainstreaming approach and the lack of available resourcing for children with high and complex needs. As a result of Study Two, it was considered important to investigate whether a useful professional development approach could be developed that would be acceptable to mainstream educators and enhance their knowledge and skill regarding the management of childhood mTBI and its potential implications in school settings.

## CHAPTER 5

### Concussion in the Classroom: Educating Educators

#### Study 3 Rationale and Overview

The findings of the first study demonstrated significantly poorer performance amongst children with mTBI 14-months post-injury on measures of emotional, behavioural and academic functioning when compared to same aged, non-injured peers. The findings of the second study showed that teachers have limited knowledge of mTBI, in spite of its high prevalence rate and the increased likelihood that children with mTBI will demonstrate persistent difficulties that may adversely impact functioning at school. The challenge now is to use this understanding to address the difficulties that children with mTBI may experience in school settings. In integrating the findings of the first two studies, it seemed that enhancing teacher knowledge would be a priority in addressing the needs of children with mTBI at school. While a lack of formative training regarding mTBI and special education at an undergraduate level was identified as an issue by teachers participating in the second study, most highlighted a need for ongoing professional development that occurs outside of tertiary education settings.

Professional development for educators has been described as essential to the continued improvement of educational systems and student outcomes (Borko, 2009). A growing body of literature has begun to examine the efficacy of particular approaches to teacher professional development in order to understand what variables contribute to the implementation of practice change leading to improved learning outcomes. Some researchers have argued that professional development is more effective if it occurs longitudinally and within classroom contexts, with teachers generating knowledge in collaboration with mentors (Garet, Porter, Desimone, Birman, & Yoon, 2001; Klingner, 2004). Others have suggested



that such an approach may be too random and inconsistent to be reliable, and continue to support the more traditional 'workshop' approach to professional development, in which an individual with expert knowledge of a given topic delivers systematic information to a teaching collective (Lord, 1994).

In spite of disagreement in the literature regarding mode of delivery, there are several variables that have been consistently identified as important contributors to the effectiveness of professional development. Klingner (2004) reviewed empirical research regarding this issue and identified several important factors. The findings of this review emphasised that teacher perceptions of the feasibility and fit of suggested practice changes was an important aspect of implementing their learning. If teachers did not perceive that practice change was relevant, valuable and could improve student performance, they were unlikely to employ new techniques. Similarly, if teachers did not consider that suggested changes could realistically be applied in their classroom, they were unlikely to benefit from professional development. Other barriers to change include teachers' perceptions of a lack of time, and low support from administrators (Klingner, Vaughn, Hughes, & Arguelles, 1999).

Gersten (1997) illustrated factors that could help address barriers to professional development implementation in terms of six principles:

1. Reality, which refers again to feasibility and fit.
2. Scope, suggesting that changes could not be too broad or extreme otherwise they would be seen to be too difficult or overwhelming - conversely, Gersten also recommended that changes not be so minor that they be perceived as trivial, as this could also act as a barrier to implementation.
3. Technical, highlighting the need for feedback and ongoing support.

4. Conceptual; that is, understanding the significance and possible benefits of using new strategies.
5. Linking practice changes to student learning.
6. Collegial Support; this refers to involvement from school principals and senior management to ensure that teachers are well-supported in their efforts to introduce their own practice changes. The latter was also emphasised by Garet et al. (2001) in their examination of the characteristics of effective teacher professional development, that highlighted the importance of collective participation by teachers from the same school in professional development activities in order to increase the likelihood of change implementation.

Guskey (2000) developed a five-level approach to the evaluation of educators' professional development. Level one examines participants' reactions to the content and delivery of the material by assessing participants' satisfaction with the learning session. It is recommended that this level is evaluated via the use of questionnaires administered at the end of workshop sessions, focus groups, interviews or personal learning logs. Level two evaluates participants' learning. In particular, it is focused on whether teachers meet learning objectives by acquiring new knowledge and skills. This level also addresses changes in teacher beliefs and dispositions. Guskey recommends that changes in teacher knowledge, skills and beliefs are measured by knowledge tests, simulations and demonstrations, or participant reflections. Level three evaluates organisational change and measures the organisation's support, advocacy, facilitation and recognition of policy and practice changes. Level four examines participants' use of new knowledge or skills and examines whether participants effectively apply new knowledge and skills. Finally, level five evaluates student learning outcomes.

Level one and two are described as formative and likely to be crucial to the success of the latter stages, which are focused on longer term organisational support and change, implementation and, ultimately, student learning outcomes. While all five levels may not be directly measured in an evaluation of professional development (particularly as the latter three are more likely to require longitudinal assessment), all may contribute to the development of such programs. Guskey recommends that those when creating a course of learning for educators and its evaluation, developers begin at Level 5 with a consideration of desired outcomes, and work backwards through the earlier levels.

### **Aim of the Study**

The purpose of the current study is to bring the findings of the first two studies together in the development of an educational intervention for teachers; that is, to utilise the findings regarding developmental functioning in children, along with the insights obtained from teachers regarding how mTBI is (or is not) managed in educational settings to develop a professional development workshop with an accompanying written resource. Furthermore, this study aims to assess the utility of both approaches to teacher professional development and examine whether the provision via schools of information regarding the neuropsychological impacts of mTBI may support teachers and families in managing possible issues that may arise in children in the 12 month period following mTBI. The study reported here is a small scale evaluation of the acceptability and usefulness of a professional development workshop and written resource regarding mTBI. Guskey's (2000) five-level approach was employed in the development of the workshop material, and the first two formative levels applied in the evaluation of outcomes. The hypotheses for this study were that a brief educational intervention for teachers would be effective in increasing their

knowledge, and that such an intervention would prove satisfying and valuable to participants in such a way that may increase the likelihood of long-term knowledge implementation.

## **Methodology**

### **Ethical Approval**

Ethical approval to conduct this research was obtained from the University of Waikato School of Psychology Ethics Committee (13/06).

### **Design**

A mixed-methods design was employed in order to enrich the study findings. The inclusion of a qualitative component was designed to triangulate and increase the validity of the quantitative data (Hanson, Creswell, Plano Clar, Petska, & Creswell, 2005).

### **Participants**

Participants were 38 teaching staff recruited from three primary-schools in Hamilton and Tauranga. The recruitment method involved emailing an introductory letter (see Appendix O) to principals in 14 Waikato and two Bay of Plenty schools, offering to provide a free professional development workshop to be evaluated by consenting teachers. The initial email included an information sheet for principals (Appendix P) and a separate information sheet for teaching staff (Appendix Q) that explained the study. The letter advised that a follow-up phone call from the primary researcher would be made within the next two weeks

to discuss possible participation. Principals were advised that they could also contact the researcher to discuss their school's possible involvement.

Seven (44%) principals were successfully contacted via email or follow-up telephone contact. Four declined involvement. Reasons for declining included the perception that teachers wouldn't have time due to upcoming Education Review Office audits (2), that TBI was not a current learning priority (1) and that staff did not perceive concussion to be a common enough problem in their classrooms to warrant professional development in the area (1). Of those schools that responded to contact attempts, three (43%) provided verbal consent to proceed with concussion workshops at a mutually agreed time and location.

The three schools that agreed to participate in the workshop and evaluation formed three groups of participants. Group one was from a Decile 8 school and was comprised of 10 females and three males. Group two was from a Decile 2 school and was comprised of seven females and two males. Group 3 was from a Decile 4 school and was comprised of 14 females and two males.

Of the total 38 participants, three (7.9%) were student teachers, three (7.9%) were assistant principals and three (7.9%) were principals. The remaining 29 (76.3%) were current primary school teachers. Participants were aged between 24 and 66 years with a median age of 46 years. They had been employed as teachers or RTLB for between one and 40 years. Excluding student teachers, the median number of years spent teaching was 20.

### **Materials and Measures**

All materials were developed by the primary researcher:

**Seminar.** Delivery was guided by the presentation of 47 PowerPoint slides (Appendix R) covering definitions and classifications of TBI, mTBI epidemiological data, possible

consequences, and suggested intervention strategies for teachers. Opportunities for reflection and questioning were built in throughout the seminar.

**Teacher Brochure.** The teacher brochure (Appendix S) constituted a brief summary of the main points from the seminar, i.e. concussion symptoms, possible ongoing effects, and management strategies for teachers.

**Teacher Background Questionnaire.** The teacher background questionnaire (Appendix T) collected information regarding the teacher's demographics, teaching background and school details.

**Concussion Quiz.** The concussion quiz (Appendix U) was designed by the primary researcher as measure of concussion knowledge. It contains nine items which are rated by respondents as True or False. Items reflected commonly debated and disputed facts from the literature with reference to some common myths about concussion (Bickerstaff, 2010; Brady & Brady, 2013; Centers for Disease Control and Prevention, 2013).

**Workshop and Brochure Evaluation Form.** The workshop and brochure evaluation form (Appendix V) was divided into two components. The first part focused on evaluation of the workshop with emphasis placed on the first two levels of Guskey's (2000) approach to the evaluation of professional development, that is, participants' reactions and learning. The second component focused on the usefulness of the teacher brochure and establishing teachers' preferred mode of learning.

## **Procedure**

Ethical approval for the current study was obtained from the University of Waikato School of Psychology Ethics Committee. All three schools selected their school staffroom as the location for delivery of the workshop. As agreed, the researcher attended each school and presented the study objectives verbally to teachers before providing them with another copy

of the teacher information sheet. Teachers were provided with the opportunity to discuss queries regarding the research and process and were informed that they may choose not to participate or withdraw at any time, without penalty, and were still welcome to attend the workshop as learning exercise regardless of their commitment to act as research participants. All attending teachers agreed to act as research participants. No participants expressed that they wished to withdraw or not answer particular questions at any point during or after the study. Written consent was then obtained from all participants (see consent form in Appendix #).

Prior to delivery of the workshop seminar, participants completed a Background Questionnaire detailing relevant demographic information and a knowledge quiz regarding concussion facts which was administered as a pre-intervention measure. The seminar itself was subsequently delivered, taking approximately 90-120 minutes (dependent on level of teacher participation and questions). Upon completion of the seminar, teachers were provided with a copy of the teacher brochure and given several minutes to study this document. Following this, teachers completed the knowledge quiz again as a post-measure along with the workshop and brochure evaluation forms.

**Quantitative Data Analysis.** Data analysis was carried out by using SPSS (version 19). Descriptive statistics were used to assess the demographic characteristics of participants and ratings of their responses to the workshop material. A repeated measures ANOVA was conducted to determine whether knowledge of concussion facts improved as a result of attending the workshop.

**Qualitative Data Analysis.** All participants qualitative responses to evaluation questions were read and analysed separately, and themes were identified that related to each

topic area. This process involved the coding of responses in order to identify similarities and differences across participants. A thematic content analysis approach was applied at the semantic level to identify patterns of meaning across the data sets (Braun & Clarke, 2006). Following review, themes were merged and then comments were reread in order to check that no other themes were emerging. Codes and themes were cross-checked by an independent person to increase reliability and validity.

**Integration of Quantitative and Qualitative Data.** The qualitative and quantitative data were then integrated in order to generate a more comprehensive account workshop's usefulness, relevance and applicability to teaching practice. The quantitative data regarding teachers' satisfaction and learning from the workshop were analysed and then combined with the qualitative data, which were then used to explore patterns of underlying meaning amongst the responses in order to establish which variables contributed to ratings of satisfaction and usefulness. The purpose of integrating these two data sets was to explore participants' perceptions of the workshop, and the meanings underlying these perceptions.



## Results

The results section will begin by presenting descriptive information regarding the outcomes of the study's quantitative measures and repeated measures analysis, followed by thematic content analysis of the qualitative results.

### Quantitative Results

**Workshop and Brochure Evaluation.** Thirty eight participants rated their satisfaction with the workshop and its usefulness. In regards to satisfaction, 20 (52.6%) rated themselves as 'very' satisfied, 14 (36.8%) as 'quite' satisfied and 4 (10.5%) as 'somewhat' satisfied. No participants rated themselves as 'not at all' satisfied.

In regards to usefulness, 16 (42.1%) rated the workshop as being 'very' useful in their teaching practice, 17 (44.7%) as 'quite' useful and 5 (13.2%) as 'somewhat' useful. No participants rated the workshop as being 'not at all' useful.

Thirty-seven participants rated the relevance of workshop topic (mTBI) to their work as a teacher. Eighteen (48.6%) rated it as 'very' relevant, 14 (36.8%) as 'quite' relevant, and five (13.5%) as 'somewhat' relevant.

Participants were asked to report how much of the content of the workshop was new information for them personally. Fifteen (39.5%) reported that 'most' of the material was new information, while the remaining 23 (60.5%) rated 'some' of the information as new. When asked to rate the likelihood that they would attempt some of the suggested strategies in their practice, 17 (44.7%) reported it was 'very' likely, 19 (50%) 'quite' likely, one (2.6%) 'somewhat' likely, and one (2.6%) 'not at all' likely.

**Brochure Evaluation.** Eighteen (47.4%) participants rated the brochure as 'very' useful, 17 (44.7%) as 'quite' useful, two (5.3%) as 'somewhat' useful, and one (2.6%) as 'not at all' useful.

Thirty-seven participants selected their preferred mode of learning. Twenty-seven (73%) preferred that both the workshop and brochure be delivered, eight (21.6%) preferred the workshop alone and two (5.4%) rated the brochure as their preferred learning mode.

**Repeated Measures ANOVA.** A one-way within subjects (or repeated measures) ANOVA was conducted to compare the effect of the workshop on concussion quiz scores in the pre-delivery and post-delivery conditions. Participants obtained higher mean test scores of concussion knowledge subsequent to engaging in the workshop ( $M = 8.5$ ,  $SD = 0.69$ ) than at baseline ( $M = 7.4$ ,  $SD = 1.58$ ). This increase was statistically significant,  $F(1,37) = 16.97$ ,  $p = 0.01$ ,  $\eta^2 = .314$ .

## Qualitative Results

### Workshop evaluation

**Usefulness.** Participants were asked to consider what was the most useful piece of learning that they obtained from participation in the workshop. Many participants reported that learning about concussion symptoms was the most useful aspect. In particular, it was noted that it was most helpful to learn about the wide range, complexity and potential seriousness of some of the symptoms.

*“Knowing the symptoms that children may have and as a teacher, how I may help.”*  
(P15)

*“The complexity of TBI symptoms and how long they may last.”* (P4)

*“The complexity of the issue and situations that arise from such injuries.”* (P11)

*“That any blow/knock to the head or form of brain shake is to be taken seriously and that the child needs close monitoring for some time. Changes may occur for that child in learning, emotions, behaviour.” (P13)*

In that vein, several participants noted that it was most useful to understand the potential persistence of concussion symptoms.

*“The potential long term effects of TBI” (P23)*

*“The length of time concussion can affect a child for.” (P36)*

In relation to the complexity of symptom identification, a number of participants highlighted a new awareness of some of the challenges that arise in establishing whether TBI is a causal factor in a child’s difficulties, along with other methodological issues that may arise in TBI research.

*“Symptoms are hard to gauge - are they a result of the injury or something else?” (P23).*

*“[It is most useful to know] that TBI relates to ability (correlation). Many, many , many TBI not reported or known about.” (P32)*

A large proportion of participants stated that the most useful aspect of the workshop was learning about teaching strategies and in-class modifications that could be made for children who were experiencing post-concussive symptoms.

*“How to provide for the student after a TBI.” (P12)*

*“Strategies such as giving child shorter tasks, rest breaks, when they return to school”. (P38)*

**Practice Changes.** Thirty five (92%) participants reported that they expected to make changes to their teaching practice as a result of attending the workshop. When asked what they might do differently in future, several themes emerged. Many participants described a heightened awareness of TBI that they suspected would lead to increased vigilance and caution around managing students injuries at school. This included consideration of how seriously injuries that occurred at school might be taken.

*“Be a lot more careful and take note after any bang to a head” (P1)*

*“Be tons more vigilant and cautious” (P5)*

*“Act more quickly - less likely to assume everything will be "ok" after a knock” (P6).*

*“Monitor suspected TBI much more closely*

Participants also suggested that they would increase their observation and monitoring of students’ symptoms and possible performance issues, particularly in the initial period following an injury, with heightened awareness of the possibility that TBI may impact on a child’s functioning in a variety of ways.

*“Be more alert to ongoing problems or behaviour changes.” (P8)*

*“Factor in the fact that a child may be unable to do something due to TBI.” (P19)*

*“Monitor children with bumps more closely. Look for symptoms.” (P21)*

Three participants noted increased empathy and tolerance for students with difficulties as a likely outcome of the workshop.

*“Tolerance / empathy to a child that may appear naughty or off task.” (P32)*

*“Be more sympathetic and understanding of children who have had a brain injury.”  
(P35)*

*“It has made me more aware that there could be a reason for behaviours.” (P37)*

Many participants noted particular strategies or modifications suggested in the workshop that they intended to employ in their future practice. In particular, they highlighted suggested techniques for adapting their communication style to meet the needs of children with cognitive processing, memory or attention difficulties.

*“Keep instructions clear and in small chunks.”*

*“Consider different ways of presenting information, giving instructions.” (P23)*

*“Maybe taking the time to explain activities and not be distressed if some do not get it.” (P25)*

The need for cognitive rest and low-stimuli activities post-injury was also emphasised by several participants, with an expectation that they would attempt to support such adaptations in the classroom and facilitate rest periods for children after sustaining a concussion.

*“Lighten workload, include rest periods.” (P7)*

*“Think of the types of activities that I am asking my children to do.” (P26)*

Several others expected to develop and utilise Individual Education Plans or care plans with all children with known injuries (as suggested in the workshop with reference to the Concussion Safety Net approach) and considered this to be a significant practice change.

*“Awareness and strategies to use when a child has past brain injury. Also definitely an IEP with all concerned.” (P27)*

*“Care plan - think we may do this informally but perhaps now formalise as and when necessary.” (P20)*

Another significant theme emerged around the topic of communication with families, with a large proportion of participants highlighting this issue as an area of likely practice

change. For some, this seemed to refer to the contacting of parents if a child has an injury at school

*“Contact parents more swiftly and stress to them the importance of brain rest and monitoring.”(P3)*

*“Communicate more with the parents if a child has had head bump.” (P8)*

For others, the need for increased communication was related to concern about changes in a child’s functioning or poor academic performance, in order to establish whether TBI might be a background factor.

*“If possible talk to parents, although broaching this subject could be difficult.” (P17)*

*“Communicate concerns with parents sooner.” (P29)*

*“Talk to parents regarding a child's history of head injury, if any.” (P36)*

## **Changes and Improvements**

**Least useful aspects and workshop improvements.** When asked to comment on the least useful aspect of the workshop, the vast majority of participants did not respond. Most of those that did respond to this question made positive comments, such as:

*“It was all useful for me.” (P9)*

*“All the information was clear and coherent and presented in a form that I wouldn't cut anything out.” (P16).*

Two participants noted less useful aspects of the workshop: focusing on strategies for managing behavioural problems, and information about how data were collected for local studies.

**Suggested Improvements to Workshop Content and Delivery.** Several participants suggested inclusion of extra information relating to TBI symptom identification and managing ongoing symptoms. However, the majority of suggested improvements related to the structure of the workshop. In particular, a large proportion requested more time for discussion and interaction.

*“Maybe a discussion from teachers on whether they had encountered students with brain injury in their classroom.” (P35)*

*“Maybe invite teachers to be more interactive and contribute their thoughts, experiences, etc.” (P30)*

*“More of a discussion of teaching practice.” (P23)*

While participants had been invited to discuss their thoughts at several time-points throughout the workshop, it was noted that a large proportion did not consider this to have been sufficient and would have welcomed increased time to discuss their experiences and reflections relating to their own work and encounters with children with mTBI.



**Summary of Workshop Outcomes.** Participants indicated that they were highly satisfied with the workshop content and delivery, finding the material to be very useful and relevant to their teaching practice. Most of the information was new to many of the participants, with all reporting that at least some of what they encountered during the workshop was fresh material. Participants reported that the most useful new information related to symptom awareness and modification strategies for use with children. Several areas of likely practice change were highlighted, which focused on symptom monitoring, increased empathy and tolerance, and the use of specific classroom-based strategies with children who experience cognitive or behavioural impairments. Furthermore, participants emphasised their intention to develop and utilise Individual Education Plans and care plans with children who have experienced mTBI and increase communication with families.

**Brochure evaluation.** Eleven (29%) participants suggested other information that should be included in the teacher brochure. Most of those highlighted the need to include a helpline phone number that people could call to get more information.

*“Helpline number – not everyone has the internet” (P33)*

Several took the opportunity to note that while the brochure was a useful accompaniment, a workshop was more useful for elaboration and clarification of the information.

*“The brochure would be useful as a reminder but a workshop is always important so one can ask questions and clarify things.” (P6)*

Overall, responses to the brochure suggested that such a tool could act as a useful aide memoir or communication device when discussing issues with parents, but would not be sufficient to address teachers' learning needs. Participants perceived that such a written resource should accompany, rather than replace, a workshop-style professional development format.

## Discussion

### Workshop Satisfaction, Usefulness and Relevance

The hypotheses of this study were that a brief education intervention would be effective in increasing teacher knowledge about mTBI, and would be acceptable and satisfying to participants. Both hypotheses were supported by the results which demonstrated significant knowledge increases and a high level of acceptability to educators. In exploring participants' satisfaction with the workshop and their perception of the material's usefulness and relevance to their teaching practice, it was noted that the vast majority (%) rated themselves as 'quite' or 'very' satisfied with the workshop and the content as 'quite' or 'very' useful and relevant to their teaching practice. The majority of participants indicated that 'some' or 'most' of the information in the workshop was new to them.

This was supported by the qualitative data, with a large proportion of participants responding positively to the issue of usefulness. It seemed that for many, exposure to information regarding the symptoms of concussion was considered to be the most useful new information, while a significant proportion also indicated the usefulness of suggested management strategies.

Establishing satisfaction amongst participants was a key learning objective of the workshop, as emphasised in Level One of Guskey's (2000) five-level approach to the evaluation of professional development for educators. Furthermore, perception of relevance is seen to be an important aspect of fit and feasibility for teachers looking to implement new learning from professional development activities (Gersten, 1997; Klingner, Vaughn, Hughes, & Arguelles, 1999). Both the quantitative and qualitative findings of this study suggest that participant satisfaction levels were high, potentially increasing the likelihood that teachers

would subsequently make changes to their teaching approach on the basis of the workshop's recommendations.

### **Learning Outcomes**

Over 90% of participants reported that they expected to utilise strategies learnt in the workshop and adapt their teaching practice when working with children with mTBI or other special needs. In discussing areas where they expected to make changes, several key themes emerged.

The first of these was around the issue of the initial response to concussion, with several participants suggesting that their first response would be to take a child's injury more seriously, obtain medical attention more promptly, and engage in careful monitoring and observation in the days and weeks following an injury. This change in response seemed to be related to participants' heightened awareness of the prevalence and symptoms of mTBI in childhood, as it was most often discussed in relation to increased knowledge of these areas. Previous research has identified teacher knowledge of mTBI characteristics as an area of particular weakness (Mohr & Bullock, 2005; Molnar, 2010; Linden, Braiden, & Miller, 2013), which was further supported by the results from Study 2 that showed significant limitations in teacher knowledge of mTBI characteristics. However, the findings from the current study indicate that a brief workshop format may be sufficient to improve teacher knowledge of mTBI. The analysis investigating concussion knowledge test score improvements demonstrated significant increases in mean test scores immediately following the seminar, which adds further support to the proposition that teacher knowledge of mTBI may be significantly improved after engagement in a professional development workshop. Increasing teacher knowledge of mTBI also addresses an important component of the workshop's objectives, in that it helps to establish the nature and prevalence of the problem, and provides

a rationale for changes in teaching practice. Without such a rationale, teachers may be less likely to employ suggested strategies (Gersten, 1997; Klingner, 2004).

Increased empathy and compassion towards children who have experienced mTBI, or demonstrate other difficulties in school settings, was also highlighted as an area of likely change by participants in this study. The possibility that children who might appear 'naughty' might in fact be experiencing other difficulties outside of their control seems to have been more salient for some participants after engaging in the workshop. This was an area highlighted by participants in the second study as an important aspect of effective teaching practice. Furthermore, young people with TBI and their families have also emphasised the need for teachers to demonstrate compassion, tolerance and patience towards children returning to school after an injury in order to smooth and support that transition (Gagnon, Swaine, Champagne and Lefebvre, 2008).

Another significant area that emerged in participants' discussions of likely practice changes related to specific strategies for use with children who demonstrate cognitive, behavioural, or emotional problems at school. In particular, it seemed that approaches such as monitoring for fatigue and allowing rest time/s and opportunities to engage in low-stimuli activities were noted by participants. Alongside these, participants also emphasised specific techniques such as adapting the communication of instructions and information to meet the needs of children with information processing, memory or attention problems. Several teachers also indicated that they intended to develop an IEP or care plan to assist with the facilitation of these strategies. The finding regarding uptake of suggested strategies is interesting, in that it could be argued that none of these techniques might be considered particularly novel or complicated. While it follows that this might enhance the likelihood that teachers will implement the strategies, due to their perceived applicability and a lack of barriers (Gersten, 1997), it also raises a question regarding current teacher knowledge of

special education approaches. In particular, this finding highlights the possibility that if such simple techniques are considered to be new information and, for some, the most useful aspect of the workshop, that the level of knowledge of strategies for use with children with disabilities may not be sufficient amongst the general teaching population to address such childrens' learning needs. Considered in light of New Zealand's inclusive education approach, in which it is expected that children with disabilities will be present in mainstream classrooms, this raises a significant issue in relation to teacher education which we will examine in more detail later in the piece.

The need for communication with families has been highlighted in previous research as an integral aspect of providing for children who have experienced TBI (Gagnon, Swaine, Champagne, & Lefebvre, 2008). This was emphasised in the workshop and seems to have been recognised by participants as important both initially, in relation to notifying parents' of injuries that occur at school, and later, if persistent difficulties emerge. Communication with parents regarding background factors, including possible TBI, was also noted by some participants as an area that they would be more likely to explore when attempting to understand the underlying nature of a child's difficulties.

### **Written Resource**

Most (92.1%) participants rated the brochure as 'quite' or 'very' useful for teachers who are new to the topic of concussion. However, only two participants indicated that the brochure would be their preferred mode of learning. The vast majority (73%) stated that they would prefer to attend a workshop and also be provided with a supplementary written resources such as a brochure or pamphlet. Qualitative comments helped to elucidate this preference for both, with several participants noting that a workshop format enabled teachers to obtain more detailed information with opportunities to question and clarify as necessary.

As principals and senior management staff were in attendance at all three workshops, alongside more junior staff, it seems likely that his format may have fulfilled another key principle of effective professional development delivery in that it facilitated collective participation and collegial support for practice change (Garet et al., 2001; Gersten, 1997). The usefulness of written resources such as brochures, however, was also highlighted as a potential learning reinforcer or aide for teachers who have already attended a workshop, or as a tool that teachers could provide to parents in their discussions of mTBI.

### **Strengths**

The current study is the first of its kind to evaluate the usefulness of an educational intervention for use with teachers to enhance knowledge and awareness of mTBI-related problems in childhood. It provides a platform for the ongoing development of mTBI-related professional development and the use of supportive practices by teachers.

The development of the concussion workshop was evidence-based, ensuring that the information provided to teachers was accurate and of a high-quality. Suggestions for intervention were also based on empirically-supported methods for addressing developmental difficulties in school settings. The learning evaluation approach was theoretically grounded in Guskey's (2000) critical levels of professional development evaluation, which facilitated the inclusion of learning goals and appropriate measurement techniques.

The use of a quantitative/qualitative approach enabled knowledge improvement to be accurately measured whilst also providing for richer information regarding participants' subjective experiences to be obtained. As such impressions are seen to be crucial to the successful implementation of professional development learning, this methodological aspect was particularly critical.

Another strength of the current study was that it was included the full staff, including senior management, of each school in which it was delivered. Garet et al. (2001) suggested that collective participation was an important aspect of ensuring that there was uptake of professional development throughout a school, and impacts for wider school policies and practices. Involvement of senior management in the current study workshop may have improved the likelihood that changes in school culture, seen to be critical to outcome improvement, would occur (Guskey, 2000).

### **Limitations**

Evaluation measures used in Study 3 were developed by the researcher and were not validated assessment tools. The concussion quiz delivered prior and subsequent to the concussion workshop was a brief, nine-item measure designed to assess teacher knowledge of basic mTBI facts. The use of a longer measure may have strengthened the reliability of the findings regarding the improvement of teacher knowledge. While the quiz was evidence-based, the use of a validated measure of TBI knowledge may enhance these results.

The evaluation form for both the workshop and teacher brochure was also developed by the researcher and was a not a validated measure. Based on Guskey's (2000) assertion that teachers' responses to and satisfaction with professional development activities are a primary aspect of whether suggested practice changes are implemented, the evaluation form sought to assess participants' reactions to the workshop and brochure and their preferred mode of learning. In this regard, it seems the form yielded useful results. However, validation of such a measure may improve the generalisability of such findings.

While current study employed the primary levels of Guskey's (2000) guidelines for the development and evaluation of teacher professional development, time constraints



precluded the examination of longer-term outcomes of the professional development workshop. In particular, it is unclear whether participation in the workshop led to changes in teacher practice and school culture, or whether knowledge improvements were maintained over time. It is also unclear whether the research ultimately led to improved student outcomes. Investigation of these later effects may have strengthened the validity of the current findings.

It is possible that time pressures may have impacted on the teachers' experience and perceptions of the workshop. It was noted by several that more time for discussion would have been appreciated. However, the opportunities for in-depth discussion were limited in part because of instructions from school principals to limit the length of the workshop so that teachers did not feel over-burdened. It seems this is a difficult balance to strike; while it is acknowledged that teachers face many time pressures and may struggle to schedule professional development workshop activities, limiting the length of such activities may negatively impact on their learning experience.

The current research represents a small-scale investigation of the feasibility and usefulness of brief professional development workshops for teachers regarding concussion. However, the sample size is relatively small and this may impact on the generalisability of the findings to the wider teacher population. Obtaining participants for the current research proved difficult, as many school principals did not respond to initial recruitment attempts. Most of those that were successfully contacted reported that they did not perceive concussion to be an important or relevant topic, or that teachers were too busy to participate in such an activity. While meaningful conclusions can be drawn from the results of the final sample, a larger sample size would enhance the reliability and generalisability of the results.

## **Future Research**

Use of a standardised measure for the evaluation of teacher professional development is recommended for future research. It would also be useful to employ a more longitudinal approach in order to follow-up with educators and obtain their reflections at a later time-point. This would enable assessment of whether practice recommendations have been implemented, school culture and policy changes have arisen and, ultimately, whether student outcomes have resultedly improved (Guskey, 2000). Future research designs may consider employing an implementation research model in order to strengthen the development and evaluation of an evidence-based intervention program (Fixsen, Naoom, Blase, Friedman, & Wallace, 2005).

Future research regarding teacher perceptions of TBI would benefit from larger sample sizes and inclusion of both kindergarten and secondary school teachers. A larger sample size may enhance the generalisability of findings. A larger study sample could also allow for sub-group analyses which might examine whether the level of mTBI awareness is different depending on training pathways and timing of training. Such analysis may help to better identify training shortcomings. The inclusion of kindergarten and secondary school teachers would assist in identifying and addressing the learning needs of those specific populations, as there may be some particular differences amongst teacher cohorts in this regard given the various developmental stages of their students and the demands of each institutional setting.

## **Summary**

The findings of this study suggest that a brief workshop regarding the characteristics and effects of mTBI, and possible classroom interventions, may be effective and useful in the enhancement of teacher knowledge relating to TBI. Furthermore, these results suggest that written resources, such as information brochures, are perceived by teachers as useful forms

accompaniments to structured professional development activities. Feelings of satisfaction and the perception that information is useful and relevant may increase the likelihood of suggested strategies being implemented with children who experience persistent difficulties following mTBI, thus enhancing their classroom functioning. Thus, the provision of professional development workshops and supporting written resources for teachers in mainstream education systems may lead to improved academic, and associated behavioural and emotional outcomes in children who have experienced mTBI.

## Chapter Six

### Summary and Conclusions

#### Overview of Findings

The findings of Study 1 show that children who experience mTBI may be at risk of ongoing developmental problems that affect their educational functioning. In particular, injured children may demonstrate impairments in emotional, behavioural, and intellectual functioning. Furthermore, they may be more likely than their non-injured peers to have academic problems and learning disorders. In spite of the possibility of such difficulties, however, the findings of Study 2 shows that teachers are rarely provided with information and resources that would help them to be aware of and appropriately address such issues at school. There are concerns amongst teachers about a lack of support, funding and resourcing for special education in mainstream classroom contexts. The findings of Study 3 are promising, however, in that they demonstrate that the provision of a brief programme of professional development can rapidly increase teachers' knowledge regarding mTBI and related developmental problems, and has the potential to lead to improved outcomes for students who experience such difficulties.

There is a significant and growing body of evidence to suggest that children who sustain mTBI may experience a range of developmental problems (Hawley, 2003; McKinlay, Grace, Horwood, Fergusson, & MacFarlane, 2009; Moore, Terryberry-Spohr, & Hope, 2006; Yeates & Taylor, 2012). However, contradictory findings suggesting that children quickly recover from post-concussive symptoms are also evident throughout the literature (e.g., Anderson, Catroppa, Morse, Haritou, & Rosenfeld, 2001; Catroppa & Anderson, 2004; Petersen, Scherwath, Fink, & Koch, 2008). Where persistent difficulties are identified, the question of whether mTBI is the cause of such problems is moot (Ponsford et al., 1999;

Bloom et al., 2001); attempts to address premorbid functioning are often methodologically weak and fail to completely control for this variable. As such, the issue of whether paediatric mTBI is a direct cause of persistent developmental psychopathology remains unclear.

However, the large body of research suggesting that children who have sustained mTBI are at greater risk of developmental problems (regardless of cause) is supported by the findings of the current research, suggesting that such children may have higher needs impacting on their academic functioning that need to be addressed in their school context.

The findings of Study One show that children with mTBI are significantly more likely than their non-injured peers to demonstrate problems in their emotional, behavioural, intellectual and academic functioning. However, the underlying cause of such problems remains unclear. It is possible that, for many children, such problems were present or emerging in the pre-injury period. The implication here is that whatever cluster of risk factors predisposes children to psychological difficulties are also risk factors for paediatric mTBI. Indeed, when we examine the TBI risk factors identified in previous research (such as socioeconomic deprivation, abuse and neglect, parental alcohol abuse, and temperament) we can see that many of these variables are also risk factors for psychological problems and cognitive impairment in childhood (Kerig, Ludlow & Wenar, 2012). The intact EF and global neuropsychological functioning of the mTBI group in Study One could suggest that the impairments experienced by children in that sample were not reflective of overall neurological injury, which may weaken the case further for a causal link between mTBI and later developmental problems. Alternatively, this finding could indicate that the effects of mTBI may be difficult to detect and more evident on specific aspects of functioning than on global measures.

However, regardless of cause, it is evident that children with mTBI experience higher levels of developmental problems than non-injured children. Or, it could be said, children

with developmental problems are at significantly higher risk of sustaining mTBI. The crucial finding here is not that of a causal link; rather, it is that a significant proportion of the child population in New Zealand may face these difficulties.

This raises the question of how mTBI should be managed in the initial stages in terms of the information and support that is provided to families and other involved parties immediately following a child's injury. It would seem that a lack of agreement within the literature regarding mTBI effects has perpetuated the lack of consistent information provided to families via medical practitioners in the first instance. Therefore, it seems important that New Zealand based guidelines for the short-term management of paediatric mTBI-related symptoms are established and disseminated amongst clinicians and on to families. Currently, there appears to be wide variation in the information provided. Consensus amongst medical and psychological practitioners and the development of evidence-based, New Zealand guidelines for concussion management is required if this issue to be addressed.

Given the large proportion of the clinical sample in Study 1 that experienced ongoing difficulties after mTBI, it could be argued that post-injury developmental screening is warranted in children who have sustained concussion. As the current research and previous epidemiological studies have highlighted the possibility that children who experience mTBI are at increased risk of other problems (regardless of cause), it may be that mTBI could act as a red flag for clinicians and teachers. In this regard, concussion could be reframed as a warning sign that a child may be at higher risk of experiencing other problems. Such screening could be offered by physicians in general practice, public health nurses, or educators. As it is already standard practice for primary care GPs and nurses to administer the parent-rated SDQ when a child turns five years old, in order to identify those at higher risk of psychological problems, it may not be problematic to administer a similar type of screening device one to two years following a concussion. While most children would be unlikely to

demonstrate ongoing problems, the benefits of early identification and intervention for those who are experiencing increased difficulties could be significant.

It is possible that children who are experiencing developmental issues may struggle to function well (in terms of both behaviour and academic performance) in school settings. As all New Zealand children may access the mainstream education curriculum, regardless of their level of disability, this may pose significant issues for children's school functioning. The findings of Study One suggest that a large proportion of children who have experienced mTBI may require increased support at school in order to successfully access the curriculum.

However, it is evident that teachers may have limited knowledge in regards to paediatric mTBI and may struggle to identify and manage children's symptoms in the post-injury period (Adams et al., 2012; Gagnon, Swain, Champagne, & Lefebvre, 2008; Glang et al., 2008; Linden, Braiden, & Miller, 2013; Mohr & Bullock, 2005; Molnar, 2010). This is in spite of New Zealand legislation and policy that requires mainstream classes to deliver education services to children with a variety of disabilities and educational needs (Greaves, 2003; Ministry of Education, 1989). In order to address educators' own professional development needs in the teaching of children with such difficulties, relevant information should be provided in a format that is acceptable and applicable to their practice (Gersten, 1997; Guskey, 2000; Klingner, 2004). Awareness levels regarding childhood TBI were found to be low and there was a noticeable absence of teacher education and professional development opportunities in this area. This is in spite of the legislative changes that took place almost 25 years ago requiring that the majority of children with disabilities in New Zealand access their education via mainstream classrooms. The lack of professional development for teachers not just in regards to TBI but special education more generally diminishes the likelihood that children with developmental problems will receive high-quality education from compassionate and understanding educators. A lack of awareness of basic

neuropsychological functions crucial to learning (such as working memory) and behaviour (such as impulse control) may impact on teachers' abilities to identify and understand the symptoms that children present with in class. It is not for a lack of interest that teachers have not accessed professional development earlier; rather, it seems this is due to a lack of professional development opportunity. This could reflect a lack of consultation between the education and health sectors in the development of educators' professional development priorities and plans. Greater communication between these sectors could enhance outcomes in this area. In order to address educators' own professional development needs in the teaching of children with high and complex needs, relevant information should be provided in a format that is acceptable and applicable to their practice (Gersten, 1997; Guskey, 2000; Klingner, 2004).

The findings of Study Three demonstrate that low levels of knowledge and awareness of childhood mTBI can be easily addressed via a brief professional development workshop. Teachers evidenced significant improvements in their knowledge levels and reported that they were satisfied with the workshop and brochure content, therefore increasing the likelihood that they would apply some aspect of new learning to their practice. It was the impression of the primary researcher that teachers understood the difficulty that health researchers have in establishing causal relationships in the study of problems such as TBI. Teachers seemed able to move past this problem during the workshop and instead consider the wider implications of local research findings that suggest that mTBI is yet another potential difficulty to which educators need to be alert. Educators seemed responsive to the notion that paediatric mTBI may be framed as a possible background factor for children who present with psychological, cognitive and / or academic problems that should be considered in the formulation of their difficulties.



Such training need not just take place in the context of post-graduate professional development; there is also the question of whether there should be a greater focus on TBI in the undergraduate training of New Zealand teachers. Teacher participants in the current research indicated that childhood TBI was not an area that was covered in their initial teacher training. Given the apparent usefulness of brief training on the topic, it would seem that such education could be delivered at an earlier stage in teacher training, rather than solely as a professional development activity. Delivering education to teachers regarding the possible consequences of TBI and management of associated difficulties at an earlier stage in their training may enhance awareness and provide a platform for further professional development.

One of the wider implications of this programme of research is that it has highlighted that teachers may perceive significant problems in the current mainstreaming approach to educating children with disabilities, and a lack of funding and resourcing available to support this approach. While many teachers in the current study seemed concerned about these issues and indicated that they did not think the current situation is working well, they also seemed reluctant to express such opinions publicly for fear of being perceived negatively by their colleagues. The heavy political overtones that flow through discussion of special education practices in New Zealand seem to be taken for granted and may impact on educators' willingness to suggest other, less ideologically-based, approaches. In a climate of budget-cuts and an apparent reluctance to rock the boat, teachers continue trying to work with a system that they seem to believe is not working for children with developmental disabilities, as it appears there is no other option. If the issues identified by teachers in this research are to be properly addressed, consideration should be given to whether a mainstream classroom is the best place for a child who is experiencing significant disabilities to spend most of their learning time. Alternatively, if it is that the mainstream approach is considered most

appropriate for disabled children, then this practice needs to be supported by proper resourcing and funding.

## **Conclusions**

There now seems to be consensus that primary-school-aged children who have experienced mTBI may be at increased risk of experiencing a variety of developmental issues. While the direction of the relationship between mTBI and persistent developmental problems remains ambiguous, the significant associations amongst these variables are evident. There is every possibility that children who have experienced mTBI and are also demonstrating emotional, behavioural, intellectual or academic problems will experience difficulties at school as a result of their impairments. In order for such problems to be properly identified and addressed, this research demonstrates that it is crucial for teachers to be supported and educated regarding paediatric mTBI, post-concussive symptoms, and the relationship of these variables to classroom functioning. The contributions of teachers to this research have indicated that they are aware of their learning needs and desire increased opportunities to address those needs.

Professional development regarding TBI for educators is a potentially low-cost, brief and easily-administered intervention that has the potential to impact on children's outcomes after mTBI by improving symptom identification and enhancing classroom management of related learning and behaviour problems. The use of written resources (such as brochures) also has the potential to serve as a mode of education and intervention that alerts teachers to the possibility that children with mTBI are at increased risk of other difficulties, and assists them to access appropriate support if they have further enquiries. These types of resources

may act as effective awareness-raising tools that can reach a large number of educators in a short time and at relatively low-cost. Delivering professional development for already-graduated teachers is key to enhancing their knowledge and practice in this area; however, it may also be useful for tertiary teacher training programmes to consider how to build the topic of TBI into teacher education in university settings, so that future generations of teachers do not experience the knowledge gaps that their predecessors report.

As the potential for developmental problems in children who have sustained mTBI has become increasingly evident over the past ten years, it is appropriate now for our focus to shift to the consideration of how best to ameliorate such problems in the setting where children spend most of their waking hours – that is, at school. A combined, multi-disciplinary approach to the development of consistent guidelines and educational resources for teachers and parents regarding mTBI is the next step in addressing this significant public health issue, so that mTBI-related difficulties can be identified and appropriately addressed and good educational outcomes achieved.

## REFERENCES

- Accident Compensation Corporation. (2006). *Traumatic Brain Injury (TBI): Rehabilitation issues in MTBI*. In A. P. D. Unit (Ed.). Wellington: ACC Provider Development Unit.
- Accident Compensation Corporation, 2013. *Concussion Service*. Retrieved from <http://www.acc.co.nz/publications/index.htm?ssBrowseSubCategory=Concussion%20Service>
- Achenbach, T. M. (1991). *Manual for the Child Behavior Checklist 4/18 and 1991 Profile*. Burlington, VT: Department of Psychiatry, University of Vermont.
- Agran, P. F., Winn, D., Anderson, C., Trent, R., & Walton-Haynes, L. (2003). Rates of pediatric injuries by 3-month intervals for children. *Pediatrics*, *111*, 683-692.
- Alloway, T. P. (2011). *Improving working memory: Supporting students' learning*. London, UK: Sage.
- American Academy of Neurology (1997). Practice parameter: The management of concussion in sports (summary statement). Report of the Quality Standards Subcommittee. *Neurology*, *48*, 581-585.
- American Academy of Pediatrics (1999). The management of minor closed head injury in children. *Pediatrics*, *104*(6), 1407-1415.
- American Congress of Rehabilitation Medicine (1993). Definition of mild traumatic brain injury. *Journal of Head Trauma Rehabilitation*, *8*(3), 86-87.
- American Psychiatric Association (2013). *Diagnostic and statistical manual of mental health disorders: DSM-5* (5<sup>th</sup> ed.). Washington, DC: American Psychiatric Publishing.

- Anderson, V., Catroppa, C., Morse, S., Haritou, F., & Rosenfeld, J. (2000). Recovery of intellectual ability following traumatic brain injury in childhood: Impact of injury severity and age at injury. *Pediatric Neurosurgery, 32*(6), 282-290.
- Anderson, V., Catroppa, C., Morse, S., Haritou, F., & Rosenfeld, J. (2001). Outcome From Mild Head Injury in Young Children: A Prospective Study. *Journal of Clinical & Experimental Neuropsychology, 23*(6), 705.
- Anderson, V., Catroppa, C., Morse, S., Haritou, F., & Rosenfeld, J. (2005). Attentional and processing skills following traumatic brain injury in early childhood. *Brain Injury, 19*(9), 699-710.
- Anderson, V., Brown, S., Newitt, H., & Hoile, H. (2011). Long-term outcome from childhood traumatic brain injury: Intellectual ability, personality, and quality of life. *Neuropsychology, 25*(2), 176-184.
- Anderson, V., Godfrey, C., Rosenfeld, J. V., & Catroppa, C. (2012). Predictors of cognitive function and recovery 10 years after traumatic brain injury in young children. *Pediatrics, 129*(2), 252-261.
- Annegers, J. F., Grabow, J. D., Kurland, J. T., & Laws, E. R. (1980). The incidence, causes and secular trends in head injury in Olmsted County, Minnesota, 1965-1974. *Neurology, 30*, 912-919.
- Asarnow, R. F., Satz, P., Light, R., & Neumann, E. (1991). Behavior problems and adaptive functioning in children with mild and severe closed head injury. *Journal of Pediatric Psychology, 16*, 543-555.
- Asarnow, R. F., Satz, P., Light, R., Zaucha, K., Lewis, R., & McCleary, C. (1995). The UCLA study of mild closed head injury in children and adolescents. In S. H. Broman

& M. E. Michel (Eds.), *Traumatic Head Injury in Children* (pp. 117-146). New York, NY: Oxford University Press.

Babikian, T., & Asarnow, R. (2009). Neurocognitive outcomes and recover after pediatric TBI: Meta-analytic review of the literature. *Neuropsychology, 23*, 283-296.

Babikian, T., Satz, P., Zaucha, K., Light, R., Lewis, R. S., & Asarnow, R. F. (2011). The UCLA longitudinal study of neurocognitive outcomes following mild pediatric traumatic brain injury. *Journal of the International Neuropsychological Society, 17*, 886-895.

Baddeley, A. (1992). Working memory. *Science, 255*, 556-559.

Barker-Collo, S. (2007). Behavioural profiles and injury severity following childhood traumatic brain injury. *Brain Impairment, 8*(1), 22-30.

Barker-Collo, S., Wilde, N. J., & Feigin, V. L. (2009). Trends in head injury incidence in New Zealand: A hospital-based study from 1997/1998 to 2003/2004. *Neuroepidemiology, 32*(1), 32-39.

Barlow, K. M., Crawford, S., Stevenson, A., Sandhu, S. S., Belanger, F., & Dewey, D. (2010). Epidemiology of postconcussion syndrome in pediatric mTBI. *Pediatrics, 126*, 174-181.

Barkley, R. (1997). Behavioral inhibition disorder and attention deficit hyperactivity disorder. *Psychology Bulletin, 121*, 65-94.

Barry, C.T., Taylor, H. G., Klein, S., Yeates, K. O. (1996). The validity of neurobehavioral symptoms reported in children after TBI. *Child Neuropsychology, 2*, 213-226.

- Barnfield, T. V., & Leathem, J. M. (1998). Incidence and outcomes of traumatic brain injury and substance abuse in a New Zealand prison population. *Brain Injury, 12*(6), 455-466.
- Bener, A., Omar, A. O., Ahmad, A. E., Al-Mulla, F. H., & Abdul Rahman, Y. S. (2010). The pattern of traumatic brain injuries: A country undergoing rapid development. *Brain Injury, 24*(2), 74-80.
- Bernstein, J., & Waber, D. (1990). Developmental neuropsychological assessment: The systemic approach. In A. Boulton, G. Baker and M. Hiscock (Eds.). *Neuromethods: Neuropsychology*, pp. 311-371. Clifton, NJ: Humana Press.
- Bickerstaff, L. (2010). *Frequently asked questions about concussion*. New York, NY: The Rosen Publishing Group.
- Bierman, K. L. (2004). *Peer rejection: Developmental processes and intervention strategies. The Guilford series on social and emotional development*. New York, NY: Guilford Press.
- Bigler, E. D. (2008). Neuropsychology and clinical neuroscience of persistent post-concussive syndrome. *Journal of the International Neuropsychological Society, 14*, 1-22.
- Bijur, P., Golding, J., Haslum, M., & Kurzon, M. (1988). Behavioral predictors of injury in school-age children. *The American Journal of Diseases of Children, 142*(12), 1302-1312.
- Black, P., Blumer, D., Wellner, A. M., Shepard, R. H., & Walker, A. E. (1981). Head trauma in children: Neurological, behavioral, and intellectual sequelae. In P. Black (Ed.), *Brain dysfunction in children: Etiology, diagnosis, and management* (pp. 171-190). New York, NY: Raven Press.

- Bloom, D. R., Levin, H. S., Ewing-Cobbs, L., Saunders, A. E., Song, J., Fletcher, J. M. (2001). Lifetime and novel psychiatric disorders after pediatric traumatic brain injury. *Journal of the American Academy of Child and Adolescent Psychiatry, 40*, 572-579.
- Borko, H. (2009). Professional development and teacher learning: Mapping the terrain. *Educational Researcher, 33*(3), 2-15.
- Bradley, R. H., & Corwyn, R. F. (2002). Socioeconomic status and child development. *Annual Review of Psychology, 53*, 371-399.
- Brady, D., & Brady, F. (2013). *Sport-related concussions: Myths and facts*. Retrieved from [http://concussiontreatment.com/images/Brady\\_and\\_Brady\\_2011\\_Concussions\\_Myths\\_and\\_Facts.pdf](http://concussiontreatment.com/images/Brady_and_Brady_2011_Concussions_Myths_and_Facts.pdf)
- Brain Injury Association of New Zealand (2013). *Concussion in Children*. Auckland, NZ: Author
- Brown, G., Chadwick, O., Shaffer, D., Rutter, M., & Traub, M. (1981). A prospective study of children with head injuries: III. Psychiatric sequelae. *Psychological Medicine, 11*, 63-78.
- Brown, A. W., Leibson, C. L., Malec, J. F., Perkins, P. K., Diehl, N. N., & Larson, D. R. (2004). Long-term survival after traumatic brain injury: A population-based analysis. *Neurorehabilitation 19*, 37-43.
- Bruns, J., & Hauser, W. A. (2003). The epidemiology of traumatic brain injury: A review. *Epilepsia, 44*(10), 2-10.
- Butnik, S. M. (2012). *Working memory and processing speed in the classroom*. Retrieved from: <http://www.educationviews.org/working-memory-processing-speed-in-the-classroom/>



- Carroll, L. J., Cassidy, J. D., Holm, L., Kraus, J., & Coronado, V. G. (2004). Methodological issues and research recommendations for mTBI: the WHO Collaborating centre Task Force on MTBI. *Journal of Rehabilitation Medicine, 43*, 113-125.
- Carroll, L. J., Cassidy, J. D., Peloso, P. M., Borg, J., Von Holst, H., & Holm, L. (2004). Prognosis for mTBI: Results of the WHO Collaborating Centre Task Force on MTBI. *Journal of Rehabilitation Medicine, 43*, 84-105.
- Catroppa, C., & Anderson, V. (1999). Recovery of educational skills following paediatric traumatic brain injury. *Pediatric Rehabilitation, 3*(4), 167-175.
- Catroppa, C., & Anderson, V. (2003). Recovery and predictors of intellectual ability two years following paediatric traumatic brain injury. *Neuropsychological Rehabilitation, 13*, 517-536.
- Catroppa, C., & Anderson, V. (2004). Recovery and predictors of language skills two years following pediatric traumatic brain injury. *Brain and Language, 88*(1), 68-78.
- Catroppa, C., Anderson, V. A., Morse, S. W., Haritou, F., Rosenfeld, J. V. (2007). Children's attentional skills 5 years post-TBI. *Journal of Pediatric Psychology, 32*(3), 354-369.
- Centers for Disease Control and Prevention (2013). *Injury prevention and control: Traumatic brain injury*. Retrieved from <http://www.cdc.gov/concussion/sports/index.html>
- Centers for Disease Control and Prevention (2013). *Attention-deficit / hyperactivity disorder*. Retrieved from <http://www.cdc.gov/ncbddd/adhd/data.html>
- Cicerone, K. D. (2002). Remediation of 'working attention' in mTBI. *Brain Injury, 16*(3), 185-195.

- Cizek, G. J., & Sandoval, J. (2003). Woodcock-Johnson ® III. In B. S. Plake, J. C. Impara, & R. A. Spies (Eds.), *Mental Measurements Yearbook* (15<sup>th</sup> ed). Lincoln, Nebraska: Buros Institute of Mental Measurements.
- Connolly, A., & Vance, A. (2010). Psychosocial factors associated with parent and teacher reports of aggression in children and adolescents with attention deficit / hyperactivity disorder. *Australian and New Zealand Journal of Psychiatry*, 44(7), 667-675.
- Cummings, D. D., Singer, H. S., Krieger, M., Miller, T. L., & Mahone, E. M. (2002). Neuropsychiatric effects of guanfacine in children with mild Tourette syndrome: A pilot study. *Clinical Neuropsychology*, 25, 325-332.
- Dise-Lewis, J. E. (2013). *Weaving a safety net after concussion*. Retrieved from: <http://www.brainline.org/content/2012/05/school-based-plan-for-student-support.html>
- Donders, J., & Janke, K. (2008). Criterion validity of the Wechsler Intelligence Scale for Children-Fourth Edition after pediatric traumatic brain injury. *Journal of the International Neuropsychological Society*, 14, 651-655.
- Ewing-Cobbs, L., Barnes, M., Fletcher, J. M., Levin, H. S., Swank, P. R., & Song, J. (2004). Modeling of Longitudinal Academic Achievement Scores After Pediatric Traumatic Brain Injury. *Developmental Neuropsychology*, 25(1/2), 107-133.
- Ewing-Cobbs, L., Fletcher, J. M., Levin, H. S., Iovino, I., & Miner, M. E. (1998). Academic achievement and academic placement following traumatic brain injury in children and adolescents: A two-year longitudinal study. *Journal of Clinical & Experimental Neuropsychology*, 20(6), 769-781.

- Farmer, J. E., Haut, J. S., Williams, J., Kapila, C., Johnstone, B., Kirk, K. S. (1999). Comprehensive assessment of memory functioning following traumatic brain injury in children. *Developmental Neuropsychology*, 15(2), 269-289.
- Fay, G. C., Jaffer, K. M., Polissar, N. L., Liao, S., Rivara, J. B., & Martin, K. M. (1994). Outcome of pediatric traumatic brain injury at three years: A cohort study. *Archives of Physical Medical Rehabilitation*, 75, 733-741.
- Feigin, V. L., Barker-Collo, S., Krishnamurthi, R., Theadom, A., & Starkey, N. (2010). Epidemiology of ischaemic stroke and traumatic brain injury. *Best Practice and Research Clinical Anaesthesiology*, 24, 485-494.
- Feigin, V. L., Theadom, A., Barker-Collo, S., Starkey, N. J., Kahan, M., Dowell, A., Brown, P., Parag, V., Kydd, R., Jones, K., Jones, A., & Shanthi, A. (2013). Incidence of traumatic brain injury in New Zealand: A population-based study. *Lancet Neurology*, 12, 53-64.
- Field, A. (2013). *Discovering statistics using IBM SPSS Statistics*. London, U.K: Sage.
- Fitzpatrick, C. (2003). Review of the Behavior Rating Inventory of Executive Function. In B. S. Plake, J. C. Impara, & R. A. Spies (Eds.), *Mental Measurements Yearbook* (15<sup>th</sup> ed). Lincoln, Nebraska: Buros Institute of Mental Measurements.
- Fixsen, D. L., Naoom, S. F., Blase, K. A., Friedman, R. M., & Wallace, F. (2005). *Implementation research: A synthesis of the literature*. Tampa, FL: University of South Florida.
- Flay, B., Berkowitz, M. W., & Bier, M. C. (2009). Elementary school-based programs theorized to support social development, prevent violence, and promote positive school climate: Description and hypothesized mechanisms of change. *Journal of Research in Character Education*, 7(2), 21-49.

- Frencham, K. A., Fox, A. M., & Mayberry, M. T. (2005). Neuropsychological studies of mTBI: A meta-analytic review of research since 1995. *Journal of Clinical and Experimental Neuropsychology, 27*, 334-351.
- Friedman, N. P., Miyake, A., Young, S. E., DeFries, J. C., Corley, R. P., Hewitt, J. K. (2008). Individual differences in executive functions are almost entirely genetic in origin. *Journal of Experimental Psychology: General, 137*(2), 201-225.
- Gagnon, I., Swaine, B., Friedman, D., & Forget, R. (2005). Exploring children's self-efficacy related to physical activity performance after mTBI. *Journal of Athletic Training, 46*, 76-84.
- Gerrard-Morris, A., Taylor, H. G., Yeates, K. O., Chertkoff Walz, N., Stancin, T., Minich, N., & Wade, S. L. (2010). Cognitive development after traumatic brain injury in young children. *Journal of the International Neuropsychological Society, 16*, 157-168.
- Gersten, R., Vaughn, S., Deshler, D., & Schiller, E. (1997). What we know about using research findings: Implications for improving special education practice. *Journal of Learning Disabilities, 30*, 466– 476.
- Gilotty, L., Kenworthy, L., Sirian, L., Black, D. O., & Wagner, A. E. (2002). Adaptive skills and executive function in autism spectrum disorders. *Child Neuropsychology, 8*, 241-248.
- Gioia, G. A., Isquith, P. K., Guy, S. C., & Kenworthy, L. (2000). BRIEF *Behavior rating inventory of executive function: Professional manual*. Lutz, FL: Psychological Assessment Resources (PAR) Inc.
- Gioia, G. A., Schneider, J. C., Isquith, P., & Vincent, D. (2008). Psychometric properties of the parent and teacher Post-Concussion Symptom Inventory (PCSI) for children and

- adolescents. *Journal of the International Neuropsychological Society*, 14(Suppl. 1), 204.
- Gioia, G. A., Schneider, J. C., Vaughan, C. G., & Isquith, P.K. (2009). Which symptom assessments and approaches are uniquely appropriate for paediatric concussion? *British Journal of Sports Medicine*, 43,(S1), i13-i22.
- Giza, C. C., & Hovda, D. A. (2001). The neurometabolic cascade of concussion. *Journal of Athletic Training*, 36, 228-235.
- Glang, A., Todis, B., Thomas, C. W., Hood, D., Bedell, G., Cockrell, J. (2008). Return to school following childhood TBI: Who gets services? *Neurorehabilitation*, 23(6), 477-486.
- Goodman, R. (1997). The Strengths and Difficulties Questionnaire: A Research Note. *Journal of Child Psychology and Psychiatry*, 38, 581-586.
- Goodman, R. (2001). Psychometric properties of the strengths and difficulties questionnaire. *Journal of the American Academy of Child and Adolescent Psychiatry*, 40(11), 1337-1345.
- Goodman, R., & Strong, S. (1999). Comparing the Strengths and Difficulties Questionnaire and the Child Behavior Checklist: Is small beautiful? *Journal of Abnormal Child Psychology*, 27(1), 17-24.
- Grietens, H., Onghena, P., Prinzie, P., Gadeyne, E., Van Assche, V., Ghesquiere, P., & Hellinckx, W. (2004). Comparisons of mothers', fathers', and teachers' reports on problem behavior in 5- to 6-year-old children. *Journal of Psychopathology and Behavioral Assessment*, 26(2), 137-146.
- Gronwall, D., Wrightson, P., & McGinn, V. (1997). Effect of mild head injury during the preschool years. *Journal of the International Neuropsychological Society*, 3, 592-597.

- Gualteri, C. T., & Johnson, L. G., & Benedict, K. B. (2004). Psychometric and clinical properties of a new computerized neurocognitive screening battery. Paper presented at the meeting of the American Neuropsychiatric Association Annual Meeting, Bal Harbor, Florida, U.S. Retrieved from <http://www.ncneuropsych.com/fullpublications.html>
- Gualteri, C. T., & Johnson, L. G. (2006). Reliability and validity of a computerized neurocognitive test battery, CNS Vital Signs. *Archives of Clinical Neuropsychology*, *21*, 623-643.
- Guskey, T. R. (2000). *Evaluating professional development*. Thousand Oaks, CA: Sage Publications.
- Guy, S. C., Isquith, P. K., & Gioia, G. A. (2004). *Behavior Rating Inventory of Executive Function-Self-Report Version: Professional Manual*. Lutz: PAR.
- Hajek, C. A., Yeates, K. O., Taylor, H. G., Bangert, B., Dietrich, A., Nuss, K. E., Rusin, J., & Wright, M. (2011). Agreement between parents and children on ratings of post-concussive symptoms following mTBI. *Child Neuropsychology*, *17*, 17-33.
- Hall, R. C. W., Hall, R. C. W., & Chapman, M. J. (2005). Definition, Diagnosis, and Forensic Implications of Postconcussional Syndrome. *Psychosomatics*, *46*(3), 195-202. doi: 10.1176/appi.psy.46.3.195
- Hanes, K. R. (2005). CNS Vital Signs Screening Battery. In R. A. Spies & B. S. Plake (Eds.), *The sixteenth mental measurements yearbook*. Lincoln, NE: Buros Institute of Mental Measurements. Retrieved from Mental Measurements Yearbook with Tests in Print database.
- Hannan, T (2005). Assessing children: Hits and myths. *Australian Psychological Society*. Retrieved from [http://www.psychology.org.au/publications/inpsych/assess\\_children/](http://www.psychology.org.au/publications/inpsych/assess_children/)

- Hanne, T. (2010). New Zealand general practice should adopt population-based screening for attention deficit hyperactivity disorder (ADHD). *Journal of Primary Health Care*, 2(2), 155-159.
- Hanson, W. E., Creswell, J. W., Plano Clark, V. L., PETSka, K. S., & Creswell, J. D. (2005). Mixed methods design in counseling psychology. *Journal of Counseling Psychology*, 52(2), 224-235.
- Hawes, D. J., & Dadds, M. R. (2004). Australian data and psychometric properties of the Strengths and Difficulties Questionnaire. *Australian and New Zealand Journal of Psychiatry*, 38, 644-651.
- Hawley, C. A. (2003). Reported problems and their resolution following mild, moderate and severe traumatic brain injury amongst children and adolescents in the U.K. *Brain Injury*, 17(2), 105-129.
- Hawley, C. A. (2004). Behaviour and school performance after brain injury. *Brain Injury*, 18(7), 645-659.
- Hawley, C. A., Ward, A. B., Magnay, A. R., & Long, J. (2004). Outcomes following childhood head injury: a population study. *Journal of Neurology, Neurosurgery and Psychiatry*, 75, 737-742. doi: :10.1136/jnnp.2003.020651
- Hawley, C. A., Ward, A. B., Magnay, A. R., & Mychalkiw, W. (2004). Return to school after brain injury. *Archives of Disease in Childhood*, 89(2), 136(137).
- Hessen, E., Nestvold, K., & Sundet, K. (2006). Neuropsychological function in a group of patients 25 years after sustaining minor head injuries as children and adolescents.
- Hessen, E., Nestvold, K., & Anderson, V. (2007). Neuropsychological function 23 years after mTBI: A comparison of outcome after paediatric and adult head injuries. *Brain Injury*, 21, 963-979.

- Holder, Y., Peden, M., Krug, E., Lund, J., Gururaj, G., Kobussingye, O. (2001). *Injury surveillance guidelines*. Geneva: World Health Organization.
- Hood, K. (2009). *Social competence at age 4 years of children born very pre-term*. Unpublished doctoral dissertation, University of Canterbury, Christchurch, New Zealand.
- Hoofien, D., Vakil, E., Gilboa, A., Donovan, P. J., & Barak, O. (2002). Comparison of the predictive power of socio-economic variables, severity of injury and age on long-term outcome of traumatic brain injury: sample-specific variables versus factors as predictors. *Brain Injury, 16*(1), 9-27.
- Hsiang, J. N., Yeung, T., Yu, A. L., & Poon, W. S. (1997). High-risk mild head injury. *Journal of Neurosurgery, 87*(2), 234-238.
- Human Rights Act No. 82. (1993). Retrieved from:  
<http://www.legislation.govt.nz/act/public/1993/0082/latest/whole.html>
- Iizuka, C., Yamashita, Y., Nagamitsu, S., Yamashita, T., Araki, Y., Ohya, T., Hara, M., Shibuya, I., Kakuma, T., Matsuishi, T. (2010). Comparison of the strengths and difficulties (SDQ) scores between children with high-functioning autism spectrum disorder (HFASD) and attention-deficit / hyperactivity disorder (AD/HD). *Brain and Development, 32*, 609-612.
- Infante-Rivard, C., & Jacques, L. (1999). Empirical study of parental recall bias. *American Journal of Epidemiology, 152*(5), 480-486.
- Jagoda, A., & Riggio, S. (2000). MTBI and the postconcussive syndrome. *Emergency Medicine Clinics of North America, 18*(2), 355-363. doi: 10.1016/s0733-8627(05)70130-9



- Janusz, J. A., Sady, M. D., & Gioia, G. A. (2012). Postconcussion symptom assessment. In M. W. Kirkwood & K. O. Yeates (Eds.), *MTBI in children and adolescents: From basic science to clinical management* (pp. 241-263). New York, NY: The Guildford Press.
- Keenan, H. T., & Bratton, S. L. (2006). Epidemiology and Outcomes of Pediatric Traumatic Brain Injury. *Developmental Neuroscience*, 28(4-5), 256-263.
- Keenan, K., & Wakschlag, L. S. (2000). More than the terrible twos: The nature and severity of behavior problems in clinic-referred preschool children. *Journal of Abnormal Child Psychology*, 28(1), 33-46.
- Kerig, P. K., & Wenar, C. (2012). *Developmental psychopathology: From infancy through adolescence*. New York, NY: McGraw-Hill.
- King, N. S., Crawford, S., Wenden, F. J., Moss, N. E., & Wade, D. T. (1995). The Rivermead Post Concussion Symptoms Questionnaire: A measure of symptoms commonly experienced after head injury and its reliability. *Journal of Neurology*, 242, 587-592.
- Kinsella, G., Prior, M., Sawyer, M., Ong, B., Murtagh, D., Eisenmajer, R., Klug, G. (1997). Predictors and indicators of academic outcome in children 2 years following traumatic brain injury. *Journal of the International Neuropsychological Society*, 3(6), 608-616.
- Kinsella, G., Ong, B., Murtagh, D., Prior, M., & Sawyer, M. (1999). The role of the family for behavioral outcome in children and adolescents following traumatic brain injury. *Journal of Consulting and Clinical Psychology*, 67, 116-123.
- Kirkwood, M. W., Yeates, K. O., & Wilson, P. E. (2006). Pediatric sport-related concussion: A review of the clinical management of an oft-neglected population. *Pediatrics*, 117, 1359-1371.

- Kirkwood, M. W., Yeates, K. O., Taylor, H. G., Randolph, C., McCrea, M., & Anderson, V. A. (2008). Management of pediatric mTBI: A neuropsychological review from injury through recovery. *The Clinical Neuropsychologist*, *22*(5), 769-800.
- Kirkwood, M. W., & Yeates, K. O. (2010). Neurobehavioral outcomes of pediatric mTBI. In V. Anderson & K. O. Yeates (Eds.), *Pediatric Traumatic Brain Injury* (pp. 94-117). New York, NY: Cambridge University Press.
- Klingner, J. K., Vaughn, S., Hughes, M. T., & Arguelles, M. E. (1999). Sustaining research-based practices in reading: A 3-year follow-up. *Remedial and Special Education*, *20*, 263-274.
- Klingner, J. K. (2004). The science of professional development. *Journal of Learning Disabilities*, *37*(3), 248-255.
- Kraus, J. F., & Chu, L. D. (2005). Epidemiology. In J. M. Silver, T. W. McAllister & S. C. Yudofsky (Eds.), *Textbook of traumatic brain injury*. (pp. 3-26). Arlington, VA: American Psychiatric Publishing, Inc.
- Kreutzer, J. S., Doherty, K. R., Harris, J. A., & Zasler, N. (1990). Alcohol use among persons with traumatic brain injury. *Journal of Head Trauma Rehabilitation*, *5*, 9-20.
- Kuczynski, A., Crawford, S., Bodell, L., Dewey, D., Barlow, K. M. (2013). Characteristics of post-traumatic headaches in children following mTBI and their response to treatment: A prospective cohort. *Developmental Medicine and Child Neurology*, *55*, 636-641.
- Kumar, S., Rao, S. L., Chandramouli, B. A., & Pillai, S. (2013). Reduced Contribution of Executive Functions in impaired Working Memory Performance in MTBI Patients. *Clinical Neurology and Neurosurgery*. doi: 10.1016/j.clineuro.2012.12.038.

- Laushey, K. M., & Heflin, L. J. (2000). Enhancing social skills of kindergarten children with autism through the training of multiple peers as tutors. *Journal of Autism and Developmental Disorders, 30*(3), 183-193.
- Leibson, C. L., Brown, A. W., Ransom, J. E., Diehl, N. N., Perkins, P. K., Mandrekar, J., & Malec, J. F. (2011). Incidence of traumatic brain injury across the full disease spectrum: A population-based medical record review study. *Epidemiology, 22*(6), 836-844.
- Levin, H. S., & Eisenberg, H. M. (1979). Neuropsychological outcome of closed head injury in children and adolescents. *Child's Brain, 5*, 281-292.
- Levin, H. S., Hanten, G., Roberson, G., Li, X., Ewing-Cobbs, L., Dennis, M., Chapman, S., Max, J. E., Hunter, J., Schachar, R., Luerssen, T. G., Swank, P. (2008). Prediction of cognitive sequelae based on abnormal computed tomography findings in children following mTBI. *Journal of Neurosurgery: Pediatrics, 1*, 461-470.
- Lezak, M. D., Howieson, D. B., & Loring, D. W. (2004). *Neuropsychological Assessment*. (4th ed.). New York: Oxford University Press.
- Light, R., Asarnow, R., Satz, P., Zaucha, K., McCleary, C., & Lewis, R. (1998). Mild closed-head injury in children and adolescents: Behavior problems and academic outcomes. *Journal of Consulting and Clinical Psychology, 66*(6), 1023-1029.
- Lock, K. J., & Gibson, J. K. (2008). Explaining Maori under-achievement in standardised reading tests: The role of social and individual characteristics. *Kotuitui: New Zealand Journal of Social Sciences Online, 3*, 1-13.
- Loher, S., Fatzer, S. T., & Roebbers, C. M. (2012). Executive functions after pediatric mild traumatic brain injury: A prospective short-term longitudinal study. *Applied Neuropsychology: Child, 0*, 1-12. doi: 10.1037/1072-5245.15.2.117

- Lord, B. (1994). Teachers' professional development: Critical collegueship and the role of professional communities. In N. Cobb (Ed.), *The future of education: Perspectives on national standards in education* (pp. 175-204). New York: College Entrance Examination Board.
- Luis, C. A., & Mittenberg, W. (2002). Mood and anxiety disorders following pediatric traumatic brain injury: A prospective study. *Journal of Clinical and Experimental Neuropsychology*, 24, 3, 270-279.
- McAllister, T. W. (2005). Mild brain injury and the postconcussion syndrome. In J. M. Silver, T. W. McAllister & S. C. Yudofsky (Eds.), *Textbook of Traumatic Brain Injury* (pp. 279-308). Arlington, VA: American Psychiatric Publishing, Inc.
- McCrory, P., Meeuwisse, W., Johnston, K., Dvorak, J., Aubry, M., Molloy, M., & Cantu, R. (2009). Consensus Statement on Concussion in Sport – the 3<sup>rd</sup> International Conference on Concussion in Sport held in Zurich, November 2008. *South African Journal of Sports Medicine*, 21(2), 36-46.
- McKinlay, A., Dalrymple-Alford, J. C., Horwood, L. J., & Fergusson, D. M. (2002). Long term psychosocial outcomes after mild head injury in early childhood. *Journal of Neurology, Neurosurgery and Psychiatry*, 73, 281-288.
- McKinlay, A., Grace, R. C., Horwood, L. J., Fergusson, D. M., Ridder, E. M., & MacFarlane, M. R. (2008). Prevalence of traumatic brain injury among children, adolescents and young adults: Prospective evidence from a birth cohort. *Brain Injury*, 22(2), 175-181.
- McKinlay, A. (2009). Controversies and outcomes associated with mTBI in childhood and adolescence. *Child: Care, Health and Development*, 36, 3-21.

- Mahone, E. M., Cirino, P. T., Cutting, L. E., Cerrone, P. M., Hagelthorn, K. M., Hiemenz, J. R., Singer, H. S., & Denckla, M. B. (2002). Validity of the Behavior Rating Inventory of Executive Function in children with ADHD and / or Tourette syndrome. *Archives of Clinical Neuropsychology, 17*, 643-662.
- Mailer, B. J., Valovich-McLeod, T. C., & Bay, R. C. (2008). Healthy youth are reliable in reporting symptoms on a graded symptom scale. *Journal of Sports Rehabilitation, 17*, 11-20.
- Maillard-Wermelinger, A., Yeates, K. O., Taylor, H. G., Rusin, J., Bangert, B., Dietrich, A., Nuss, K., & Wright, M. (2009). MTBI and executive function in school-aged children. *Developmental Rehabilitation, 12*(5), 330-341.
- Malojic, B., Mubrin, Z., Coric, B., Susnic, M., & Spilich, G. J. (2008). Consequences of mTBI on information processing assessed with attention and short-term memory tasks. *Journal of Neurotrauma, 25*, 30-37.
- Mangeot, S., Armstrong, K., Colvin, A. N., Yeates, K. O., & Taylor, H. G. (2002). Long-term executive function deficits in children with traumatic brain injuries: Assessment using the Behavior Rating Inventory of Executive Function (BRIEF). *Child Neuropsychology, 8*, 271-284.
- Margulies, S. (2000). The postconcussion syndrome after mild head trauma: is brain damage overdiagnosed? *Journal of Clinical Neuroscience, 7*(5), 400-408. doi: 10.1054/jocn.1999.0681
- Mark, E. M. (2011). *The influence of premorbid attention and behavior problems on neurobehavioral outcomes from pediatric mTBI* (Doctoral thesis, Ohio University, Ohio, United States). Retrieved from [etd.ohiolink.edu/view.cgi?acc\\_num=ohiou1308314375](http://etd.ohiolink.edu/view.cgi?acc_num=ohiou1308314375)

- Max, J. E., Robin, D. A. (1997). Traumatic brain injury in children and adolescents: Psychiatric disorders at two years. *Journal of the American Academy of Child & Adolescent Psychiatry, 36*(9), 1278-1286.
- Max, J. E., Lansing, A. E., Koele, S. L., Castillo, C. S., Bokura, H., & Schachar, R. (2004). Attention deficit hyperactivity disorder in children and adolescents following traumatic brain injury. *Developmental Neuropsychology, 25*(1&2), 159-177.
- Miller, G. A., & Chapman, J. P. (2001). Misunderstanding analysis of covariance. *Journal of Abnormal Psychology, 110*(1), 40-48.
- Ministry of Education (2011). *National Standards*. Retrieved from:  
<http://www.minedu.govt.nz/theMinistry/EducationInitiatives/NationalStandards.aspx>
- Ministry of Education (2013). *School decile ratings*. Retrieved from:  
<http://www.minedu.govt.nz/Parents/AllAges/EducationInNZ/SchoolsInNewZealand/SchoolDecileRatings.aspx>
- Ministry of Health (2013). *Head Injury*. Retrieved from <http://www.health.govt.nz/your-health/conditions-and-treatments/accidents-and-injuries/head-injury>
- Mittenberg, W., & Strauman, S. (2000). Diagnosis of mild head injury and the postconcussion syndrome. *Journal of Head Trauma Rehabilitation, 15*(2), 783-791.
- Mittenburg, W., Wittner, M. S., Miller, L. J. (1997). Postconcussion syndrome occurs in children. *Neuropsychology, 11*, 447-452.
- Molnar, S. B. (2010). *Teachers' understanding of traumatic brain injury*. Unpublished master's thesis, Ohio University, Athens, OH, United States of America.
- Moore, E. L., Terryberry-Spohr, L., & Hope, D. A. (2006). Mild traumatic brain injury and anxiety sequelae: A review of the literature. *Brain Injury, 20*(2), 117-132.

- Morray, J. P., Tyler, D. D., Jones, T.K., Stuntz, J. T., Lemire, R. J. (1984). Coma scale for use in brain-injured children. *Critical Care Medicine*, 12(12), 1018-1020.
- Muscara, F., Catroppa, C., & Anderson, V. (2008). The impact of injury severity on executive function 7-10 years following pediatric traumatic brain injury. *Developmental Neuropsychology*, 33(5), 623-636.
- Nadebaum, C., Anderson, V., & Catroppa, C. (2007). Executive function outcomes following traumatic brain injury in young children: A five year follow-up. *Developmental Neuropsychology. Special Issue: Neuro-Cognitive Consequences of White Matter Injury in Childhood*, 32, 703-728.
- National Center for Injury Prevention and Control. (2011). WISQAR, from <http://www.cdc.gov/injury/wisqars/index.html>
- New, M., Razzion, B., Lewin, A., Schlumpf, K., & Joseph, J. (2002). Mental health service use in a community Head Start population. *Archives of Pediatrics and Adolescent Medicine*, 156(7), 721-727.
- New Zealand Guidelines Group. (2006). *Traumatic brain injury: Diagnosis, acute management and rehabilitation*. Wellington: New Zealand Guidelines Group.
- New Zealand Neurological Foundation (2013). *Mild Head Injury: A Patient's Guide*. <http://www.familydoctor.co.nz/index.asp?U=conditions&A=8040>
- Ogden, J. A., & McFarlane-Nathan, G. (1997). Cultural bias in the neuropsychological assessment of young Maori men. *New Zealand Journal of Psychology*, 26(2), 2-12.
- Olsson, K. A., Lloyd, O. T., Lebrocque, R. M., McKinlay, L., Anderson, V. A., Kenardy, J. A. (2013). Predictors of child post-concussion symptoms at 6 and 18 months following mTBI. *Brain Injury*, 27(2), 145-157.
- Ornstein, T. J., Max, J. E., Schachar, R., Dennis, M., Barnes, M., Ewing-Cobbs, L., & Levin,

- H. S. (2013). Response inhibition in children with and without ADHD after traumatic brain injury. *Journal of Neuropsychology, 7*, 1-11.
- O'Shanick, G. J., & O'Shanick, A. M. (2005). Personality Disorders. In J. M. Silver, T. W. McAllister & S. C. Yudofsky (Eds.), *Textbook of traumatic brain injury* (pp. 245-258). Arlington, VA: American Psychiatric Publishing, Inc.
- Parsons, J. (2010). Cognitive rest: The often neglected aspect of concussion management. *Athletic Therapy Today, 15*(2), 1-3.
- Petersen, C., Sherwath, A., Fink, J., Koch, U. (2008). Health care needs of children and adolescents with a traumatic brain injury. *Bundesgesundheitsblatt, Gesundheitsforschung, Gesundheitsschutz, 51*(6), 629-636.
- Piland, S. G., Motl, R. W., Ferrara, M. S., & Peterson, C. L. (2003). Evidence for the factorial and construct validity of a self-report concussion symptoms scale. *Medicine and Science in Sports and Exercise, 38*, 104-112.
- Piland, S. G., Motl, R. W., Guskiewicz, K. M., McCrea, M., & Ferrara, M. S. (2006). Structural validity of a self-report concussion-related symptom scale. *Medicine and Science in Sports and Exercise, 38*, 27-32.
- Pless, I. B., Taylor, H. G., & Arsenault, L. (1995). The relationship between vigilance deficits and traffic injuries involving children. *Pediatrics, 95*, 219-224.
- Ponsford, J., Wilmott, C., Rothwell, A, Cameron, P., Ayton, G., Nelms, R., Curran, C., Ng. K. (1999). Cognitive and behavioral outcomes following mild traumatic head injury in children. *Journal of Head Trauma Rehabilitation, 14*(4), 360-372.
- Randolph, C., Millis, S., Barr, W. B., McCrea, M., Guskiewicz, K. M., Hammeke, T. A., et al. (2009). Concussion Symptoms Inventory: An empirically derived scale for



monitoring resolution of symptoms following sports-related concussioin. *Archives of Clinical Neuropsychology*, 24, 219-229.

Raskin, S., & Mateer, C. (1994). Rehabilitation of cognitive impairments. In D. Good & J. R. Couch (Eds.), *Handbook of Neurorehabilitation*. New York, NY: Marcel-Dekker.

Raskin, S. and Mateer, C. (1994) Rehabilitation of cognitive impairments. In Good (ed.): *Handbook of NeuroRehabilitation*. Marcel-Dekker: New York.

Reaveley, N., & Jorm, A. F. (2010). Prevention and early intervention to improve mental health in higher education students: A review. *Early Intervention in Psychiatry*, 4(2), 123-142.

Reger, M. L., Poulos, A. M., Buen, F., Giza, C. C., Hovda, D. A., & Fanselow, M. S. (2012). Concussive brain injury enhances fear learning and excitatory processes in the amygdala. *Biological Psychiatry*, 71, 335-343.

Reynolds, C. R., & Kamphaus, R. W. (1992). *Behavior Assessment System for Children*. Circle Pines, MN: American Guidance Service.

Rieger, B. P., Lewandowski, L. J., Callahan, J. M., Spenceley, L., Truckenmiller, A., Gathje, R., & Miller, L. A. (2013). A prospective study of symptoms and neurocognitive outcomes in youth with concussion vs orthopaedic injuries. *Brain Injury*, 27(2), 169-178.

Ries, J., Zabel, T. A., & Mahone, E. M. (2003). Parent report of adaptive abilities and executive functions in children and adolescents with myelomeningocele and hydrocephalus. *Archives of Clinical Neuropsychology*, 18, 762.

Rourke, B. P. (1985). *Neuropsychology of learning disabilities: Essentials of subtype analysis*. New York, NY: Guilford Press.

- Rutland-Brown, W., Wallace, L. J. D., Faul, M. D., & Langlois, J. A. (2005). Traumatic brain injury hospitalizations among American Indians/Alaska Natives. *Journal of Head Trauma Rehabilitation, 20*(3), 205-214.
- Sadock, B. J., & Sadock, V. A. (2003). *Synopsis of Psychiatry*. New York: Lippincott Williams & Wilkins.
- Salcido, R., & Costich, J. F. (1992). Recurrent traumatic brain injury. *Brain Injury, 6*, 293-298.
- Sattler, J. M., & Dumont, R. (2004). *Assessment of children: WISC-IV and WPPSI-III Supplement*. San Diego: Sattler.
- Sattler, J. M. (2008). *Assessment of children: Cognitive foundations (5<sup>th</sup> ed.)* San Diego, CA: Author.
- Schewath, A., Sommerfeldt, D. W., Bindt, C., Nolte, A., Boiger, A., Koch, U., & Petersen-Ewert, C. (2011). Identifying children and adolescents with cognitive dysfunction following mTBI - Preliminary findings on abbreviated neuropsychological testing. *Brain Injury, 25*(4), 401-408.
- Schraw, G. (2003). Review of the Behavior Rating Inventory of Executive Function. In B. S. Plake, J. C. Impara, & R. A. Spies (Eds.), *Mental Measurements Yearbook (15<sup>th</sup> ed.)*. Lincoln, Nebraska: Buros Institute of Mental Measurements.
- Sesma, H. W., Slomine, B. S., Ding, R., McCarthy, M. L. (2008). Executive functioning in the first year after pediatric traumatic brain injury. *Pediatrics, 121*(6), 1686-1695. doi: 10.1542/peds.2007.2461
- Shaffer, D., Bijur, P., Oliver, F. D., Chadwick, O. F., & Rutter, M. (1980). Head injury and later reading disability. *Journal of American Academy of Child Psychiatry, 19*, 592-610.

- Sharpe, S., Kool, B., Dalziel, S., & Ameratunga, S. (2011). MTBI: Improving quality of care in the paediatric emergency department setting. *Journal of Paediatrics and Child Health, 48*, 170-176.
- Siegel, L. S., & Ryan, E. B. (1989). The development of working memory in normally achieving and subtypes of learning disabled children. *Child Development, 60*, 973-980.
- Simonsen, B., Fairbanks, S., Briesch, A., Myers, D., & Sugai, G. (2008). Evidence-based practices in classroom management: Considerations for research to practice. *Education and Treatment of Children, 31*(3), 351-380.
- Stanger, C., & Lewis, M. (1993). Agreement among parents, teachers, and children on internalizing and externalizing behavior problems. *Journal of Clinical Child Psychology, 22*(1), 107-116.
- Strauss, E., Sherman, E. M. S., & Spreen, O. (2006). *A Compendium of Neuropsychological Tests: Administration, Norms and Commentary (Third ed.)*. New York, NY: Oxford University Press.
- Stein, S. (2007). Review of Behavioral Assessment System for Children, Second Edition (BASC-2). In C. R. Reynolds & R. W. Kamphaus (Eds.), *Mental Measurements Yearbook (17<sup>th</sup> ed.)*. (pp. 96-102). Lincoln, Nebraska: Buros Institute of Mental Measurements.
- Swart, G. T. (2005). The Clinician's Guide to the Behaviour Assessment System for Children. *Journal of the Canadian Academy of Child and Adolescent Psychiatry, 14*(3), 90.
- Sylva, K. (1994). School influences on children's development. *Journal of Child Psychology and Psychiatry, 35*(1), 135-170.

- Tarazi, R., Mahone, E. M., & Zabel, T. A. (2007). Self-care independence in children with neurological disorders: An interactional model of adaptive demands and executive dysfunction. *Rehabilitation Psychology, 52*, 196-205.
- Taylor, H. G., & Alden, J. (1997). Age-related differences in outcomes following childhood brain insults: An introduction and overview. *Journal of the International Neuropsychological Society, 3*, 555-567.
- Taylor, H. G., Yeates, K. O., Wade, S. L., Drotar, D., Stancin, T., & Minich, N. (2002). A prospective study of short- and long-term outcomes after traumatic brain injury in children: Behavior and achievement. *Neuropsychology, 16*(1), 15-27.
- Taylor, H. G., Dietrich, A., Nuss, K., Wright, M., Rusin, J., Bangert, B., Minich, N., & Yeates, K. O. (2010). Post-concussive symptoms in children with mTBI. *Neuropsychology, 24*(2), 148-159.
- Thaler, N. S., Belo, D. T., Randall, C., Goldstein, G., Mayfield, J., & Allen, D. N. (2010). IQ profiles are associated with differences in behavioral functioning following pediatric traumatic brain injury. *Archives of Clinical Neuropsychology, 25* (8), 781-790.
- Thaler, N. S., Mayfield, J., Reynolds, C. R., Hadland, C., & Allen, D. N. (2012). Teacher-reported behavioral disturbances in children with traumatic brain injury: An examination of the BASC-2. *Applied Neuropsychology: Child, 1*(1), 30-37.
- Theadom, A., Barker-Collo, S., Feigin, V. L., Starkey, N. J., Jones, K., Jones, A., Ameratunga, S., Barber, P. A. (2011). The spectrum captured: A methodological approach to studying incidence and outcomes of traumatic brain injury on a population level. *Neuroepidemiology, 38*, 18-29.
- Thompson, B. (2005). *Review of the Wechsler Intelligence Scale for Children-Fourth Edition*. In R. A. Spies & B. S. Plake (Eds.), *The sixteenth mental measurements yearbook*.

Lincoln, NE: Buros Institute of Mental Measurements. Retrieved from Mental Measurements Yearbook with Tests in Print database.

Thurman, D., Alverson, C., Dunn, K., Guerrero, J., & Sniezek, J. E. (1999). Traumatic brain injury in the United States: A public health perspective. *Journal of Head Trauma Rehabilitation, 14*(6), 602-615.

Tremont, G., Mittenberg, W., Miller, L. J. (1999). Acute intellectual effects of pediatric head trauma. *Child Neuropsychology, 5*(2), 104-114.

Torner, J. C., Schootman, M., Rizzo, M., & Tranel, D. (1996). *Epidemiology of closed head injury. head Injury and postconcussive syndrome*. New York: Churchill Livingstone.

Treutler, C. M., & Epkins, C. C. (2003). Are discrepancies among child, mother, and father reports on children's behavior related to parents psychological symptoms and aspects of parent-child relationships? *Journal of Abnormal Child Psychology, 31*(1), 13-27.

Vanderploeg, R. D., Curtiss, G., & Belanger, H. G. Long-term neuropsychological outcomes following mild traumatic brain injury. *Journal of the International Neuropsychological Society, 11*(3), 228-236.

Villalba-Cota, J., Trujillo-Hernandez, B., Vasquez, C., Coli-Cardenas, R., & Torres-Ornelas, P. (2004). Causes of accidents in children aged 0-14 years and risk factors related to the family environment. *Annals of Tropical Paediatrics, 24*, 53-57.

Von Holst, H. (2007). Traumatic brain injury. In V. L. Feigin & D. A. Bennett (Eds.), *Handbook of clinical neuroepidemiology*, p. 197-232.

Waber, D. P., Gerber, E. B., Turcios, V. Y., Wagner, E. R., Forbes, P. W. (2006). Executive functions and performance on high-stakes testing in children from urban schools. *Developmental Neuropsychology, 29*, 459-477.

- Wassenberg, R., Max, J. E., Lindgren, S. D., & Schatz, A. (2004). Sustained attention in children and adolescents after traumatic brain injury: Relation to severity of injury, adaptive functioning, ADHD and social background. *Brain Injury, 18*(8), 751-764.
- Waxweiler, R. J., Thurman, D., Sniezek, J. E., Sosin, D., & O'Neill, J. (1995). Monitoring the impact of traumatic brain injury. *Journal of Neurotrauma, 12*(4), 509-516.
- Wechsler, D. (1987). *Wechsler memory scale-revised manual*. San Antonio: The Psychological Corporation.
- Wechsler, D. (2004). *The Wechsler Intelligence Scale for Children - Fourth Edition*. London, U.K: Pearson Assessment.
- Widum, C. S., & Hiller-Sturmhofel, S. (2001). Alcohol abuse as a risk factor for and consequence of child abuse. *Alcohol Research Health, 25*, 52-57.
- Williams, D., & Mateer, C. A. (1992). Developmental impact of frontal lobe injury in middle childhood. *Brain and Cognition, 20*, 196-204.
- Wilde, E. A., McCauley, S. R., Hunger, J. V., Bigler, E. D., Chu, Z., Wang, Z. J., Hanten, G. R., Troyanskaya, M., Yallampalli, R., Li, X., Chia, J., & Levin, H. S. (2008). Diffusion tensor imaging of acute mTBI in adolescents. *Neurology, 70*, 948-955.
- Winqvist, S., Luukinen, H., Jokelainen, J., Lehtilahti, M., Näyhä, S., & Hillbom, M. (2008). Recurrent traumatic brain injury is predicted by the index injury occurring under the influence of alcohol. *Brain Injury, 22*(10), 780-785. doi: 10.1080/02699050802339397
- Wrightson, P., & Gronwall, D. (1998). Mild head injury in New Zealand: Incidence of injury and persisting symptoms. *New Zealand Medical Journal, 111*(1062), 99-101.

- Woodcock, R. W., McGrew, K. S., & Mather, N. (2001). *Woodcock -Johnson III Tests of Achievement*. Itasca, IL: Riverside Publishing.
- Woodcock, R. W., Shrank, F. A., McGrew, K. S., & Mather, N. (2009). *Woodcock Johnson III NU Tests of Achievement Brief Battery*. Itasca: Riverside Publishing.
- World Health Organisation. (2005). *Injuries in the WHO European region: burden, challenges and policy response. Background paper for the 55th session of Head Trauma Rehabilitation*.
- World Health Organisation (2006). *Neurological disorders: Public health challenges*. Geneva, Switzerland: WHO Press.
- Wozniak, J. R., Krach, L., Ward, E., Mueller, B. A., Muetzel, R., Schnoebelen, S., Kiragu, A., & Lim, K. O. (2007). Neurocognitive and neuroimaging correlates of pediatric traumatic brain injury: A diffusion tensor imaging (DTI) study. *Archives of Clinical Neuropsychology*, 22(5), 555-568.
- Yeates, K. O., Swift, E., Taylor, H. G., Wade, S. L., Drotar, D., Stancin, T. (2004). Short-and long-term social outcomes following pediatric traumatic brain injury. *Journal of the International Neuropsychological Society*, 10, 412-426.
- Yeates, K. O., & Taylor, H. G. (2005). Neurobehavioural outcomes of mild head injury in children and adolescents. . *Pediatric Rehabilitation*, 8, 5-16.
- Yeates, K. O. , Taylor, H. G., Rusin, J., Bangert, B., Dietrich, A., Nuss, K., Wright, M., Nagin, D. S., Jones, B. L. (2009). Longitudinal trajectories of postconcussive symptoms in children with mild traumatic brain injuries and their relationship to acute clinical status. *Pediatrics*, 123(3), 735-743.
- Yeates, K. O. (2010). MTBI and postconcussive symptoms in children and adolescents. *Journal of the International Neuropsychological Society*, 16(6), 953-960.

- Yeates, K. O., & Taylor, H. G. (2012). Neurobehavioral Outcomes. In M. W. Kirkwood & K. O. Yeates (Eds.), *MTBI in children and adolescents: From basic science to clinical management* (pp. 124-141). New York, NY: The Guildford Press.
- Yeates, K. O., Taylor, H. G., Rusin, J. Bangert, B., Dietrich, A., Nuss, K., & Wright, M. (2012). Premorbid child and family functioning as predictors of post-concussive symptoms in children with mild traumatic brain injuries. *International Journal of Developmental Neuroscience*, *30*, 231-237.
- Yeates, K. O., Gerhardt, C. A., Bigler, E. D., Abildskov, T., Dennis, M., Rubin, K. H., Stancin, T., Taylor, H. G., & Vannatta, K. (2013). Peer relationships of children with traumatic brain injury. *Journal of the International Neuropsychological Society*, *19*, 518-527.
- Youngstrom, E., Loeber, R., & Stouthamer-Loeber, M. (2000). Patterns and correlates of agreement between parent, teacher, and male adolescent ratings of externalising and internalising problems. *Journal of Consulting and Clinical Psychology*, *68*(6), 1038-1050.
- Yvisaker, M., & Feeney, T. (1998). School re-entry after traumatic brain injury. In M. Yvislaker (Ed.), *Traumatic Brain Injury Rehabilitation: Children and Adolescents* (2<sup>nd</sup> edition), pp. 369-384, Boston : Butterworth-Heinemann.



## Appendix A

### Introductory Letter to Parents / Guardians

Dear Parent/Guardian

Thank you for agreeing to be contacted regarding possible participation in follow-up studies attached to the BIONIC Traumatic Brain Injury study. Your ongoing contribution to this research is appreciated.

We are now conducting some longer-term follow-up research and are interested in collecting further information about your child's experience after a head injury. Please find enclosed some information regarding this child study. A researcher from the project will telephone you within the next fortnight to discuss this further and invite your participation.

If you have any queries in the meantime, please do not hesitate to contact the Principal Investigator, Dr Nicola Starkey, on 07 8384466 (extension 6472) or Research Officer, Rosalind Case, on 07 838 4466 (extension 8607).

Thank you very much for your time.

Yours sincerely,



Dr Nicola Starkey  
Principal Investigator  
COBIC Study  
Email:



Rosalind Case  
Research Officer  
COBIC Study  
Email:

## Appendix B

### Introductory Letter to Matched Cohort Group Parents / Guardians

Dear Parent/Guardian

Thank you for agreeing to receive information about the Consequences of Brain Injury in Childhood Study (COBIC). This research builds upon the BIONIC traumatic brain injury study that has identified over 300 children who have had a brain injury between 1<sup>st</sup> March 2010 and 28<sup>th</sup> February 2011. The key aims of the COBIC study are to assess the longer-term developmental impact of brain injury in childhood (up to three years post-injury) and compare the cognitive, social and behavioural development of children post-TBI with a group of children who are free from brain injury. The study has been approved by the Northern Y Regional Ethics Committee and is funded by the Health Research Council of New Zealand and a Lottery Health Research Grant. We now need non-injured children and teenagers to join our study so we can find out more about the effects of brain injury.

Please find enclosed some additional information about the study. If we already have your contact details, a COBIC researcher will telephone you within the next fortnight to discuss the study and invite your participation. If you are interested in taking part and/or we don't have your contact details, please ring the Principal Investigator, Dr Nicola Starkey, on 07 8384466 (extension 6472), Research Officer, Rosalind Case, on 07 838 4466 (extension 8607) or email [COBIC@waikato.ac.nz](mailto:COBIC@waikato.ac.nz).

Thank you very much for your time.

Yours sincerely,



Dr Nicola Starkey  
Principal Investigator  
COBIC Study  
Email:



Rosalind Case  
Research Officer  
COBIC Study  
Email:

Appendix C

Introductory Letter to Teachers

Dear TEACHER NAME

CHILD'S NAME is taking part in our research study and HIS/HER parent, PARENT'S NAME, has given HIS/HER consent for us to contact you regarding HIS/HER child's functioning at school.

The aim of our research is to examine the long-term consequences of traumatic brain injury in childhood (COBIC). The study has been approved by the Northern Y Regional Ethics Committee and is funded by the Health Research Council of New Zealand and a Lottery Health Research Grant. Part of this regional study focuses specifically on children's academic achievement and school related functioning, and we would like to invite you to complete the enclosed questionnaire. Please note, we are studying children with and without brain injury, so this request may concern a child who has or has not had a brain injury.

Please be assured that any information you provide is completely confidential. The questionnaire will take approximately 20 minutes to complete. For each completed questionnaire, the school will receive a \$10 book voucher as a token of our appreciation. While we are aware that you are busy, any information you can provide will be greatly appreciated, and will help us to more fully understand the overall effects of brain injury during childhood.

We would greatly appreciate it if you could return the completed questionnaire booklet to us at your nearest convenience by using the enclosed postage paid envelope. If you have any questions about the study or the questionnaire please do not hesitate to contact Principal Investigator, Dr Nicola Starkey, on 07 8384466 (extension 6472) or Research Officer, Rosalind Case, on 07 838 4466 (extension 8607).

Thank you very much for your time.

Yours sincerely,



Dr Nicola Starkey  
Principal Investigator  
COBIC Study  
Email:



Rosalind Case  
Research Officer  
COBIC Study  
Email:

Appendix D

Parent / Guardian Information Sheet and Consent Form



## The Consequences of Brain Injury In Childhood (COBIC) Parent (Proxy) Information Sheet - Preschool Children

---

### *Who are we?*

---

We are a team of people who work in universities and health care services in New Zealand. We would like to help children and teenagers who have had a head injury and to find out information that will make treatment better. For us to find out how head injury affects children and teenagers, we need to talk to those who have had a head injury and to those who haven't.

---

### An invitation

---

The aim of this study is to examine the long term effects of head injury in children and adolescents. You are being invited to take in this research study because you represent a child who:

- 1) had a head injury (brain injury) between March 2010 and February 2011,
- OR
- 2) you are volunteering your child to become part of the non-injured comparison group.

This study is coordinated by the School of Psychology, University of Waikato, Hamilton, in collaboration with the National Institute for Stroke and Applied Neurosciences, AUT University, Auckland.

Your participation is entirely voluntary (your choice). You do not have to take part in this study. If you choose not to take part, any care or treatment that your child is currently receiving will not be affected. If you do agree to take part, you/ your child are free to withdraw from the study at any time, without having to give a reason. Withdrawing at any time will in no way affect your or your child's future health care. To help you make your decision please read this information brochure. You may take as much time as you like to consider whether or not to take part.

---

### What are the aims of this study?

---

The main aim of the study is to find out about the long-term effects of head injury during childhood or adolescence (under 16 years of age). We will be looking at how children and adolescents recover, 1, 2 and 3 years after their



injury, and compare them to children and teenagers of a similar age who have not had a head injury.

The study aims to find out what the effects of the head injury (if any) are on:

- Social behaviour
- Memory and other cognitive functioning
- Quality of life
- The families of people with head injury

We hope this study will be of long-term benefit to New Zealanders in identifying the effects of head injury, and we hope it will eventually lead to improved care and help for children with head injury.

---

#### Who can take part in this study?

---

We need two groups of children / adolescents to take part in this study - those who have had a head injury and those who haven't. You and your child can take part in this study if:

- a) You took part in the BIONIC (Brain Injury Outcomes New Zealand in the Community) study and your child was under 16 years of age when they had a head injury. This means your child had a head injury between 1<sup>st</sup> March 2010 and 28<sup>th</sup> February 2011.

OR

- b) Your child is between 1- 16 years of age, has not had a head injury and would be willing to be part of the comparison group.

We are asking for your consent (as their parent/proxy) for your child to take part. We will talk to your child directly and we would also like to ask you some questions about your child's behavior and wellbeing as well finding out about your general health. We will explain the study to your child so that they can ask any questions they might have and we will obtain their assent to take part.

In addition, we would like to ask your child's pre-school teacher to take part so that we can find out if a head injury affects a child's behavior at school. We will ask you if you would like to nominate a teacher to answer some questions.

---

#### How many people will be in the study?

---

We estimate about 690 children will be involved in this study.

---

#### What happens if I do decide to take part?

---

If you decide you/ your child would like to take part, your participation would be for two years only. In total there will be three assessments - at the start of the study, and then in 1 year and 2 years time. Each assessment will take place over 1 sessions of approximately 90 minutes each. This is about half a day of your time over 2 years.

The researcher will ring you and ask you some questions over the phone. They will then arrange a time to meet with you and your child face-to-face to complete the assessment. This meeting can be at your home, at the University or other suitable place. Each assessment will include answering some questions about any illnesses or injuries your child may have had. In addition, you will be asked questions about your child's behavior and mood, as well as questions relating to your health and wellbeing.

Most children find these tasks enjoyable. Feedback about the assessments is not routinely given. All researchers who will be asking these questions and working with your child will have been specially trained for this project. These assessments can be conducted over more than 2 sessions if you would prefer.

---

#### What will my child have to do?

---

We would also like to carry out some activities with your child which can be done at home. These activities will help us to monitor your child's progress and enable us to see if head injuries affect their ability to pay attention, the way they think and how they play with a familiar person. We have found previously that children find these activities enjoyable and the activities will be suitable for the age of your child. The activities will last for a total of 1.5 hours (depending upon the age of your child) and we will do these over several sessions. You are welcome to stay with your child during these activities.

---

#### What is the time-span for the study?

---

The study is expected to start on 1 March 2011 and will continue until 31 October 2014.

---

#### How will the study affect me?

---

Taking part in this study will take some of your time and require you to answer a series of questions and for your child to complete some activities. There are no known risks caused by this study. Your (or your child's) usual medical care will not be affected in any way by participating in the study, or withdrawing from the study at any stage. Your (and your child's) participation in this study will be stopped should any harmful effects appear or if the doctor feels it is not in your best interests to continue. Similarly your doctor may at any time provide you (or your child) with any other treatment he/she considers necessary.

This study will be of benefit to the wider population. There is no guarantee that you will benefit directly from being involved in this study. However, if your child has had a head injury, you will be given an opportunity to discuss this with a researcher. The results obtained from your participation may help others with this condition in the future.

---

### Compensation

---

An age appropriate gift or voucher (\$20) will be provided to you / your child after completion of each of the interviews (3 gifts or \$60 in total).

---

### Confidentiality

---

The study files and all other information that you provide will remain strictly confidential, unless there is an immediate risk of serious harm to yourselves or others. No material that could personally identify you (or your child) will be used in any reports on this study. Upon completion of the study your records will be stored for at least 10 year after your child's 16<sup>th</sup> birthday in a secure place at the University of Waikato. All computer records will be password protected. All future use of the information collected will be strictly controlled in accordance with the Privacy Act.

---

### Your rights

---

If you have any queries or concerns about your rights as a participant in this study, you may wish to contact a Health and Disability Advocate at the Health Advocates Trust, Telephone: **0800 555 050**, email: [advocacy@hdc.org.nz](mailto:advocacy@hdc.org.nz).

Or Te Puna Oranga (Waikato DHB Maori Health Unit), Hockin Building, Level 1, Pembroke wSt, P.O.Box 934, Hamilton. Ph: (07) 834 3644. Fax: (07) 834 3619.

---

### Finally

---

This study has received Ethical Approval from the Northern Region Y Ethics Committee Ref NTY/11/02/2016). If you would like some more information about the study please feel free to contact the researchers:

Dr Nicola Starkey, Senior Lecturer, Department of Psychology, University of Waikato, Hamilton, on 07 8384466 ext 6472 or email; [nstarkey@waikato.ac.nz](mailto:nstarkey@waikato.ac.nz)

---

### Study Investigators

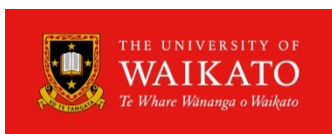
---

The principal investigator for this study is: **Dr Nicola Starkey (contact detail above)**

***Please keep this brochure for your information.Thank you for reading about this study***

Appendix E

Child Information Sheet and Consent Form



## **The Consequences of Brain Injury In Childhood (COBIC)**

### **Child and Adolescent Participant Information Sheet (under 16)**

#### *Who are we?*

We are a team of people who work in universities and health care services in New Zealand. We would like to help people who have had a head injury and to find out information that will make treatment better.

#### *What is the study about?*

To help us to do this we would like to ask people who have had a head injury about any problems they have (such as finding it difficult to remember things) and to see how quickly they get better. We also want to talk to people who haven't had a head injury so we can find out more about how a head injury affects people.

We are asking every child who had a head injury and took part in the BIONIC study to take part in this study as well. We also want children who are under 16 years of age and have not had a head injury to take part. You do not have to be involved in the study and you can stop taking part any time you want to. You can ask us any questions you like before you say that you would like to take part.

#### *What will happen if I want to take part?*

We would like to ask your parent or a person who looks after you some questions and if you have had another head injury we would like to look through what the doctors have written about your injury. If you would like us to stop talking to your parent or person who looks after you at any point, that's okay, please just tell us you want us to stop talking to them.

Having a head injury can sometimes effect how well people can remember things, how they think and how they behave. We would like to compare people who have had a head injury and people who haven't had a head injury to find out more about how a head injury effects how people remember, how they think and also how they get on at school. So if it's ok with you and your parents we would also like to talk to your school teacher to find out about how you are getting on at school.

A researcher will come to visit you (where you live, or somewhere easy for you) and bring some activities that will help us to look how you remember things and how you think. We hope that you find these activities enjoyable. The activities last for about 4 hours, but we will split these activities up so that you can do them on at least two different days. We will also ask you some questions about things you like doing and how you are feeling. This is not a test so we don't usually tell you how you did.

To help us to see how quickly people get better, we will ask you to answer the same questions and to do the same activities now, and in 1 year and 2 years time. At each time point we will come to see you twice, for about 90 minutes each time. In total this will take about 1.5 days of your time over 2 years.

---

### *Do I have to take part?*

---

No, it is up to you. If you would like to help us with the study, a researcher will ask you to sign a form to say that you are happy to take part.

You are free to stop your part the study at any time and you do not have to give us a reason. If you have had a head injury and you are still receiving treatment, this will not change whether you take part in this study or not. If you have any worries or questions about the study you can come and talk to us.



We will keep everything private but if we think that you might not be safe we might have to tell some other adults who can help us to keep you safe.

---

### *How many people will be in the study?*

---

We think there will be about 690 children and young people from New Zealand taking part in this study. Around half of them will have had a head injury.

---

### *How long does the study go on for?*

---

We will be starting the study in April 2011 and will continue until the end of October 2014.

---

### *What will happen afterwards?*

---

When we look at what everyone has told us, we will write about what we have found. We won't write your name anywhere, so people won't know that what you have said was from you.

After the study has finished we will keep all your information locked in a cupboard at the University. Only the people working on this study will be able to look at this information.

We will keep everything private but if we think that you might not be safe we might have to tell some other adults who can help us to keep you safe.

---

### *How will the study affect me?*

---

We cannot promise that the study will help you, but the information that we find out will help us to treat people better in the future.

To say thank you, we will give you a gift or voucher (\$20) after you have finished the activities now, and when you do the activities in 1 and 2 years time (3 gifts or \$60 vouchers in total).



---

*Has this study been approved by anybody?*

---

Before any research goes ahead it has to be checked by a Research Ethics Committee. They make sure that the research is fair. This study has been checked and approved by the Northern Region Y Ethics Committee (Ref NTY/11/02/016).

---

*What if I have any questions?*

---

If you would like to contact someone about the study or if you have any worries, you can talk to any member of the team or you can phone;

Nicola Starkey who runs the study;

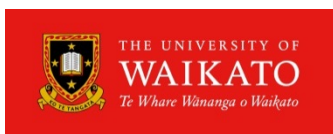
Telephone: 07 8384466 ext 6472

***Thank you for reading about this study  
You can keep this information.***



Appendix F

Case Eligibility / Ascertainment Form



## The Consequences of Brain Injury In Childhood

(COBIC)

### FORM CE: Case Ascertainment/Eligibility - For ALL Participants (Phone)

#### 1. General Questions – Section 1

Q#	Label	Field format
1.1	NIH Number	
1.2	Gender	Male Female
1.3	Date of Birth	ddmmyy
1.4.1	TBI between 1 March 2010 and 28 Feb 2011 and registered in BIONIC?	Yes – go to 1.4.4 No – go to 1.4.2
1.4.2	TBI free since birth?	Yes – go to 1.4.3 No – ineligible for study, go to 1.4.5
1.4.3	Are they age/gender matched to TBI participant?	Yes – go to 1.4.4 No – ineligible for study, go to 1.4.5
1.4.4	Are they a resident of Hamilton /Waikato District	Yes - go to 1.5 No – ineligible for the study, go to 1.4.5
1.4.5	Can we keep your contact details for future	Yes - stop here, sign and date form No - stop here, sign and date form

	<u>studies?</u>	
1.5	Area of Residence	Resident of Hamilton Resident of Waikato
1.6	Ethnicity (tick one on each line) <u>New Zealand European</u> Maori Samoan Cook Island Maori Tongan Niuean Chinese Indian Other (such as Dutch, Japanese, Tokelauan)	Yes/No Yes/No Yes/No Yes/No Yes/No Yes/No Yes/No Yes/No Yes/No
1.6.1	If other, please specify	Text

Appendix G  
Contact Details Form



## The Consequences of Brain Injury In Childhood (COBIC)

### Form CC: Contact Details (For ALL Participants)

TO BE COMPLETED FOR EVERY PARTICIPANT OR IF THE PARTICIPANTS OR FAMILY MEMBERS DETAILS CHANGE

<b>Date of Completion</b>	DD/MM/YYYY											
<b>Participant Details</b>												
Title:												
First name:												
Family name:												
Street Address:												
Suburb:												
Town												
City												
Post code												
Telephone number	Area				Number							
Alternative telephone number												
Sex	<input type="checkbox"/>	Male	or	<input type="checkbox"/>	Female							
Is this your permanent address	No, Yes											
If this is not your permanent address, how long do you expect to stay here	___ days Do Not Know											
<b>Alternative contact address</b>												
Street Address:												
Suburb:												

Town	
City	
Post code	

**Parent Contact Details (Person identified to complete Form P)**

Title:	
First name:	
Family name:	
Relationship to participant	
Street Address:	
Suburb:	
Town	
City	
Post code	
Residential telephone number	Area <input type="text"/> <input type="text"/>   Number <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>
Mobile telephone number	

**Formal Caregiver**

Does the participant have a formal Caregiver?	No, Yes (If yes or baseline, fill in the caregivers details)
First name:	
Family name:	
Street Address:	
Suburb:	
Town	
City	
Post code	
Residential telephone number	Area <input type="text"/> <input type="text"/>   Number <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>
Mobile telephone number	



Mobile telephone number											
Do they have more than one General Practitioner?	No, Yes (If yes, fill in the Alternative GP details)										
<b>Alternative GP</b>											
Title:											
First name:											
Family name:											
Street Address:											
Suburb:											
Town											
City											
Post code											
Telephone number											
Area	<table border="1"> <tr> <td></td> <td></td> </tr> </table>										
Number	<table border="1"> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </table>										

<b>Next of Kin</b>															
First Name															
Family name:															
Relationship to participant															
Street Address:															
Suburb:															
Town															
City															
Post code															
Telephone number	<table border="1"> <tr> <td>Area</td> <td></td> <td></td> <td></td> <td>Number</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </table>	Area				Number									
Area				Number											
Mobile telephone number															



Appendix H

Control Parent Demographic Questionnaire

Please ensure the parent/proxy has signed and dated the consent form and that the details on form C are correct and not likely to change before the next assessment.

If the person is unable to consent to participate in the study, we ask a representative (you) to answer some questions on their behalf. A proxy is someone who is a parent / legal guardian or relative who lives with the child.

G.0	Assessment (tick one only)	12 months 24 months 36 months
G.1	Date of assessment	Dd/mm/yy
G.2	Participant is alive on scheduled assessment date	Yes No Unknown

### 1. Adaptation / ongoing treatment – Bionic participants only

1.4	Has their home (or current accommodation) had aids, appliances or modifications to allow them to live there since their head injury?	Yes No
1.4.1	If yes, which of the following: (tick all that apply)	Communication aids Commode chair Rails in bedroom Rails in bathroom Walking stick or other aid Ramps Other
1.4.2	If other, please specify	Text
1.10	Since their head injury, do they require unpaid help from another person for everyday activities (e.g., dressing, shopping, showering)?	Yes No
1.10.1	If yes, who is the person who helps them the most but who is not paid to do so? (tick one only)	Spouse/partner Parent Child Sibling Other relative Neighbour Friend Other
1.10.2	If other, please specify	Text

## 2. Rehabilitation Received and Health Economic Data (all participants)

Q#	Label	Field Format
	<i>Have they received any of the following in <b>LAST 7 DAYS?</b></i>	
2.2	<b>Home carers</b> (e.g., cleaning, cooking other than that provided by family, friends or caregivers)	Yes No
2.2.1	If yes, number visits in last week	2 digits
2.2.2	If yes, hours per visit	3 digits (with decimal)
2.2.3	If yes who paid for this service ( <i>tick one only</i> )	Personal payment Caregiver Insurance Residential Home DHB ACC
2.2.4	How satisfied are you with the level of service they received on a scale of 1 (very unsatisfied) to 10 (very satisfied)?	2 digits
2.3	<b>Help with personal care</b> (e.g., dressing, showering other than that provided by family, friends or caregivers)	Yes No
2.3.1	If yes, number visits in last week	2 digits
2.3.2	If yes, hours per visit	3 digits (with decimal)
2.3.3	If yes who paid for this service ( <i>tick one only</i> )	Personal payment Caregiver Insurance Residential Home DHB ACC
2.3.4	How satisfied are you with the level of service they received On a scale of 1 (very unsatisfied) to 10 (very satisfied)?	2 digits
2.5	<i>Have they received any of the following in <b>LAST 28 DAYS?</b> (tick as many as apply)</i>  If any ticked please specify details for each below	None Visiting nurses Physiotherapy Occupational Therapy Speech Therapy Medical Specialist (eg., neurologist, psychiatrist) Day care or Day hospital Psychologist Counsellor General Practitioner Social Worker

<b>Rehabilitation Received 1</b>		
2.5.1	Type of service	
2.5.2	Number visits in last month	2 digits
2.5.3	Hours per visit	3 digits (with decimal)
2.5.4	Who paid for this service (tick one only)	Personal payment Caregiver Insurance Residential Home DHB ACC
2.5.5	Where did this take place ( <i>tick one only</i> )	Professionals office/ practice At home Outpatient clinic Hospital Residential Home Other
2.5.5.1	If other, please specify	Text
2.5.6	How satisfied are you with the level of service they received On a scale of 1 (very unsatisfied) to 10 (very satisfied)?	2 digits

<b>Rehabilitation Received 2</b>		
2.6.1	Type of service	
2.6.2	Number visits in last month	2 digits
2.6.3	Hours per visit	3 digits (with decimal)
2.6.4	Who paid for this service (tick one only)	Personal payment Caregiver Insurance Residential Home DHB ACC
2.6.5	Where did this take place ( <i>tick one only</i> )	Professionals office/ practice At home Outpatient clinic Hospital Residential Home Other
2.6.5.1	If other, please specify	Text
2.6.6	How satisfied are you with the level of service they received On a scale of 1 (very unsatisfied) to 10 (very satisfied)?	2 digits

2.7	Did you or your child experience any barriers to accessing these services?	Yes/No
2.7.1	If yes, what were the barriers?	Text
2.8	Were the services received acceptable to the child's culture? (tick one only)	Not at all A little bit Somewhat Very
2.8.1	If not at all, what did you feel was not acceptable?	Text

Appendix I

Clinical and Control (COBIC) Parent Demographic Questionnaire

### 3. General Information

G.0	Assessment (tick one only)	12 months 24 months 36 months
G.1	Date of assessment	Dd/mm/yy
G.2	Participant is alive on scheduled assessment date	Yes No Unknown
G.9	Is English your first language?	Yes No
G.9.1	If no, do you need an interpreter?	Yes No
G.9.2	If Yes, what language?	Text
G.10	What is your date of birth?	Ddmmyyyy
G.11	What is your gender?	Male Female
G.12.1	What is your Ethnicity (tick one on each line) New Zealand European Maori Samoan Cook Island Maori Tongan Niuean Chinese Indian Other (such as Dutch, Japanese, Tokelauan)	Yes/No Yes/No Yes/No Yes/No Yes/No Yes/No Yes/No Yes/No Yes/No
G.12.1	If other, please specify	Text
	<i>Baseline only</i>	
D.1	If employed, what is your main occupation?	Text
D.2	If yes, how many hours per week do you work? (tick one only)	Full time (35+ hours per week) 20-34 hours per week <20 hours per week
D.3	What is the highest level of education that you attained? (tick one only)	Primary School High School Polytechnic University
D.4	Are you the main income earner in the family/household?	Yes No
D.5	If no, what is the main lifetime occupation of the main income earner?	Text
D.6	What is your current marital status? (tick one only)	Married, civil union, de facto Separated/divorced/widowed Never married (single) Unknown
G.14	In the last month was your child they having any problems with any of the following: (tick as many as apply)	Bladder control Memory or other cognitive difficulties Mood (e.g., depression) Sleep Other health-related problems
G.14.1	If other, please specify	Text

G.15	Does your child have any disability (Physical, cognitive or mental)? If no, continue to question GS.21	Yes No
G.15.1	If yes, what is their main disabling injury or illness? Specify	Text
G.15.2	Are they receiving any benefit for their main disability (such as injury compensation, disability allowance or support)? If no, continue to question GS.19	Yes No
G.15.3	If yes, in what year did you start receiving this benefit?	4 digits

**At follow up assessments only**

G.5	Has the child entered permanent residential care since last assessment?	Yes No
G.5.1	If yes, date of entry into permanent residential care	Dd/mm/20yy
G.6	Has the child been admitted to hospital since the last assessment?	Yes No
G.6.1	If yes, date last admitted to hospital	Dd/mm/20yy
G.7	Has the child had a serious fall since the last assessment?	
G.7.1	If yes, date of fall/injury	Dd/mm/20yy
G.13	Has the participant had a subsequent head injury since the last assessment? If yes, please complete form CH	Yes No

**Collect for all assessments**

GS.21	Does the child have any other diagnosed health problems?	Yes No				
GS.21.1	If yes, what is their diagnosis?	Text				
GS.22	Is the child currently taking any medication?	Yes No				
GS.22.1 If yes, what medications is the child currently taking? (Ask to see that participant's medication bottles/packets to record this information)						
No	Name	Dose	Unit	Dispensing date	Amount of medication (e.g., number of tablets taken each time medicine is taken)	Frequency
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
GS.23	Do you provide any care for the child?	Yes				

	If no, continue to question GS.24	No
GS.23.1	If yes, have you had to take any time off work to provide care?	Yes No
GS.23.2	If yes, how many hours a day do you provide care for the child?	2 digits

**For BIONIC participants only:**

GS.29	What is the most disabling issue for the participant now (Physical, cognitive or mental)?	Specify
GS.29.1	Are they receiving any benefit for their main disability (such as injury compensation, disability allowance or support)?	Yes No
GS.29.2	If yes, when did they start receiving this benefit?	yyyy

**4. Living arrangements (of Participant)**

Q #	Label	Field format
2.0.1	What type of accommodation do you live in? (tick one only)	Inpatient Family or friend's home Foster home / care centre Other
2.0.2	If other, please specify:	Text
2.11	Estimated child's height (baseline assessment only)	3 digits.2 digits cm
2.12	Estimated child's weight (baseline assessment only)	2 digits kg



Appendix J  
Teacher Questionnaire

This booklet contains a number of statements that describe children's behaviour play and social development. These statements cover a wide age range (5-18 years), so you may find that some seem a little inappropriate for your pupil. However, it would be very helpful if you could answer ALL of the questions as best you can even if you feel a little uncertain of your answer or the questions seem a little daft.

Most questions involve ticking or circling your answer to each question. If you feel that an answer you give does not reflect your experiences adequately, please feel free to write additional comments in the spaces provided.

Before filling in the questionnaire please fill in your name, and today's date in the spaces provided. If you are the child's teacher or child care provider, please check the box next to the response that best describes how well you know the child and indicate how long you have known the child in the space provided.

Teachers Name: \_\_\_\_\_ Today's Date: \_\_\_\_\_

How well do you know the child?      Not well      Moderately well      Very well

I have known the child for: \_\_\_\_\_ months \_\_\_\_\_ years

#### 1.1 Overall impressions of the child.

Overall, how would you rate this child's progress in the following subjects in comparison with other children of the same age?

	Delayed	Below average	Average	Above Average	Advanced
1. Reading	1	2	3	4	5
2. Handwriting	1	2	3	4	5
3. Spelling	1	2	3	4	5
4. Mathematics	1	2	3	4	5
5. Physical Education	1	2	3	4	5
6. Language written	1	2	3	4	5
7. Language expressive	1	2	3	4	5
8. Language comprehensive	1	2	3	4	5

1.2. Overall, how would you rate this child's behaviour in comparison to other children of the same age?

Much	Worse	About the	Better	Much
------	-------	-----------	--------	------

worse		same		better
1	2	3	4	5

1.3. In your view does this child have any learning problems in one/more of the above areas?

A lot	Some	None
1	2	3

Please specify: \_\_\_\_\_

1.4. To your knowledge, does this child have any significant health problems (e.g., vision, hearing, orthopaedic) that affect his/her school performance?

A lot	Some	None
1	2	3

Please specify: \_\_\_\_\_

1.5 How popular is this child with his /her classmates?

Very popular	Well liked	Liked	Tolerated	Unpopular	Very unpopular	Isolated
1	2	3	4	5	6	7

1.6 Attendance

In the last year to your knowledge has the child been referred by the school to any of the following services (NB "Referral" relates to requests made by the school for individual attention rather than testing conducted on a routine basis; i.e., it does not include vision/ hearing screening).

	Yes	No
Specialist education services	1	2
Private tuition (e.g., Kip McGrath, Basic Plus, Number Works, Kumon)	1	2
Occupational Therapy	1	2



1.8 Where is this child performing in relation to the expected mathematics and literacy standards for children of this age?

**1.8.1 Mathematics standard (please circle)**

Above (1 yr or more above)	At (within 1 year)	Below (1 year below)	Well below (> 1 year below)
-------------------------------	-----------------------	-------------------------	--------------------------------

1.8.2 If the child is performing 'well below' please indicate their current mathematics stage / level

\_\_\_\_\_

**1.8.3 Reading standard (please circle)**

Above (1 yr or more above)	At (within 1 year)	Below (1 year below)	Well below (> 1 year below)
-------------------------------	-----------------------	-------------------------	--------------------------------

1.8.4 If the child is performing 'well below' please indicate their current reading stage / level

\_\_\_\_\_

**1.8.5 Writing standard (please circle)**

Above (1 yr or more above)	At (within 1 year)	Below (1 year below)	Well below (> 1 year below)
-------------------------------	-----------------------	-------------------------	--------------------------------

1.8.6 If the child is performing 'well below' please indicate their current writing stage / level

\_\_\_\_\_

1.9 Do you have any concerns about this child's achievement and behaviour?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

### 1.10 Additional Comments

If you have any further comments that you would like to add, please feel free to use the space below:

---

---

---

---

---

---

---

---

---

---

---

Thank you for your help!

Appendix K

Study 2 - Introductory Letter to Principals

### Email to Principal

To Whom It May Concern

You may already be aware of the Consequences of Brain Injury in Childhood (COBIC) study which has been taking place in the Waikato region over the past year. The key aims of the COBIC study are to examine long-term developmental functioning in children with a brain injury and to compare their cognitive, social and behaviour development with a group of children who have not had an injury. The study has been approved by the Northern Y Regional Ethics Committee and is funded by the Health Research Council of New Zealand and a Lottery Health Research Grant.

A smaller, follow-up study to COBIC is seeking to find out more in-depth information regarding teacher perspectives on brain injury in childhood. The reason for this email is to request your consent to potentially approach a teacher or teachers in your school to ask them to engage in a 30-60 minute interview regarding their understanding and views about brain injury. Participation is of course voluntary and anonymous. The findings of this research would be used in a doctoral thesis in the School of Psychology at the University of Waikato.

Please find attached an information sheet regarding this study. A researcher will be in touch with you within the next few weeks to discuss the study and answer any questions you may have. In the meantime if you have any queries, please do not hesitate to contact me on (BLANK), or my supervisor, Dr Nicola Starkey on (BLANK)

Thank you very much for your time.

Yours sincerely,

Rosalind Case

Clinical Psychologist / Research Officer

COBIC Study



Appendix L  
Information Sheet for Teachers

# Teacher Perspectives on Traumatic Brain Injury Information Sheet

Contact: Rosalind Case, School of Psychology, University of Waikato

Telephone:

Email:

Supervisor: Dr Nicola Starkey (School of Psychology, University of Waikato)

---

## **What is this study about?**

The aim of the current study is to understand more about teacher perspectives on traumatic brain injury (TBI) in children. We are interested in knowing more about your understanding of TBI, your education and learning in this area and your experiences with head-injured children.

## **What does the study involve?**

You will be asked to partake in an interview of approximately 30-60 minutes duration that will be undertaken at a mutually convenient time and location. As a token of appreciation for your time and contribution to this study, you will be provided with a \$20 voucher on completion of the interview.

## **What will happen to the information?**

The information derived from the interviews will be analysed in relation to the aims of the study. The information will be used in a Doctoral thesis and may also lead to possible publication in academic articles and conference proceedings. All names will be anonymised (by utilizing codes) so participants can not be identified and audiotapes will be wiped after transcribing is completed.

## **If you choose to participate in this study, what are your rights?**

The researchers will respect your rights to:

Withdraw from the study at any time

Ask questions about the study at any time

Decline to answer questions

Remain anonymous in the study findings

Be given a summary of the research findings

This study has received ethical approval from the University of Waikato School of Psychology. If you have any concerns about this project, you may contact Professor Mary Foster of the Research and Ethics Committee on (BLANK)

This study is supported by funding from the Health Research Council.

If you have any further questions relating to this study, please contact Rosalind Case on (BLANK)

Thank you.

Appendix M  
Semi-Structured Interview Schedule

## Semi-Structured Interview Guide

### Preamble

Introduction to topic

Brief background of COBIC project

Rapport-building discussion – likely to include topics covered in demographic background information form (e.g., teaching history, current status, etc.)

### Broad topic areas will include but are not limited to:

*Understanding of TBI (e.g., definitions, general consequences)*

mild TBI / concussion (symptoms, impact)

Short and long-term consequences of TBI in childhood

Expectations for children with TBI

Risk factors

*Education and Learning – Teacher’s Exposure to TBI*

Formal learning experiences

Informal learning experiences

Personal/professional exposure to TBI

TBI in the classroom

Satisfaction with/usefulness of previous learning

### Examples of Possible Interview Questions

What is your understanding of Traumatic Brain Injury

What are the consequences of Traumatic Brain Injury

What effects do you think concussion has on a child’s functioning?

What impact do you think a recent concussion could have on a child’s social behaviour?

What sort of children are more at risk of head injury?

What do you need as a teacher to be able to support children with TBI in the classroom?

How satisfied are you with your current level of knowledge relating to childhood TBI?

Where did you learn about TBI?

Appendix N  
Teacher Consent Form

## Consent Form



THE UNIVERSITY OF  
**WAIKATO**  
*Te Whare Wānanga o Waikato*

Research Project: Teacher Perspectives on Traumatic Brain Injury

Name of Researcher: Rosalind Case

Name of Supervisor (if applicable): Dr Nicola Starkey

---

I have received an information sheet about this research project or the researcher has explained the study to me. I have had the chance to ask any questions and discuss my participation with other people. Any questions have been answered to my satisfaction.

I agree to participate in this research project and I understand that I may withdraw at any time. If I have any concerns about this project, I may contact Dr Lewis Bizo of the Research and Ethics Committee (phone: BLANK, e-mail BLANK)

Participant's Name: \_\_\_\_\_ Signature: \_\_\_\_\_ Date: \_\_\_\_\_

Appendix O

Study 3 Email to Principals



## Email to Principal

To Whom It May Concern

The reason for this email is to offer teachers at your school a free professional development workshop regarding the impact of concussion on child functioning in school settings.

You may already be aware of the Consequences of Brain Injury in Childhood (COBIC) study which has been taking place in the Waikato region over the past two years. One of the key aims of the COBIC study has been to examine long-term developmental functioning in children following concussion. A smaller, follow-up study to COBIC then sought find out more in-depth information regarding teacher perspectives on brain injury in childhood. Over 20 teachers from schools in the Waikato and Bay of Plenty engaged in interviews in 2012 to discuss their understanding of and insights relating to the impact of mild traumatic brain injury on childrens' functioning in school settings.

On the basis of the findings from the two earlier studies mentioned here, we have developed a free professional development workshop and information resource for teachers. We are now seeking to evaluate the usefulness of this workshop and information booklet and would like to invite teachers from your school to attend this 3-hour professional development workshop and be involved in this evaluation.

Please see the attached information sheet for more details regarding this free professional development and research participation opportunity for your teachers. I will be in touch with you within the next few weeks to discuss the study and answer any questions you may have. In the meantime if you have any queries, please do not hesitate to contact me on 07 838 4466 (ext. 8607) or 021 135 9744, or my supervisor, Dr Nicola Starkey on 07 838 4466 (ext. 6472).

Thank you very much for your time.

Yours sincerely,

Rosalind Case

Clinical Psychologist / Research Officer

COBIC Study

Appendix P  
Information Sheet for Principals



## Concussion in the Classroom: An Education Package for Teachers

# Information Sheet for Principals

Contact: Rosalind Case, School of Psychology, University of Waikato

Telephone:

Email:

Supervisor: Dr Nicola Starkey (School of Psychology, University of Waikato)

---

### What is this study about?

The aim of the current study is to evaluate the usefulness of a professional development workshop for teachers relating to concussion in primary-school-aged children. We are interested in examining how teachers can be supported to delivering education services to children who may be experiencing difficulties as the result of concussion.

### What does the study involve?

Teachers from your school are invited to attend a professional development workshop of approximately three hours duration. This will include a 2-hour workshop regarding concussion and its impact and management in schools settings. It will also include time for teachers to complete a consent form, background information sheet and evaluation of the workshop. The workshop is delivered by a registered Clinical Psychologist and we encourage its inclusion in teachers' portfolios of professional development activities for 2013.

### How much does it cost?

There is no cost associated with the workshop. Light refreshments will be provided.

### Do teachers have to participate in the study?

No, participation is of voluntary. Teachers can still attend the workshop even if they do not wish to complete the evaluation forms. However, their participation in the evaluation component of the workshop is very much appreciated.

**What will happen to the information?**

The information derived from teachers' feedback will be analysed in relation to the aims of the study. The information will be used in a Doctoral thesis and may also lead to possible publication in academic articles and conference proceedings. All names will be anonymised (by utilizing codes) so participants can not be identified.

**If teachers choose to participate in this study, what are your rights?**

The researchers will respect participants' rights to:

- Withdraw from the study at any time
- Ask questions about the study at any time
- Decline to answer questions
- Remain anonymous in the study findings
- Be given a summary of the research findings

This study has received ethical approval from the University of Waikato School of Psychology. If you have any concerns about this project, you may contact Professor Lewis Bizo of the Research and Ethics Committee on 838 4466 ext. 6402 or [lbizo@waikato.ac.nz](mailto:lbizo@waikato.ac.nz)

This study is supported by funding from the Health Research Council.

**HOW DO I SIGN UP?**

If you are interested in teachers from your school participating in this workshop, or if you have any queries regarding this study, please contact Rosalind Case, Clinical Psychologist, on BLANK or BLANK

Yours sincerely,

Rosalind Case

Clinical Psychologist / Research Officer

Appendix Q

Study 3 – Information Sheet for Teachers



## Concussion in the Classroom: An Education Package for Teachers

# Information Sheet for Teachers

Contact: Rosalind Case, School of Psychology, University of Waikato

Telephone: 07 838 4466 (ext. 8607) / 021 135 9744

Email: [rcase@waikato.ac.nz](mailto:rcase@waikato.ac.nz)

Supervisor: Dr Nicola Starkey (School of Psychology, University of Waikato)

### What is this study about?

The aim of the current study is to evaluate the usefulness of a professional development workshop for teachers relating to concussion in primary-school-aged children. We are interested in examining how teachers can be supported to delivering education services to children who may be experiencing difficulties as the result of concussion.

### What does the study involve?

You are invited to attend a professional development workshop of approximately three hours duration. This will include a 2-hour workshop regarding concussion and its impact and management in schools settings.

If you agree, you will be invited complete a consent form, background information sheet and evaluation of the workshop. The workshop is delivered by a registered Clinical Psychologist and we encourage you to include it in your portfolio of professional development activities for 2013. There is no cost associated with this workshop. Light refreshments will be provided.

### How much does it cost?

There is no cost associated with the workshop. Light refreshments will be provided.

### Do I have to participate in the study?

No, participation is of voluntary. You can still attend the workshop even if you do not wish to complete the evaluation forms. However, your participation in the evaluation component of the workshop is very much appreciated.

**What will happen to the information?**

The information derived from your feedback will be analysed in relation to the aims of the study. The information will be used in a Doctoral thesis and may also lead to possible publication in academic articles and conference proceedings. All names will be anonymised (by utilising codes) so participants can not be identified.

**If you choose to participate in this study, what are your rights?**

The researchers will respect your rights to:

- Withdraw from the study at any time
- Ask questions about the study at any time
- Decline to answer questions
- Remain anonymous in the study findings
- Be given a summary of the research findings

This study has received ethical approval from the University of Waikato School of Psychology. If you have any concerns about this project, you may contact Dr Michael O'Driscoll of the Research and Ethics Committee (phone: 838 8899 ext.8899, e-mail [psyc0181@waikato.ac.nz](mailto:psyc0181@waikato.ac.nz))

This study is supported by funding from the Health Research Council.

**HOW DO I SIGN UP?**

If you are interested in participating or simply have queries regarding this study, please contact Rosalind Case, Clinical Psychologist, on BLANK

Yours sincerely,

Rosalind Case

Clinical Psychologist / Research Officer

COBIC Study

Appendix R

Concussion Seminar Powerpoint Slides



# CONCUSSION IN THE CLASSROOM

## THE EFFECTS OF MILD TRAUMATIC BRAIN INJURY

Rosalind Case  
Clinical Psychologist  
2013

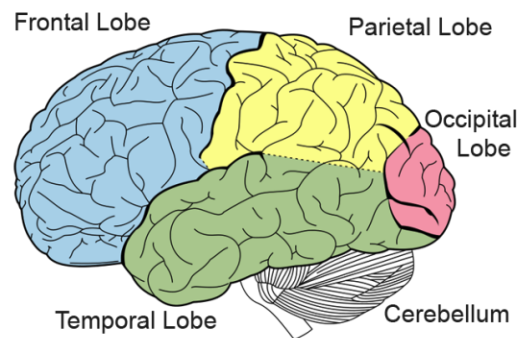
### Seminar Plan

- Understanding mild traumatic brain injury
- Short-term effects in children
- Possible long-term effects
- Strategies for teachers
- Workshop Evaluation

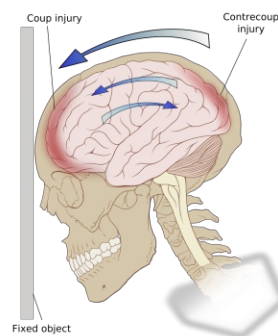
### Traumatic Brain Injury (TBI)

- **What is TBI?**
  - “An acute brain injury resulting from mechanical energy to the head from external forces.” (World Health Organisation, 2005)
- Immediate post-injury symptoms may include **one or more** of the following:
  1. Confusion or disorientation
  2. Loss of consciousness
  3. Post-traumatic amnesia
  4. Other neurological abnormalities (e.g. focal neurological signs, seizure, intracranial lesion)

## The Brain



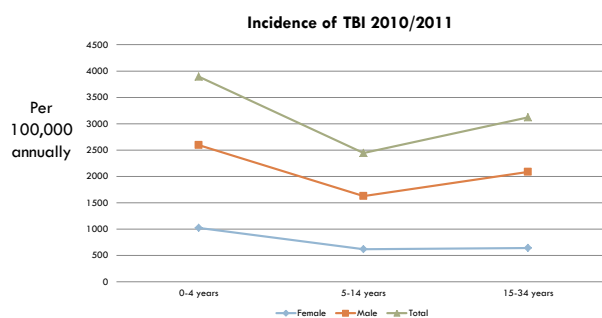
## Coup / Contrecoup



## How Common is Mild TBI?

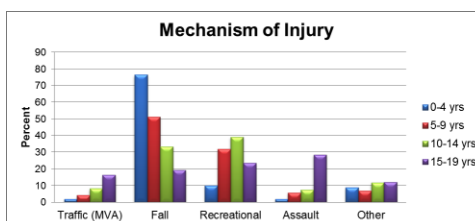
- Latest rates suggest 1000-1500 per 100,000 children experience mild TBI annually (Feigin et al., 2013)
- 30% of young people will experience mild TBI before age 25 (McKinlay, 2008)
  - 1/3 of these people will experience multiple concussions

## Local Incidence Rates



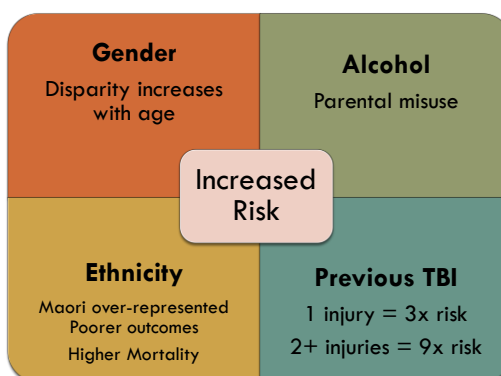
Incidence of TBI in those aged 0-34 years – BIONIC 2010/2011

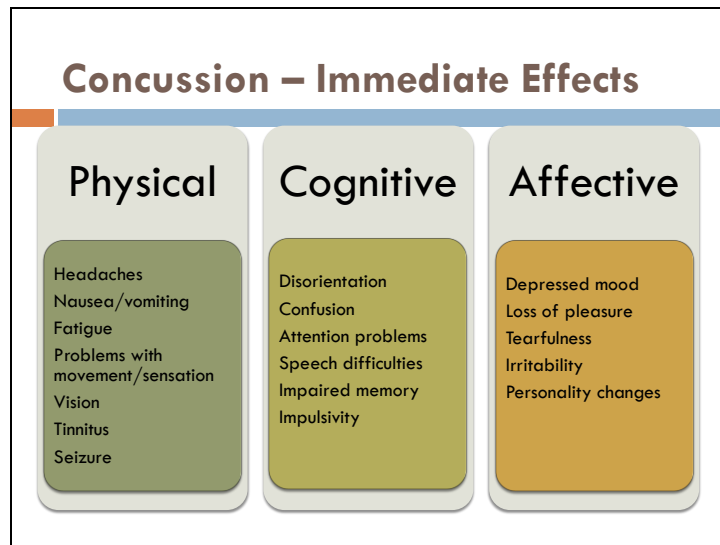
## Causes of TBI



Cause of TBI in those aged 0-19 years – BIONIC 2010/2011

## Risk Factors





### How long do these problems last?

- 24-48 hours?
- 80% of adults will experience symptoms for one to three months
- The majority of residual issues are resolved within a year

### Post-Concussion Symptoms

- Typical symptoms in children:
  - Irritable mood, hyperactivity, fatigue, attention problems
- Post-Concussion Syndrome
  - We know it exists in adults, but not so clear in children...

## Longer-Term Difficulties in Children

- Less is known about the effects of mild TBI in children than in adults
- Conflicting data
  - Persistent difficulties may be present after mild TBI
  - Evidence to suggest learning, attention, memory, processing speed, mood and personality may be affected
  - Multiple injuries may increase risk

## Concussion in childhood

- Vulnerability vs plasticity
  - Plasticity – the brain's ability to repair
- Consider childhood concussion in a developmental context
  - Skill acquisition
  - Learning
  - Socialisation
  - Dependence on family system

## A quick recap

- Concussion is very common in childhood and adolescence
- Some children are at higher risk than others
- There are a wide variety of short-term symptoms
- It is possible that some of these symptoms will last longer for some children

## Some Local Research

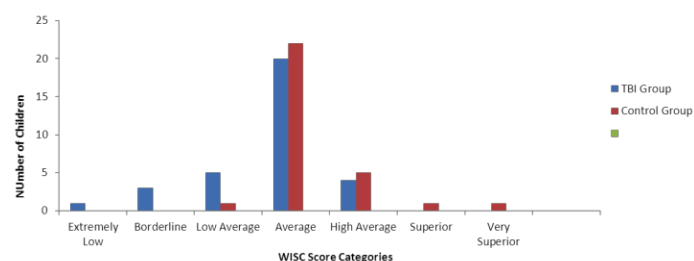
- Two large studies have taken place in the Waikato
  - ▣ **BIONIC** (2010 – 2012)
    - Investigated TBI (mild to severe) in 1369 individuals in the Waikato region
  - ▣ **COBIC – The Consequences of Brain Injury in Childhood** (2011 – Present)
    - Investigated the longer-term effects of TBI in young people aged 0-16 years at time of injury

## COBIC Primary School Study

- Children aged between 5-11 years at time of injury
  - ▣ All injuries in this group were mild (concussion)
  - ▣ 41 children assessed 12 months after their injury
  - ▣ Results compared against a group of non-injured children
- Analysis is ongoing but early results suggest...

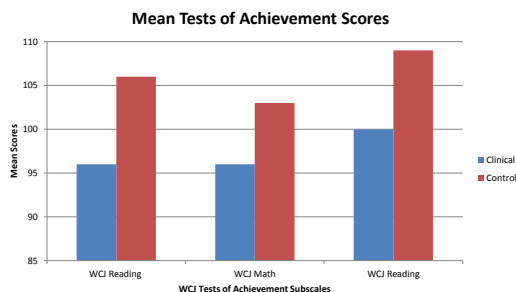
## Results - Cognitive Functioning

- Children in the TBI group have significantly lower FSIQ scores



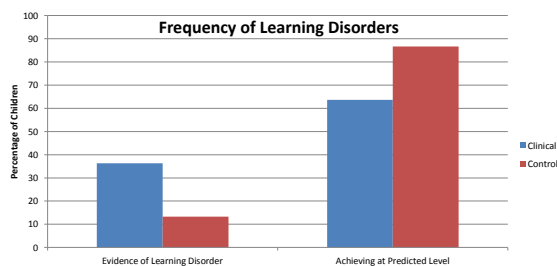
## Results - Academic Functioning

- Children in the TBI group have significantly lower scores than their same-aged peers in reading, maths and writing tests



## Ability/Achievement Discrepancies

- Children with TBI are significantly more likely to present with learning disorders



## Emotional and Social Functioning

- Parents of children with TBI perceive their children to have higher levels of emotional problems and hyperactivity, than controls.
- However, no significant differences in conduct and social problems.

## What do these results suggest?

- We need to interpret this data with caution
- Cause, effect or (mere) correlation?
  - Which came first? Chicken/egg effect
- Children who experience concussion are more likely to have cognitive, academic, emotional and social difficulties than their non-injured peers
- ***But is this a result of their injury?***

## High Risk Children

- Regardless of cause, the needs of this group can not be ignored
- Ongoing problems may be noticeable in the classroom and playground
- How can teachers be supported to support these children?

## What do we know about potential long-term effects?

- Executive Functions
- Behavioural changes
- Emotional problems
- Social skills deficits
- Academic Functioning



## Executive Functions

- 'Higher-order' cognitive processes
- Associated with frontal lobe
- Includes:
  - Memory
  - Attention
  - Organisation / Planning
  - Impulse Control
  - Information Processing
  - Judgement
  - Concept Formation
  - Problem-Solving

## Behavioural and Emotional Problems

- Often most difficult for parents to cope with
- Persistent
- Externalising behaviours common
  - Aggression, reduced anger regulation, hyperactivity
- Internalising behaviours may also present
  - Depression, apathy, anxiety, etc.

## Social Impacts

- Limited evidence
- Subtle changes may lead to difficulties
  - Frustration tolerance
  - Impulsivity
  - Post-concussive emotional symptoms may impact
- Other factors may create issues with peers
  - Time off school
  - Perception of special treatment
  - Bullying

## Academic Functioning

- Conflicting data...
- Impaired cognitive function can impact on academic performance
  - Learning and retention
  - Attention and behaviour
  - Processing speed
- Lack of information for parents and teachers
  - Most teachers won't even be told it happened...

## Has TBI been a problem in your classroom?

- Reflection
- Concerning students
- How do we untangle this stuff and apply it to our work?

## What Can You Do?

- Establishing whether a child's problems are a result of TBI can be difficult
  - Pre-injury information helps
- There is little in the way of treatment for mild injuries
- Rehabilitation approach

## Collaborating with Families

- **Bi-directional flow of communication**
  - Encouraging parents to provide school with info
  - Prompt contact with parents if injuries occur at school
- **Working together to support the child**
  - Meeting to discuss possible impacts and how these can be managed at school
  - Working with the unconcerned parent
  - Working with the hyper-vigilant parent
    - Is there such a thing as being too cautious?

## Initial Short-Term Safety-Net Approach\*

- **School-based plan of temporary accommodations in the first three months after injury**
  - School team meeting
  - Share concussion education resources
  - Develop student support plan procedure

\*based on Dize-Lewis' *Weaving a Safety Net After Concussion* (2012)  
[www.brainline.org](http://www.brainline.org)

## Strategies and Modifications

- **Protecting the Child's Physical Safety**
  - Children should not engage in high-risk physical activities
  - Minimise noise and stimulation wherever possible, especially in the first few days after injury; provide cognitive rest
- **Managing Fatigue**
  - Reduce assignment load
  - Rest periods during the day

## Strategies and Modifications

### □ Attention and Hyperactivity

- Your usual approach!
- Clear expectations and instructions
- Seating near front of class
- Minimising distraction and interferences
- Long or arduous tasks may be more difficult
- Consider noise levels

## Strategies and Modifications

### □ Memory Problems

- Brief instructions
- Directions in both oral and written formats
- Large tasks broken into smaller components
- Repetition
- Written cues
- Lists and organisers

## Strategies and Modifications

### □ Information Processing

- Some children may struggle with verbally-presented information
  - Slow down
  - Repeat information
- Others may have difficulty processing visual information
  - Provide extra time to complete written or drawing tasks and tests

## Strategies and Modifications

### □ Behavioural Problems

- Especially important to engage parents
- Develop a behaviour management plan together
- Use behavioural principles
  - Where possible, ignore unwanted behaviours
    - Unless safety or wellbeing of others is impacted
  - Notice and praise (reinforce) good behaviour
  - Be consistent and firm in enforcing boundaries
    - But don't forget your unconditional positive regard for this child!  
Warmth and compassion essential

## Behavioural Modification

### □ Principles of applied behaviourism – ABCs

- Antecedent – Behaviour – Consequence
- Observe and measure behaviour –
- Establish the function
  - What is the child trying to achieve?
  - What reinforces the behaviour? (attention, avoidance, etc.)
- Alter the consequence
  - Where possible, ignore unwanted behaviours
    - Unless safety or wellbeing of others is impacted
  - Notice and praise (reinforce) good behaviour
  - Be consistent and firm in enforcing boundaries
    - But don't forget your unconditional positive regard for this child! Warmth and compassion essential

## Behavioural Modification

- Where possible, ignore unwanted behaviours
  - Unless safety or wellbeing is at risk
- Notice and praise (reinforce) good behaviour
- Be consistent and firm in enforcing boundaries
  - Remembering your unconditional positive regard for this child!  
Warmth and compassion essential

## Strategies and Modifications

- **Social Difficulties**
  - Engage prosocial peers
  - Avoid placing child in stressful situations
  - Provide opportunities for child to be successful
  - Be alert to fatigue, mood changes and confusion
  - Model appropriate language, conflict resolution, etc.
  - Assist child to make a plan for managing playground situations – rehearse. Engage others.
  - Discuss more formal intervention opportunities with parents
    - E.g. extra-curricular activities, Social Skills Groups, Cognitive Behaviour Therapy

## Enhancing Test Situations

- Additional time to complete tests.
- Reduce distractions
- Allow breaks in longer exams/tests is possible
- Allow oral exams/reader-writer assistance
- Assess knowledge using multiple-choice instead of open-ended questions.
- Allow student to clarify and explain responses on exams (and assignments).
- Consider appropriateness of standardised tests

## Take Home Messages

- Concussion could contribute to a child's difficulties
- Communicating with parents is key
- Identify the child's individual needs and examine what modifications you can make in your class
- Creative, practical, affordable strategies
- Individual Education Plans
- **Please notify parents if a child has a fall or injury at school, even if it seems mild!**

## Helpful links

- New Zealand Guidelines Group Best Practice Guidelines for TBI  
[http://www.nzgg.org.nz/library\\_resources/60\)](http://www.nzgg.org.nz/library_resources/60)
- US-based resource for school issues related to TBI:  
[http://www.brainline.org/landing\\_pages/categories/school\\_results.php?feat=brainline%20kids](http://www.brainline.org/landing_pages/categories/school_results.php?feat=brainline%20kids)
- The Brain Injury Association of NZ <http://www.brain-injury.org.nz/>

Appendix S

Teacher Brochure



## How should children be managed at school after concussion?

Communicate with parents about the child's symptoms and how family and school can work together to support the child.

Together, consider practical strategies for managing ongoing symptoms.

An individualised approach to the short-term management of any ongoing symptoms can help children recover and return to their full level of functioning.

For more helpful information we recommend websites such as

**[www.brainline.org](http://www.brainline.org)** resources for teachers and parents

## Suggestions for Schools

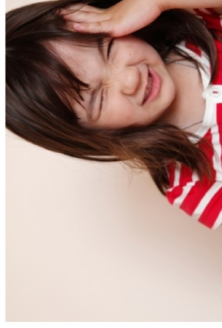
If a child seems to have ongoing symptoms from concussion it may be appropriate to make some adjustments in class and on the playground.

Here are some suggestions for managing ongoing symptoms:

- **Fatigue** - an after-lunch rest period may be appropriate
- **Memory problems** - assistance with taking notes or writing lists may be helpful
- **Attention problems** - strategies like seating a child at the front of the classroom, minimising distractions and keeping noise levels low may be helpful
- **Information processing** - Give slow, clear instructions. Provide extra time for tasks
- **Headaches** - Discuss medication management with families. Reduce child's exposure to stimulating activities noise



## Concussion in the Classroom



## Supporting children and adolescents after concussion

Information and management strategies for teachers



## What is concussion?

**Concussion is a brain injury.**

It may occur from just a minor bump on the head, or from the head being shaken.

Symptoms may occur immediately but in some cases not for days or weeks.

Initial symptoms of concussion may include:

- Headache or a feeling of pressure in the head
- Temporary loss of consciousness
- Confusion or feeling as if in a fog
- Amnesia surrounding the traumatic event
- Dizziness or "seeing stars"
- Ringing in the ears
- Nausea or vomiting
- Slurred speech

## Concussion at School

Always seek medical attention for children or teenagers with suspected concussion.

Contact parents

### How long do symptoms last?

Symptoms may seem better after just a few days. However, a few children may experience ongoing issues.

**Long-term symptoms may include:**

- Ongoing headaches
- Concentration and memory complaints
- Irritability
- Sensitivity to light and noise
- Sleep disturbances
- Mood and personality changes
- Fatigue
- Disorders of taste and smell
- Difficulty with school-work

## Returning to School

It is strongly advised that children rest at home until the initial symptoms of concussion are gone.

When children do return to school, it is possible that ongoing symptoms will be present.



## Returning to Sport?

When all symptoms are fully resolved children can return to playing sports. This process may take weeks or months.

If a child has had more than two concussions, it may be advisable for them to have the rest of the season off. Families should discuss this

Appendix T

Study 3 – Background Questionnaire

## Concussion in the Classroom

### Background Questionnaire

ID (office use only)	
Gender	Male / Female
Date of Birth	
Job Title	
How many years teaching experience do you have?	
What year did you obtain your teaching qualification?	
Age group of current class (Age/School Year)	
Have you participated in earlier COBIC studies in the past two years (i.e. completed a teacher questionnaire regarding a child in your class or participated in an interview about your perspectives on head injury?)	Yes/No
Can we keep your contact details for future studies?	Yes/No
School Area	Hamilton City Waikato Bay of Plenty
School Decile	
Do you have a background in Special Education (e.g., SES, RTLB, Teacher Aide)	Yes/No
<b>Ethnicity (please circle as many as apply)</b> New Zealand European	Yes/No
Maori	Yes/No
Samoan	Yes/No
Cook Island Maori	Yes/No
Tongan	Yes/No
Niuean	Yes/No
Chinese	Yes/No
Indian	Yes/No
Other	Yes/No
If other, please specify	

Appendix U  
Concussion Quiz

**Concussion Quiz**

Concussion is different to a Traumatic Brain Injury **True / False**

You have to lose consciousness to be diagnosed with concussion **True / False**

Concussion has no effect on children's academic performance **True / False**

All concussion symptoms should be gone within two weeks. **True / False**

Concussion only has long-lasting effects if a particular part of the brain is injured. **True / False**

Some people experience concussion symptoms for months or years **True / False**

Children and adults recover differently from concussion **True / False**

Concussions result only from a direct blow to the head. **True / False**

Symptoms of a concussion are very obvious and happen immediately after the injury. **True / False**

---

Appendix V

Seminar and Brochure Evaluation Form

## WORKSHOP EVALUATION FORM

**Please rate the following statements:**

1. *How satisfied were you with today's workshop?*

1	2	3	4
Not at all	Somewhat	Quite	Very

1. *How useful do you think the learning from this workshop will be in your teaching practice?*

1	2	3	4
Not at all	Somewhat	Quite	Very

2. *How relevant is the topic of mild traumatic brain injury to your work as a teacher?*

1	2	3	4
Not at all	Somewhat	Quite	Very

3. *How much of the content in today's workshop was new information for you?*

1	2	3	4
None	Some	Most	All

4. *How likely is it that you might try some of the suggested strategies for managing post-concussive difficulties with the children that you work with?*

1	2	3	4
Not at all	Somewhat	Quite	Very

6. *What was the most useful thing that you learned in today's workshop?*

---



---



---



---



---



7. *What might you do differently in your teaching practice as a result of attending this workshop?*

---

---

---

---

8. *What was the least useful aspect of today's workshop?*

---

---

---

---

9. *How could the workshop be changed and improved for next time?*

---

---

---

---

10. *What other information could be included?*

---

---

---

## TEACHER BROCHURE EVALUATION FORM

1. *How useful is the brochure for teachers who are new to the topic of concussion?*

1  
Not at all

2  
Somewhat

3  
Quite

4  
Very

2. *What other information should be included in the teacher brochure?*

---



---



---

3. *What information does not need to be included in the teacher brochure?*

---



---



---

4. *Upon reviewing the brochure and attending the workshop, which is your preferred mode of learning? (please circle one) :*

- a. brief pamphlet or brochure on the topic of mild tbi
- b. professional development workshop
- c. Both options should be included
- d. Neither

*please suggest another mode that you think would be more useful:* \_\_\_\_\_

---



---

5. *Where would be the most helpful place to make brochures, posters and other written resources available for **teachers** (please circle one)?*

- a. staffroom
- b. school reception
- c. online (e.g., school website, via Ministry of Education or Ministry of Health, etc.)
- d. other: \_\_\_\_\_

6. *Where would be the most helpful place to make brochures, posters and other written resources available for **parents** (please circle one)?*

- a. school reception
- b. attached to school newsletters
- c. online
- d. GP practices and hospitals
- e. sports clubs
- f. other: \_\_\_\_\_