SCHOOL OF PSYCHOLOGY - DOCTORATE IN CLINICAL PSYCHOLOGY

MAJOR RESEARCH PROJECT

LITERATURE REVIEW: A Review of Emotional Empathy Abilities in Adults with Traumatic Brain Injury

EMPIRICAL PAPER: The Association between Traumatic Brain Injury, Behavioural Factors and Facial Emotion Recognition Skills in Delinquent Youth

Submitted by **Sarah Cook**, to the University of Exeter as a thesis for the degree of **Doctor of Clinical Psychology, May 2014**

Signature: ……

Table of Contents

Tables

Literature Review

Empirical Paper

Figures

Literature Review

AUTHOR'S DECLARATION

The literature review was completed independently by the author.

The study was designed by the author. Participants recruited at time-point one were recruited by an MSc student Miriam Cohen in May 2013 for the project "Storm, Stress and Broken Brains: The Influence of Traumatic Brain Injury on Socio-Emotional Processing in Delinquent Adolescents". Participants recruited at time-point two between October 2013 and March 2014 were collected jointly by the author and another DClinPsy trainee, Heloise Hunt. Her project utilised additional measures for the project "Impulsivity and Risk-Taking in Adolescent Young Offenders: Does Traumatic Brain Injury Play a Role?". A total of 12 participants were tested by Heloise Hunt and 11 by the author. All other aspects of the study were completed by the author including data entry, analysis, and write up.

LITERATURE REVIEW COVER SHEET

TITLE: A Review of Emotional Empathy Abilities in Adults with Traumatic Brain Injury

TRAINEE NAME: Sarah Cook

SUPERVISORS

PRIMARY:
Prof. Huw Williams, Associate Professor, University of Exeter

SECONDARY:
Dr Nick Moberly, Senior Lecturer, University of Exeter

TARGET JOURNAL: Journal of International Neuropsychological Society
WORD COUNT: 3,992 (excluding headings, tables, figures and references)
DATE OF SUBMISSION: Resubmission 15th August 2014

DECLARATION:
I certify that all material in this literature review which is not my own work has been identified and that no material has been previously submitted and approved for the award of a degree by this or any other University.

A Review of Emotional Empathy Abilities in Adults with Traumatic Brain Injury

Abstract

Objectives. The social brain is sensitive to disruption after traumatic brain injury (TBI) that can leave aspects of social cognition impaired. Empathy has been defined as the "binding force" of social cognition, allowing individuals to share experiences and perspectives. Emotional empathy (EE) is the ability to share similar emotional experiences or having an appropriate emotional response to another person's feelings, and the main aim of the review was to consider the relationship between TBI and EE and critically evaluate the studies in this area.

Method. Eight databases were searched using combinations of key words. A total of 14 papers were included in the review.

Results. EE is impaired in people with moderate to severe TBI as compared to controls in the majority of studies. Links between EE, behavior and other social cognition abilities are unclear and require further attention. Furthermore, the association between mild TBI and EE has been comparably less well studied. EE is most commonly measured with self-report questionnaires, and it is unclear how EE deficits translate into behavioural difficulties. The risk of bias in the studies is low.

Conclusions. More large scale research, utilising dynamic, sophisticated and ecologically valid measures of EE, and examining the neuropsychological underpinnings and behavioral consequences of EE is needed in order to draw conclusions for clinical practice.

Key words: emotional empathy, affective empathy, empathic concern, brain injury, TBI, head injury, adults.

Introduction

Traumatic brain injury (TBI), defined as “an alteration in brain function, or other evidence of brain pathology, caused by an external force” (Menon, Schwab, Wright, & Mass, 2010, p. 1638), represents a significant public health problem in the UK and across the world with an incidence of approximately 235 per 100,000 in Europe (Tagliaferri, Compagnone, Korsic, Servadei, & Kraus, 2006). Changes in emotional and social behaviour and cognition after TBI are relatively common and have serious consequences for psychosocial outcome (Kendall & Terry, 1996; Levin, 1995; Prigatano, 1992). Social cognition can be seen as one of many higher order cognitive functions required for effective social skills (Beauchamp & Anderson, 2010) and includes a range of abilities including theory of mind (ToM), empathy, face and emotion perception, attribution, and moral reasoning. The focus of this review will be to examine emotional empathy (EE).

Empathy has been defined as the “binding force” of social cognition allowing individuals to share experiences and perspectives (Eslinger, Parkinson, & Shamay, 2002), and impairments in empathy have been found to be central to a number of neurological and psychiatric conditions including stroke (Grattan & Eslinger, 1989), autism (Dziobek et al., 2008) and schizophrenia (Lee, Farrow, Spence & Woodruff, 2004). Empathy itself is a broad concept which refers to our ability to mentally simulate others’ mental states, both emotionally and cognitively, and helps us to predict their experiences, intentions and needs (Preston & de Waal, 2002). This distinction between affective and cognitive components overlaps with Frith and Frith’s (2010) model of mirroring and mentalizing systems in social cognition. Emotional empathy (EE; also known as affective empathy), which is the focus of this review, is the ability to share similar emotional experiences (Mehrabian

& Epstein, 1972) or having an appropriate emotional response to another person's feelings (i.e., empathic concern; Davis, 1980). Cognitive empathy (CE) however is the ability to adopt others' point of view (e.g., ToM). Although dissociable, it has been suggested that these processes are at least partially overlapping (Shamay Tsoory, Aharon-Peretz, & Perry, 2009). There has been relatively more published on CE and ToM as compared to EE, highlighting possible impairment in the empathy domain in many neurological samples. For example, Grattan and Eslinger (1989) found that over half of their sample of stroke and TBI participants reported low CE compared to controls, and Bibby and McDonald (2005) found patients with severe TBI were impaired in ToM tasks as compared to healthy controls.

Furthermore, a third type of empathy has been also been identified (Blair, 2005), which is that of "motor empathy" referring to the tendency to automatically mimic and synchronise facial expressions, vocalisations, postures and movements with those of another (Hatfield, Cacioppo, & Rapson,1994). Also known as 'emotional contagion', this relies on mirror neurons which show activity during the execution and observation of an action (Rizzolatti, Fogassi, & Gallese, 2001). There is some debate about whether this emotional contagion is separate to (Blair, 2005) or part of EE (Hatfield et al., 1994). Certainly at a neurological level, CE and EE have been shown to have two dissociable pathways in the brain (Shamay-Tsoory et al., 2009). CE involves the ventromedial prefrontal cortex (also involved in cognitive control & executive functions; Miller & Cohen, 2001) whereas the EE pathway primarily involves the insula, amygdala and anterior cingulate cortex (structures involved in general emotion processing; Shamay-Tsoory et al., 2009). Furthermore, EE specifically seems to recruit various "extended"

systems (e.g., insular cortex; Jabbi, Swart & Keysers, 2007; Wicker et al., 2003), and is therefore special due to its facilitation of somatic, sensory and motor representations of other people's mental states and increased vigorous mirroring as compared to CE (Nummenmaa, Hirvonen, Parkkola, & Hietanen, 2008). Although motor and EE have been distinguished conceptually, the ability to feel how someone else feels will rely on both affective and mirroring components, thus blurring the distinctness of this third form of empathy. It is likely that the empathy systems share anatomical overlap but can also operate independent of one another (Blair, 2005).

Most of the literature examining these pathways underlying empathy have included diverse neurological samples including stroke, TBI and acquired brain injuries such as tumours. TBI commonly involves pathology to the anterior brain regions which are involved in social cognition (Tasker et al., 2005) and therefore the structures underlying this are particularly vulnerable to disruption. Although TBI produces variable and diffuse neuropathology, some typical patterns arise as a result of acceleration-deceleration forces that disrupt brain tissue (Bigler, 2007) and disrupt connections between subcortical and frontal systems (e.g., diffuse axonal injury; Kennedy et al., 2009) thus leading to socio-emotional impairments. Possible predictors of outcome after adult TBI include age of injury, level of education, injury severity and time since injury (Bowman, 1996; Tate & Broe, 1999), but it is unclear how these relate to EE. On a clinical level it is difficult to see how empathy deficits manifest behaviourally. CE could be reflected in a lack of social discretion and poor awareness of the emotional states of others thus leading to difficult social encounters, and it could be hypothesized that diminished EE may be reflected in cold emotional responding (Wood & Williams, 2008). Despite it being

advantageous to treat complex impairments in social cognition (Neumann, Zupan, Malec, & Hammond, 2014), little is known about the links between empathy impairment and behaviour. Similarly, alexithymia, defined as a difficulty in identifying, describing, differentiating and experiencing one's own feelings can also be impaired after TBI, however its links with EE are unclear. Theoretically, a difficulty feeling and experiencing one's own emotions could interfere with the ability to share the emotional experience of another, because experiencing how they feel could rely on the self-awareness of internal emotion that is impaired in alexithymia. Therefore, alexithymia could be a contributing factor to reduced EE performance (Neumann et al., 2014). In addition, researchers propose that facial mimicry reflects an internal simulation of the perceived facial expression in order to facilitate understanding of others' emotion (Atkinson & Adolphs, 2005), and is therefore linked to both EE and facial emotional recognition. Taken together, there are a number of factors including alexithymia, cognition and mirroring which could have important links with EE, but currently these are not well understood.

In neuro-rehabilitation, it is vital that clients develop improved skills for social interaction and participation. The effectiveness of rehabilitation however often focuses on the compensation or remediation of specific neurocognitive deficits (e.g. Cicerone et al., 2011), and there is a lack of evidence to guide clinical practice around social cognition difficulties in people with TBI. This review is aimed at providing a starting point for a better understanding of what is known about a vital aspect of social competence, that of EE, which forms part of the 'glue' of social exchanges which may be impacted by TBI. Although the literature has demonstrated these impairments may also be present in other neurological and psychiatric conditions, this review will focus solely on

TBI so as the literature can be synthesised for this specific group and be helpful for neurorehabilitation.

The purpose of this review, therefore, is to integrate the empirical literature that has investigated EE after TBI in adults, in an effort to better understand any level of impairment, how it is tested for and its associations with other key abilities and disorders after TBI. Although general reviews of social cognition after TBI exist (e.g., Bornhofen & McDonald, 2008; McDonald, 2013), there is no review with a sole focus on EE, and this review is timely given the quantity of studies examining EE which have been published in the last three years. The research questions for this review are therefore: (1) How has EE been examined after TBI? (2) Is EE impaired after TBI? (3) What is the relationship between EE and other factors in TBI?

Method

The search strategy involved systematic review of published peer-reviewed articles from 1950 to 2014. Seven databases were searched; EBSCO, Web of Knowledge, JSTOR, Science Direct, PsycARTICLES, PsycINFO and Medline PubMed. The following search terms were used to search titles, abstracts and key words: “emotional empathy”, “affective empathy”, “empathic concern”, “adults”, “brain injury”, “TBI” and “head injury”. Terms were searched in combinations using “AND” to combine an empathy-related and head injury- related term, and “OR” with terms within each category. e.g., “emotional empathy OR empathic concern AND head injury”.

To be included in the review, studies needed to include (a) a distinct TBI sample (b) an EE measure (c) an adult sample (>18 years). Studies were excluded if (a) not in English, (b) full text was not obtainable, (c) considered

other neurological disorders (e.g., stroke, tumours, ABI) or neurodevelopmental conditions (e.g., autism), (d) measured only CE, or (e) were not original research (e.g., review papers). A total of 384 citations resulted from these combinations of search terms across the databases. Removal of duplicates and screening of titles and abstracts led to 25 full-text papers being read. A further 11 studies were excluded based on inclusion/exclusion criteria, resulting in 14 papers for review (see figure 1).

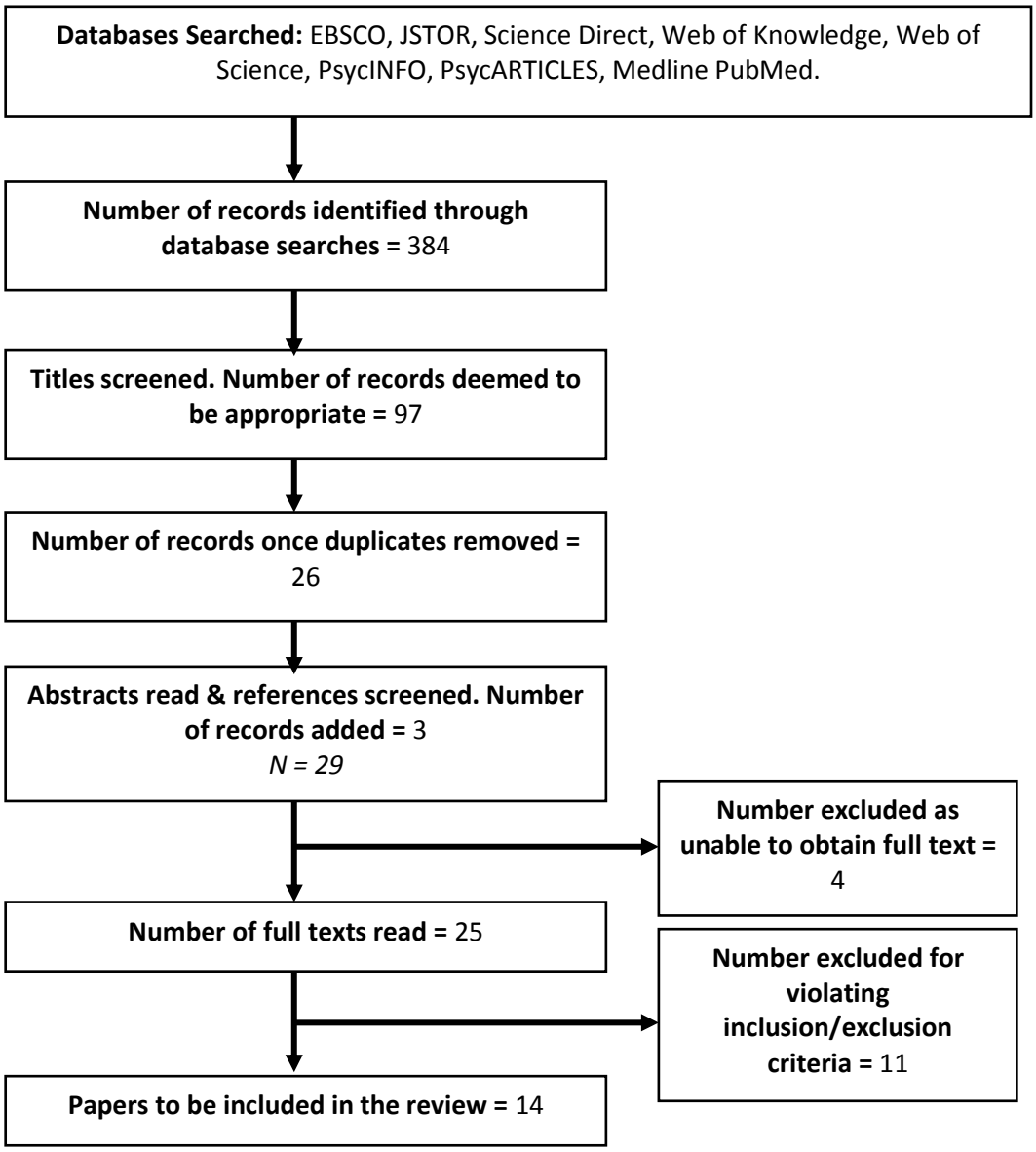


Figure 1. Search strategy and process of identification, screening, eligibility and inclusion for the review.

Data were extracted from the full text using a data extraction form (see appendix A) which examined study design, methodology, analysis, results and author's conclusions. Quality of the papers was assessed using The Cochrane Collaboration's tool for assessing risk of bias (see appendix B; Higgins, Altman & Sterne, 2011). Strengths and limitations, appropriateness of methodology and measures, statistical issues, quality of reporting and generalizability of findings were all considered. A total of 14 papers were reviewed (see Table 1).

Table 1. Studies included in the review including study characteristics, measures, findings and critical evaluation

Study	Study Aims	Design	Sample characteristics	Measures	Main EE findings & estimated effect size (*d*)*	Evaluation & Risk of Bias
Bardenh-agen et al., 1999	To examine two cases of severe TBI and the long term social and cognitive sequelae.	Case study design	**Place of study:** Australia **TBI Group** (n=2) No demographic information given to ensure confidentiality. - Initially seen for routine neuropsychological assessment. - Severe TBI - 20 years post injury	**Emotional Empathy Measure(s):** *Questionnaire Measure of Emotional Empathy (QMEE; self-report)* **Other Measures:** WAIS-R, WMS-R, NART, BDI, BNT, MMPI-2, WCST, Trail Making & Short Category Test Controlled word Association Test State-Trait Anxiety Inventory Pushbutton Maze test 14 months later re-administered: WAIS-III, WMS-III; Delayed alternation task; Object alternation task; Delayed matching to sample task; 6 Elements Task; Hogan Empathy scale; Brock Adaptive Functioning Scale	• HB scored 1 SD above the mean on QMEE. Wife rated him closer to the mean for men. • NL self-rated above the mean, but his brother rated 0, suggesting that although he rates his empathy as normal, it may not be perceived by others that way. **Estimated effect size(s):** not possible to calculate.	**Strengths:** In depth exploration of cases with multiple neuropsychological measures. **Limitations:** Very small sample with no comparison. Difficult to generalise. Cases were 20 years post injury which is significantly more than other studies. **Possible Sources of bias:** Difficult to generalise these findings for a small and specific sample. **Risk of Bias:** High. High with small sample. Cannot generalise.
de Sousa, McDonald, Rushby, Dimoska & James, 2010	To examine the relationship between self-reported emotional and cognitive empathy and psychophysiol ogical responding to emotionally evocative pictures.	Case control, between groups design comparing TBI with matched controls.	**Place of study:** Australia **TBI Group** (n=20) - Severe TB I (PTA >1day) - At least one year post injury - Recruited from brain injury units - Exclusion: aphasia or agnosia, unable to comprehend instructions. **Control Group** (n = 22) - Matched on gender and education level. - Controls were significantly younger. Authors reported therefore creating age-adjusted subgroups (TBI <55 years *n*=15 & control >23 years, *n*=18) and reported whole sample and age-adjusted group results in the analysis.	**Emotional Empathy Measure(s):** *Balanced Emotional Empathy scale* (*BEES; self-report) Interpersonal Reactivity Index*(IRI; IRI-EC is empathic concern; self-report) *Empathy Quotient (EQ;* self-report*)* **Other Measures:** Stimuli presented from the International Affective Picture System DASS-21 Facial EMG & skin conductance measured	• TBI group had significantly lower levels of EE on all 3 measures (BEES, IRI-EC & EQ-ER) as compared to the control group and the normative data for BEES and IRI. Significant differences remained for age-adjusted group. • Based on norms/z scores in the BEES manual, participants in TBI and control groups were split into those with low, and normal empathy • 70% of TBI showed low EE compared to 31.8% of controls on BEES. • 82% of controls had normal EE as measured by IRI-EC and EQ-ER as compared to 55% (IRI-EC) and 50% (EQ) of TBI. **Estimated effect size(s):** BEES *d*=0.94; IRI-EC *d*=1.23 EQ *d*=0.85	**Strengths:** Used multiple measures to assess EE. Describes excluded data clearly. **Limitations:** Although multiple measures of EE used, these are all questionnaire and self-report and lack dynamism or ecological validity. **Possible Sources of bias:** Well reported outcome data. **Risk of Bias:** Low.

de Sousa, McDonald, Rushby, Dimoska & James, 2011.	To examine the relationship between emotional empathy and emotional responsivity in patients with TBI.	Case control, between groups comparing TBI with matched controls.	**Place of study:** Australia **TBI Group** (n= 21) - Severe TB I (PTA >1day) - At least 8 months post injury - Recruited from brain injury units - Exclusion: aphasia or agnosia, unable to comprehend instructions. **Control Group** (n = 22) - Matched on gender and education level. - Controls were significantly younger. Authors reported therefore creating age-adjusted subgroups (TBI <55 years *n*=15 & control >23 years, *n*=18) and reported whole sample and age-adjusted group results in the analysis.	**Emotional Empathy Measure(s):** *BEES* **Other Measures:** Stimuli pictures of facial affect from Pictures of Facial Affect series DASS-21 Facial EMG and skin conductance measured.	• TBI group reported significantly lower EE scores as measured by BEES as compared to controls. Significant difference remained for age-adjusted groups. • Based on norms/z scores in the BEES manual, participants in TBI and control groups were split into those with low, and normal empathy • 66.7% had low EE in TBI vs 31.8% of controls. • There was no association between low EE and zygomaticus activity. • Participants in the TBI group who were low on EE showed greater corrugator activity in response to happy compared to angry facial expression. • Low EE TBI participants showed increases in skin conductance for happy as compared to angry faces (reverse for controls). **Estimated effect size(s):** BEES *d*=0.90	**Strengths:** Integrates questionnaire methods with psychophysiological recording. **Limitations:** Static images of faces used lack ecological validity. Relatively small sample. No power analysis. **Possible Sources of bias:** 18 of the 22 TBI clients took part in the 2010 study. It is not possible to identify which ones so this study provides some replication of results already reported in 2010, with 4 new participants added into the analysis. Relevant for BEES only. **Risk of Bias:** Low.
de Sousa, McDonald & Rushby, 2012	To (a)examine the presence of self-reported EE, contagion deficits & impaired physiological reaction to emotional film stimuli in people with TBI, & (b) investigate if these were associated with loss of emotional control/drive as reflected in behavioural changes in TBI.	Case control, between groups design comparing TBI with matched controls.	**Place of study:** Australia **TBI Group** (n=21) - Severe TB I (PTA >1day) - At least 8 months post injury - Recruited from brain injury units - Exclusion: aphasia or agnosia, unable to comprehend instructions. **Control Group** (n=25) - Matched on gender and education level. - Controls were significantly younger. Authors reported therefore creating age-adjusted subgroups (TBI <55 years *n*=15 & control >22 years, *n*=18) and reported whole sample and age-adjusted group results in the analysis. - No history of neurological, developmental or substance misuse disorders.	**Emotional Empathy Measure(s):** *BEES* *The Emotion Contagion Scale* (ESC; self-report) **Other Measures:** WTAR DASS-21 The Current Behaviour Scale Self-Assessment Manikin Emotional film clip stimuli Psychophysiological recording (facial EMG, skin conductance)	• Participants in the TBI group reported significantly lower EE on the BEES and ECS as compared to controls. Results remained significant for the age-adjusted group. • Based on norms/z scores in the BEES manual, participants in TBI and control groups were split into those with low, and normal empathy • 71% of individuals with TBI exhibited low EE compared to 16% of controls. • 57% of the TBI group had low ECS scores compared to 28% of controls. • Those in the TBI group with low EE had greater loss of motivation as compared to the normal EE group. • No significant correlations between EE and physiological responses were found. • The TBI group had impaired facial contagion responses to both positive and negative film clips and lower arousal to negative clips as compared to controls. **Estimated effect size(s):** Not possible to calculate (overall means not given)	**Strengths:** Examines the association between EE and behaviour. Uses dynamic and ecologically valid film clip stimuli. **Limitations:** Relatively small and heterogeneous sample. **Possible Sources of bias:** The authors do not make it clear whether any of these participants had taken part in either of their previous studies (2010, 2011). Although numbers slightly differ, it is not clear if each of the 3 samples are separate and therefore whether there is a possible bias in duplicating the findings related to EE. **Risk of Bias:** Unclear.

Leopold et al., 2012	To compare performance of patients with left, right and bilateral vmPFC lesions on two TOM tasks - cognitive and affective.	Case control, between groups design comparing TBI with matched controls (veterans).	**Place of study:** USA **TBI Groups** (TBI with vmPFC damage n = 30; TBI with PC damage n = 76) - Focal penetrating TBI with either posterior cortex damage or vmPFC damage. - Recruited from Vietnam Head Injury Study Registry **Control Group** (n=55) - Matched with both TBI groups on age, IQ, depression, working memory and verbal naming ability.	**Emotional Empathy Measure(s):** *BEES* **Other Measures:** Faux Pas task Happe Story Task Mayer-Salovey-Caruso Emotional Intelligence Test.	• Groups did not differ significantly on EE scores. • Positive correlation found between performance on affective TOM task and EE for bilateral vmPFC patients only and not unilateral. **Estimated effect size(s):** Not possible to calculate, means and standard deviations not reported.	**Strengths:** Considers neurological systems in emotional empathy. **Limitations:** Unequal group sizes. **Possible Sources of bias:** Sample specifically is for penetrating TBI, indicating possible selection bias, with presumably most participants classified as severe TBI. Sample from Vietnam veterans, but no detail was given about the screening or inclusion of those with mental health difficulties which may be common with this population. **Risk of Bias:** Low
McLellan & McKinlay, 2013	To examine deficits in emotion perception in adults with TBI during childhood and investigate relationships between emotion perception skills, empathy and TOM.	Case control, comparing mild TBI with moderate/ severe TBI and matched controls with orthopaedic injuries.	**Place of study:** New Zealand **TBI Groups** (Mild TBI n = 18, moderate/severe TBI n=15) - Mild (LOC<20min or PTA<1 day), moderate or severe TBI (PTA >1 day) - Aged 18-30 - Minimum 5 years post injury **Control Group** (n = 19) - Matched to both TBI groups on NART and estimated verbal IQ. - Excluded if experienced a TBI event	**Emotional Empathy Measure(s):** *IRI* **Other Measures:** Emotion sensitivity task Facial expression recognition task Faux pas test	• No group differences found in total empathy scores. • Data for individual subtests of the IRI was not available. **Estimated effect size(s):** IRI *d*=0.15 for moderate/severe TBI *d*=0.08 for mild TBI	**Strengths:** Reports effect sizes. Considers mild TBI as well as moderate/severe. **Limitations:** Didn't report subscale scores to differentiate between emotional and cognitive empathy. **Possible Sources of bias:** Exclusion criteria not reported. Sample aged below 30, so does not span all of adulthood. **Risk of Bias:** Low.
Milders, Fuchs & Crawford, 2003	(a) To identify impairments in expression recognition, understanding of situations and intentions,	Case control, comparing TBI with matched controls.	**Place of study:** UK **TBI Group** (n=17) - Moderate/severe TBI as measured by GCS <12. - Recruited from rehabilitation centres.	**Emotional Empathy Measure(s):** *EEQ (Emotional Empathy Questionnaire*: self-report*)* **Other Measures:** Neuropsychology Behaviour and Affect Profile	• No significant difference found between the TBI group and controls on EE. **Estimated effect size(s):** EEQ *d*=0.14	**Strengths:** Assessed multiple aspects of social cognition. One of few studies to look at the relationship between social cognition impairment and behaviour. **Limitations:** Does not

	and flexibility in patients with moderate to severe TBI, and (b) To investigate the relationships between these impairments with ratings concerning the patients behaviour		- Mean time since injury 4.4 years. - Sample reported no history of psychiatric or substance misuse **Control Group** (n=17) - Healthy controls recruited from a psychology department and newspaper advert - Matched on age, education and gender.	Social Integration Questionnaire 4 tests for facial expressions (naming facial expression, matching facial expression across identity, matching expression across situation (verbal and picture) Facial recognition test 4 emotional prosody tests (emotional prosody discrimination, naming emotional prosody, conflicting emotional prosody, non-emotional prosody discrimination) Faux Pas Test Eye test 2 Cognitive flexibility tests (Ruff Figural Fluency Test, Uses for Objects)		describe a priori inclusion/exclusion criteria, only the sample characteristics. Not all measures are standardised. **Possible Sources of bias:** Possible selection bias in this small sample recruited from a rehabilitation centre where participants have received some interventions and had been prepared to return to work. Those with more severe behavioural issues would not be included in the sample since they would not be able to return to work, so the sample may not be representative and may have underestimated social emotional difficulties in the TBI population. Moderate/severe TBI only. **Risk of Bias:** Low
Muller at al., 2010	To (a) explore abilities to infer others' mental states through several ToM tasks in TBI (b) understand the interaction between ToM and other aspects of social cognition like empathy, language and executive functioning.	Case control, between groups design comparing TBI with matched controls.	**Place of study:** France **TBI Group** (n = 15) - Severe TBI - Recruited from rehab centre, a nursing home for TBI and a unit for Evaluation, Training and Social and Vocational Counselling - Exclusion: premorbid psychiatric or substance misuse **Control Group** (n = 15) - Healthy sample, matched on age, sex & education - No history of neurological or psychiatric history	**Emotional Empathy Measure(s):** *IRI* **Other Measures:** WAIS-R Stroop Colour Word Test Trail Making Test A and B Verbal Fluency CVLT 4 ToM Tasks (Faux pas, false belief, character intention test and reading the eyes in the mind) Interpretation of indirect speech act task	• No significant difference found between TBI and controls on IRI • No correlation between empathic concern subtest and TOM. **Estimated effect size(s):** IRI-EC *d*=0.45	**Strengths:** Provides appendix of measures and describes these clearly so is replicable. **Limitations:** Small sample. Did not examine IQ. **Possible Sources of bias:** Selection bias for severe TBI only. **Risk of Bias:** Low.

Neumann et al., 2014	To (a) determine alexithymia, affect recognition and empathy differences in participants with and without TBI (b) explore the amount of affect recognition variance explained by alexithymia, and (c) the amount of empathy variance explained by alexithymia and affect recognition.	Case control, between groups design comparing TBI with matched controls.	**Place of study:** USA & Canada **TBI Group** (n=60) - Moderate-Severe injuries determined by PTA >1 day; GCS <12; LOC>30min or self-report if no medical record. - Age 18-65. - Able to process auditory and visual information - Minimum 6 months post injury - Recruited from brain injury rehabilitation clinics and community. - Exclusion: autism, neurological or psychiatric disorder, impaired vision/hearing, TBI <8 years age. **Control Group** (n =60) - Healthy controls recruited from the community, universities, family and friends of participants - Matched on age and gender - same exclusion criteria and history of TBI	**Emotional Empathy Measure(s):** *IRI* **Other Measures:** TAS-20 Diagnostic Assessment of Non Verbal Affect 2 - Accuracy of Adult Faces and Adult Paralanguage	• TBI group scored significantly lower on empathic concern scale of IRI as compared to controls. • GCS/PTA/LOC not correlated with EE • EE variance was not explained by alexithymia or affect recognition in controls or TBI, but explained variance in cognitive empathy (16.5%) for TBI group only. **Estimated effect size(s):** IRI-EC *d*=0.55	**Strengths:** Explored why differences in EE may exist. **Limitations:** Used self-report TBI data for some participants. Didn't collect any mood or neuropsychological measures. Unclear if empathic concern subscale is fully representative of EE. **Possible Sources of bias:** Not clear how representative the sample is; the proportion recruited from support groups and clinics. Moderate/Severe only. **Risk of Bias:** Low.
Rushby et al., 2013	To examine the relationship between empathy deficits and psychophysiol ogical responsivity in adults with TBI.	Case control, between groups comparing TBI with matched controls.	**Place of study:** Australia **TBI Group** (n=19) - Severe TBI leading to inpatient rehab - At least 1 year post-injury - Exclusion: no prior history of psychiatric, developmental or neurological disorders, aphasia/agnosia, those who cannot comprehend instructions **Control Group** (n=25) - Health controls from the community - Matched in gender and education - No history of TBI, neurological or psychiatric disorders	**Emotional Empathy Measure(s):** *BEES* *ECS* **Other Measures:** WTAR DASS-21 Emotional film clip stimuli Psychophysiological recording (facial EMG, skin conductance and heart rate)	• TBI group reported significantly lower EE on both questionnaires as compared to controls. • Higher empathy scores were significantly correlated with higher physiological arousal for TBI group only. • Emotional contagion normalised with repeated exposures to film stimuli. **Estimated effect size(s):** Not possible to calculate. Does not report means or standard deviations.	**Strengths:** Looked at multiple exposures of film clip stimuli, which is ecologically valid and allowed the author to make recommendations for intervention i.e. that given multiple exposures, people with TBI can experience empathy. **Limitations:** Small and heterogeneous sample in terms of severity and neuropathology. **Possible Sources of bias:** Possible selection bias with severe TBI only. Overall very well reported outcomes. **Risk of Bias:** Low.

Shamay, Aharon-Peretz, Berger & Tomer, 2001	To examine the effect of lesions to the PRC on cognitive and emotional empathy.	Case control, between groups comparing TBI with age-matched controls.	**Place of study:** Japan **TBI Group** (n=11) - Recruited participants had been referred for cognitive assessment in a neurology unit following removal of meningioma or penetrating head injury - Exclusion: aphasia, visual/motor impairment, pre-existing psychiatric or neurological disease. **Control Group** (n = 8) - Healthy controls - Age matched to TBI group	**Emotional Empathy Measure(s):** *QMEE* *IRI* **Other Measures:** Hogan Empathy scale Cognitive flexibility measures (WCST, Trail Making Test, Verbal Fluency, Design Fluency, Alternative uses test & one subtest from Torrance Test of Creative Thinking) Recognising facial expression task Affective prosody task Task for ironic meaning.	• Patients scored significantly lower than controls on all empathy scales. • Performance on cognitive flexibility was not related to EE. • Decrease in scores for understanding ironic meaning was correlated with EE for TBI but not controls. **Estimated effect size(s):** Not possible to calculate. Does not report means or standard deviations.	**Strengths:** Separates out cognitive and emotional empathy clearly. Clear reporting of correlations. **Limitations:**. Small sample and lack of detailed reporting. **Possible Sources of bias:** Paper is lacking in detail for the outcomes providing a possible reporting bias. No demographic information is given increasing the risk of bias. **Risk of Bias:** Unclear.
Spikman, Timmerman, Mildersm Veestra & van der Naalt, 2012	To assess (a) whether TBI participants are impaired on social cognition measures, if the measures are related to each other, and whether they relate to cognitive measures, and (b) whether social cognition tests are sensitive to injury and prefrontal damage	Case control, between groups comparing TBI with matched controls.	**Place of study:** Netherlands **TBI Group** (n = 28) - Moderate-severe TBI, GCS <13 or PTA >1 day. - Participants previously attended neurology department. - Exclusion: >1 TBI, other neurological conditions, psychiatric or substance misuse problems. **Control Group** (n = 55) - Recruited from newspaper advert - Matched on age, gender and education - Excluded if history of TBI	**Emotional Empathy Measure(s):** *EEQ* **Other Measures:** Trail making test Rey's Auditorily Verbal Learning Task Zoo Map Test Six Elements Test Facial Expressions of emotion-Stimuli Test Cartoon Test (ToM) Short Faux Pas test	• TBI had significantly lower EE compared to controls in a t-test. • EE was not significantly correlated with other social cognition measures, the cognitive measures or PTA/GCS/lesion location. • Only the face task was correlated with GCS, PTA and OFC lesion location. **Estimated effect size:** EEQ *d*=0.69	**Strengths:** Describes analysis and effect sizes thoroughly. **Limitations:** Complex tasks for executive functioning tapping into multiple domains which may have obscured effects of single domains on social cognition tasks. **Possible Sources of bias:** No mild TBI sample. Results generalizable only to moderate severe. **Risk of Bias:** Low.

Wood & Williams, 2008	To explore (a) Impact of TBI on EE (b) relationship between EE and neuropsychological ability, (c) influence of low EE on affect	Case control, between groups comparing TBI with matched controls.	**Place of study:** UK **TBI Group** (n = 89) - Aged 22-71 (account for immature frontal lobes important for empathy) - GCS of 3-15 Recruited from Head Injury Clinic for LT sequalea. - Exclusion: pre-accident history of personality disorder, LD, dysphagia or neurological disorder **Control Group** (n = 84) - Matched on age, SES & gender to TBI group	**Emotional Empathy Measure(s):** *BEES* **Other Measures:** WAIS subtests Zoo Map Test Hayling Test Brixton test BDI BAI	• Based on norms/z scores in the BEES manual, participants in TBI and control groups were split into those with low, normal and high EE for comparison. • 60.7% of the TBI group had low EE compared 31% of controls which was significantly lower. • No relationship found between low mood/anxiety and EE. • Males had lower EE compared to females • No relationship found between injury severity and EE. • No relationship found between EE and neuropsychological testing, suggesting that EE is independent of cognitive abilities per se. **Estimated effect size(s):** Not possible to calculate. Does not report means or standard deviations.	**Strengths:** Included a power analysis. Large sample size. Considers impact of cognitive abilities of social cognition. Range of severity. Recruited over age 22 to account for ongoing brain development. **Limitations:** Not clear about the severity of TBI included i.e. gives mean PTA and GCS with range only. Unclear where controls recruited from. Does not report if parametric assumptions were met. **Possible sources of bias:** Doesn't discuss missing data clearly and where this is, only acknowledges some participants had different measures/didn't do all. Recruited from a setting where patients were referred for problems with everyday behaviour, which provide a selection bias. **Risk of Bias:** Low
Williams & Wood, 2010	(a) examine the prevalence of TBI and alexithymia in TBI & compare to controls (b) examine relationship between alexithymia, EE & TBI, (c) examine relationship b/w injury severity, alexithymia & EE	Case control, between groups comparing TBI with matched controls.	**Place of study:** UK **TBI Group** (n = 64) - Over age 20. - Moderate or severe TBI as measured by PTA or GCS. - Recruited from Head Injury Clinic for LT neuropsychological sequalae. - Exclusion: pre-accident history of personality disorder, LD, dysphagia or neurological disorder **Control group** (n = 64) - Matched on gender, age, SES and employment. - Recruited from family and friends from the University	**Emotional Empathy Measure(s):** *BEES* **Other Measures:** TAS-20 WAIS III subtests (verbal, cog flexibility, working memory)	• 60.9% of the TBI group reported high alexithymia compared to 10.9% of controls, and 64.1% of TBI group had low EE compared to 34.4% of controls • Hierarchical regression for impact of cognitive abilities on TAS-20 and BEES was non- significant for the TBI group. • Significant moderate negative correlation between TAS-20 and BEES for both groups • No relationship between injury severity and EE/TAS-20. • Alexithymia explained 9% of the variance in EE scores. **Estimated effect size(s):** BEES *d*=0.68	**Strengths:** Provides details on assumptions prior to analysis. Large sample size. **Limitations:** Use of self-report measures. Did not assess for alexithymia difficulties pre-injury. **Possible Sources of bias:** Clearly states the TBI participants did not take part in 2008 study. Recruited from a setting where patients were referred for problems with everyday behaviour, which may provide a selection bias. **Risk of Bias:** Low.

*It was beyond the scope of this review to examine results beyond those related to EE, so these are the only results reported. Estimate of effect size was calculated based on reported means and standard deviations in the study and is reported as Cohen's *d* for each EE measure.
Note: EE, Emotional Empathy; SES, Socioeconomic status; PTA, post-traumatic amnesia; GCS, Glasgow Coma Scale; LOC, Loss of consciousness.
Measures: QMEE, Questionnaire Measure of Emotional Empathy; EEQ, Emotional Empathy Questionnaire; BEES, Balanced Emotional Empathy Scale; TAS-20, Toronto Alexithymia Scale 20; BDI, Beck Depression Inventory; BAI, Beck Anxiety Inventory; DASS-21, Depression and Anxiety Scale 21; WTAR, Wechsler Test of Adult Reading; WAIS-R, Wechsler Adult Intelligence Scale Revised; WMS-R, Wechsler Memory Scale Revised; WAIS-III, Wechsler Adult Intelligence Scale III; WMS-III, Wechsler Memory Scale III; CVLT, California Verbal Learning Test; WCST, Wisconsin Cart Sorting Test; NART, National Adult Reading Test; MMPI-2, Minnesota Multi-axial Personality Inventory 2; BNT, Boston Naming Test.

Results

Review question 1: How has EE been examined after TBI?

Design. A total of 14 papers were reviewed. Thirteen were between-groups designs comparing adults with TBI with a matched control group and one was a case study. All papers were cross-sectional and observational, therefore causal inferences cannot be made.

Participants. Total sample sizes ranged from 2 participants (Bardenhagen et al., 1999) to 173 participants (Wood & Williams, 2008), with a range of 11-89 in the TBI groups of comparative studies. The majority of studies excluded participants with a history of psychiatric disorder, substance misuse or neurodevelopmental disabilities. TBI participants were recruited from medical units in 12 studies (e.g., rehabilitation centres, neurology departments) and three also recruited from the community. Two studies recruited participants from a pre-existing database of TBI participants. TBI was determined in 12 studies by length of post traumatic amnesia (PTA), using the Glasgow Coma Scale (GCS; Teasdale & Jennett, 1974) or by loss of consciousness (LOC). One of these studies used self-report data where medical records were unavailable. Two studies did not report their classification for severity. Six studies included participants with severe TBI only, four included moderate/severe only, and two included mild, moderate and severe injuries.

Measures. The studies employed a range of cognitive, personality, mood and social cognition measures dependant on their aims. EE was assessed using five measures which were all self-report questionnaires: the Questionnaire Measure of Emotional Empathy (QMEE, also known as Emotional Empathy Questionnaire, EEQ; Mehrabian & Epstein, 1972), The Balanced Emotional Empathy Scale (BEES; Mehrabian, 2000), The Emotional

Contagion Scale (ECS; Doherty, 1997), the Empathy Quotient (EQ; Baron-Cohen & Wheelwright, 2004; 'emotional reactivity' subscale based on factor analysis by Lawrence, Shaw, Baker, Baron-Cohen & David, 2004) and the Interpersonal Reactivity Index (IRI; Davis, 1980; 1983; 'empathic concern subscale'). Several studies also included psychophysiological measurements.

Method of analysis. Twelve studies employed parametric statistics to make between-group comparisons including t-tests, ANOVA, and MANOVA. They also examined associations with bivariate correlations. Two studies employed non-parametric methods (Mann Whitney U & Kruskall Wallis tests), whilst the case study provided only descriptive analysis.

Review question 2: Is EE impaired after TBI? Nine studies found statistically significant impairments in EE as compared to controls (de Sousa et al., 2010; de Sousa et al., 2011; de Sousa et al., 2012; Neumann et al., 2014; Rushby et al., 2013; Shamay et al., 2001; Spikman et al., 2012; Williams & Wood, 2010; Wood & Williams, 2008), as measured by self-report questionnaires (i.e. BEES, IRI, EQ, ECS & EEQ) . Across the studies (de Sousa et al., 2010; de Sousa et al., 2011; de Sousa et al., 2012; Williams & Wood, 2010; Wood & Williams, 2008), between 57%-82% of participants in the TBI groups had low EE scores as compared to between 16%-55% of control participants, as measured by z-scores compared to the questionnaire norms. Effect sizes were reported by three authors (Neumann et al., 2014; Wood & Williams, 2010; Spikman, et al., 2012), and calculated by the review author for the remaining studies. Cohen's *d* were medium to large, ranging from 0.5 to 1.23.

Four studies found no significant differences between EE scores for TBI participants and controls (Leopold et al., 2012; McLellan & McKinlay, 2013; Milders et al., 2003; Muller et al., 2010). These studies used the same self-report measures as the nine studies which found significant differences (i.e. IRI, BEES & EEQ), and had small to medium effect sizes of d=0.14, d=0.15, d=0.08 and d=0.45.

Review question 3: What is the relationship between EE and other factors in TBI? Studies examined the relationships between EE and alexithymia, other social cognition measures (e.g. emotion recognition & ToM), cognition, injury characteristics, and behaviour.

Two studies examined the relationships between EE and alexithymia. Wood and Williams (2010) found a significant moderate negative correlation between alexithymia and EE for controls and TBI, and alexithymia explained 9% of variance in EE scores. In contrast, Neumann et al., (2014) found that EE variance was not significantly explained by either alexithymia or affect recognition.

Psychophysiological measures (e.g. skin conductance response, SCR; facial electromyography, EMG) were used by four studies to examine links between EE, emotional contagion and responsivity, yielding mixed results. Several studies found support for the idea that emotional contagion is associated with EE, finding that ECS and BEES scores were correlated (Rushby et al., 2013), there was a relationship between low EE and abnormal facial EMG responsivity (de Sousa et al., 2012), and high EE TBI participants could mimic faces like controls (de Sousa, 2011). In contrast to this, two studies by de Sousa and colleagues (2010, 2012) found that facial EMG and

emotional valence ratings failed to distinguish between TBI participants with low and high EE. Mixed results were also found for the responsivity of the TBI group to positive and negative stimuli, with de Sousa et al. (2011) finding facial EMG and SCR to angry facial expressions only was associated with poor EE, yet de Sousa et al. (2010) found SCR was only weakly related to poor EE and for positive stimuli only. Furthermore de Sousa et al. (2012) found limited facial EMG in the TBI group for both positive and negative stimuli.

No significant associations were found between EE and ToM in two studies (Muller et al., 2010; Spikman et al., 2012), however a significant positive correlation was found between performance on an affective ToM task and EE for patients with bilateral, but not unilateral ventromedial prefrontal cortex lesions (Leopold et al., 2012). EE was correlated with lower scores for understanding ironic meaning (Shamay et al., 2001).

Four studies examined associations between EE and neuropsychological tests of cognitive flexibility, working memory, verbal abilities, executive functioning, processing speed and attention. None found a significant relationship between EE and cognitive abilities (Shamay et al., 2001; Spikman et al., 2012; Williams & Wood, 2008; Wood & Williams, 2010).

In all four studies examining the association between EE scores and injury severity (as measured by GCS, PTA or LOC; Neumann et al., 2014; Spikman et al., 2012; Woods & Williams, 2008; Williams & Wood, 2010), and one examining the association between EE and lesions location (Spikman et al., 2012), the associations were non-significant.

Just one study examined the impact of EE on behaviour and found that participants in the TBI group who had high EE had reduced emotional control

and there was a weak significant association between low EE and loss of motivation (de Sousa et al., 2012).

Discussion

The majority of studies found a significant impairment in EE after moderate to severe TBI compared to controls. Four studies however did not find this difference, possibly due to small sample size in these studies and a population effect that may be at most medium in size (Cohen, 1992), as inferred from effect size estimates in the available studies. Taking the median sample size in these studies together with an alpha level of 0.05, these studies would only have sufficient power (.80) to detect an effect size of d=0.87, highlighting that these studies were underpowered.

The cause of EE impairment remains unclear, as study designs cannot infer causality, and the evidence suggests that injury severity, time since injury and co-existing cognitive deficits are unrelated (Williams & Wood, 2010; Wood & Williams, 2008). Several studies found no associations between EE and CE, supporting the literature that these are distinct, dissociable facets of empathy (Nummenmaa et al., 2008; Shamay-Tsoory et al., 2009). However, de Sousa and colleagues (2010) found this dissociation was not present when taking into account behavioural data (i.e., SCR & EMG) contributing to the view that there is a connection between the empathy components which are served by separate but overlapping systems (e.g., Preston & de Waal, 2002). This contrast demonstrates the benefits of triangulating behavioural methods with self-report in future studies.

Studies examining the links between emotional contagion and EE are perhaps most interesting in this area, but have yielded mixed results. Taken

together they suggest that EE and emotional contagion are related features and this questions the theoretical distinction between EE and motor empathy, further supporting the idea that these perhaps operate in parallel or share underlying processes. Although these studies suggest there may be a link between EE and a specific pattern of abnormal emotional responsivity, the results for positive or negative valence are mixed and further research is needed to tease this apart. Dysregulated emotional responding may have negative effects on relationships and one could hypothesise that they impact on a person with TBI's social abilities. Furthermore, two studies found that low arousal, as measured by SCR, was associated with low EE and that this also has the potential to influence interpersonal relationships (Rushby et al., 2013; de Sousa et al., 2010). Overall, however the relationships between self-reported EE, arousal, emotion contagion and facial mimicry are unclear and require further investigation. The behavioural consequences of impaired EE were neglected in all the studies which limit the extent to which clinical significance can be determined.

Strengths and weaknesses of the literature. Injury severity was measured using well validated methods including the GCS, PTA and LOC. A strength of both Woods and Williams' papers (2008, 2010) was that they included adults over age 22 which accounted for the possible confound of the developing social brain, however no other studies took this into consideration. This is important given that evidence indicates that the prefrontal cortex, involved in empathy (Vollm et al., 2006), is one of the latest areas of the brain to mature (Casey, Giedd, & Thomas, 2000) and therefore may be a confound for younger participants. Other weaknesses included small and

heterogeneous samples which neglected mild TBI, and the tendency for studies to make sweeping statements about the 'impact' of low EE on functioning, without necessarily measuring the association between EE and behaviour or being able to infer causality. The measurement of EE was reliant on self-report measures, although these have acceptable reliability with coefficient alphas ranging from α=0.77 (IRI; Davis, 1980) to α=0.90 (ECS; Doherty, 1997), and correlate highly with each other (de Sousa et al., 2010). These measures however require the individual to be insightful and honest about their difficulties, yet this population is associated with poor insight into deficits (McDonald, Togther, & Code, 1999). Researchers justified the use of self-report measures based on research by Kinsella, Moran, Ford and Ponsford (1988) which indicated that individuals' with head injury self-rated their difficulties similarly to how their 'close others' rated them. Importantly however, the authors do note a dearth of appropriate measures formeasuring EE and some have moved towards more dynamic, ecologically valid methods (e.g., film clips; psychophysiological methods). Furthermore, it was a strength of several studies that they explored the underpinnings of EE in terms of arousal and cognition, rather than solely investigating the presence of an impairment (e.g. Rushby et al., 2013).

Risk of bias in the studies. Overall risk of bias was deemed to be low. The main source of bias came from the recruitment of the TBI population and the inclusion criteria. Authors lacked specificity when making conclusions, for example about injury severity so some statements are misleading. Only two studies included mild TBI in their sample, leaving the results biased towards moderate and severe injuries. Many studies recruited from medical

rehabilitation centres which are likely to bias the results as individuals who are suited to rehabilitation may not have the most severe social cognition difficulties. Generally data was well reported, however only one study provided an a priori power calculation (Wood & Williams, 2010) and few reported effect sizes. In addition, there were several studies where it was unclear whether (a) the controls were screened for a history of TBI and (b) if the sample had participated in previous related studies (e.g., de Sousa et al., 2010; 2012), which created a potential bias in the duplication of published results. Furthermore the cross-sectional correlational nature of the research means little can be said about causality i.e., does EE impairment cause TBI? TBI cause EE impairment? Or a third factor cause both? Future research should employ longitudinal design to combat some of these issues and track the course of EE impairment over time. Furthermore, the association between TBI severity and EE should be further explored, including larger samples (including mild TBI) adequately powered for correlational design.

Strengths and weaknesses of this review. This review had a specific focus on synthesising the literature examining EE in adults with TBI. This review is unique and draws together EE findings which are commonly presented alongside many other measures and may be lost in wider discussions of social cognition. The search for papers was systematic, considered relevant terms and searched appropriate databases. The quality of the papers and risk of bias were thoroughly assessed. This review also highlights the growing interest in EE, with twelve out of fifteen studies published in the last 5 years. The review however had several exclusion

criteria which may be viewed as a weakness: it is only applicable to TBI and not other neurological conditions or acquired brain injury.

Implications. Empathy has been described as a key aspect of social cognition and competence, and it has been suggested that weaknesses in CE and EE may underpin many of the neurobehavioural disorders associated with TBI (Wood, 2001), highlighting the importance of fully understanding EE deficits. Few clinical practice implications can be drawn from this review due to a lack of evidence for the mechanisms underlying EE and its relationship to other social cognition skills. The lack of understanding of how EE impairment translates to behavioural difficulties also makes it difficult to make recommendations for the target of intervention.

Conclusion

The main conclusion that can be drawn from this review is that there is a body of evidence that strongly suggests that EE is impaired after moderate to severe TBI in adults. Initial evidence suggests that injury severity and cognitive abilities are unrelated to the level of impairment, however further research is needed to confirm these findings. The relationships between mild TBI and EE, and TBI and alexithymia require further attention. In addition, the literature sheds little light on how EE impairment translates to behavioural difficulties. The focus of future studies should be in the recruitment of well powered, representative samples which consider some of the mechanisms involved in EE and how this translates to everyday behaviour, perhaps using longitudinal designs that allow these issues to be teased out. Another focus of future research should be the development of more dynamic, ecologically

valid measures of EE. At a clinical level, deficits in empathy could underpin disorders associated with TBI and therefore it is important to understand the nature of such deficits to inform possible intervention.

References

Atkinson, A., & Adolphs, R. (2005). Visual emotion perception: mechanisms and processe. In L Feldman-Barret, P. M. Neidenthal, & P. Winkielman (Eds.) *Emotion and Consciousness*. (pp.150-184). New York: Guildford Press.

Bardenhagen, F. J., Bowden, S. C., Shields, R. B., McKay, V., Smith, P. J., Vogrin, S., … & Cook, M. J. (1999). Psychosocial and neuropsychological outcomes in two high-functioning males 20 years after traumatic brain injury. *Neurocase: The Neural Basis of Cognition*, *5*, 325-343.

Baron-Cohen, S., & Wheelwright, S. (2004). The empathy quotient: an investigation of adults with Asperger syndrome, or high functioning autism, and normal sex differences. *Jounral of Autism and Developmental Disorders*, *34*, 163-175.

Beauchamp, M. H., & Anderson, V. (2010). SOCIAL: an integrative framework for the development of social skills. *Psychological Bulletin*, *136*, 39-64.

Bibby, H., & McDonald, S. (2005). Theory of mind after traumatic brain injury. *Neuropsychologia*, *43*, 99-114.

Bigler, E. D. (2007). Anterior and middle cranial fossa in traumatic brain injury: relevant neuroanatomy and neuropathology in the study of neuropsychological outcome. *Neuropsychology, 21*, 515-531.

Blair, R. J. R. (2005). Responding to the emotions of others: Dissociating forms of empathy through the study of typical and psychiatric populations. *Consciousness and Cognition*, *14*, 698-718.

Bornhofen, C., & McDonald, S. (2008). Emotion perception deficits following traumatic brain injury: A review of the evidence and rationale for intervention. *Journal of the International Neuropsychological Society, 14,* 511–525.

Bowman, M. (1996). Ecological validity of neuropsy- chological and other predictors following head injury. *The Clinical Neuropsychologist*, *10*, 382–396.

Casey, B. J., Giedd, J. N., & Thomas, K. M. (2000). Structural and functional brain development and its relation to cognitive development. *Biological Psychology, 54*, 241-257.

Cicerone, K. D., Langenbahn, D. M., Braden, C., Malec, J. F., Kalmar, K., Fraas, M., …& Ashman, T. (2011). Evidence-based cognitive rehabilitation: updates review of the literature from 2003 through 2008. *Archives of Physical Medicine Rehabilitation*, *92*, 519-530.

Cohen, J. (1992). A power primer. *Psychological Bulletin*, *112*, 155-159.

Davis, M. H. (1980). A multidimensional approach to individual differences in empathy. *JSAS Catalog of Selected Documents in Psychology, 10*, 85.

Davis, M. H. (1983). Measuring individual differences in empathy: Evidence for a multidimensional approach. *Journal of Personality and Social Psychology, 44*, 113-126.

de Sousa, A., McDonald, S., Rushby, J., Li, S., Dimoska, A., & James, C. (2010). Why don't you feel how I feel? Insight into the absence of empathy after severe traumatic brain injury. *Neuropsychologia*, *48*, 3538-3595.

de Sousa A., McDonald, S., Rushby, J., Li, S., Dimoska, A., & James, C. (2011). Understanding deficits in empathy after traumatic brain injury: the role of affective responsivity. *Cortex*, *47*, 526-535.

de Sousa, A., McDonald, S., & Rushby, J. (2012). Changes in emotional empathy, affective responsivity, and behavior following severe traumatic brain injury. *Journal of Clinical and Experimental Neuropsychology*, *34*, 606-623.

Doherty, R. W. (1997). The emotional contagion scale: a measure of individual differences. *Journal of Nonverbal Behaviour*, *21*, 131-154.

Dziobek, I., Rogers, K., Fleck, S., Bahnemann, M., Heekeren, H. R., Wolf, O. T., … & Convit, A. (2008). Dissociation of cognitive and emotional empathy in adults with Asperger Syndrome using the Multifaceted Empathy Test (MET). *Journal of Autism & Developmental Disorders*, *38*, 464-473.

Eslinger, P.J., Parkinson, K., & Shamay, S.G. (2002). Empathy and social-emotional factors in recovery from stroke. *Current Opinion in Neurology*, *15*, 91–97.

Frith, U., & Frith, C. D. (2010). The social brain: allowing humans to boldly go where no other species has been. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *365*, 165-176.

Grattan, L.,& Eslinger, P. (1989). Higher cognition and social behaviour. Changes in cognitive flexibility and empathy after cerebral lesions. Neuropsychology, 3, 175–185.

Hatfield, E., Cacioppo, J. T., & Rapson, R. (1994). *Emotional contagion.* New York: Cambridge University Press.

Higgins, J. P. T., Altman, D. G., & Sterne, A. C. (2011). Chapter 8: Assessing risk of bias in included studies. In J. P. T. Higgina & S. Green (eds.). *Cochrane Handbook for Systematic Reviews of Interventions,* Version 5.1.0. The Cochrane Collaboration.

Jabbi, M., Swart, M., & Keysers, C. (2007). Empathy for positive and negative emotions in the gustatory cortex. *Neuroimage*, *34*, 1744-1753.

Kendall, E. & Terry, D. (1996). Psychosocial adjustment following closed head injury: A model for understanding individual differences and predicting outcome. *Neuropsychological Rehabilitation*, *6*, 101–132.

Kennedy, M. R. T., Wozniak, J. R., Meutzel, R. L., Meuller, B. A., Chiou, H. H., Pantekoek, K., & Lim, K. O. (2009). White matter and neyrocognitive changes in adults with chronic traumatic brain injury. *Journal of the International Neuropsychological Society*, *15*, 130-136.

Kinsella, G., Moran, C., Ford, B., Ponsford, J. (1988). Emotional disorder and its assessment within the severe head injured population. *Psychological Medicine*, *18*, 59-63.

Lawrence, E. J., Shaw, P., Baker, D., Baron-Cohen, S., & David, A. S. (2004). Measuring empathy; reliability and validity of the Empathy Quotient. *Psychological Medicine*, *34*, 911-919.

Lee, K. H., Farrow, T. F., Spence, S. A., & Woodruff, P. W. (2004). Social cognition, brain networks and schizophrenia. *Psychological Medicine*, *34*,391-400.

Levin, H. S. (1995). Neurobehavioral outcome of closed head injury: Implications for clinical trials. *Journal of Neurotrauma*, *12*, 601– 610.

Leopold, A., Kruger, F., del Monte, O., Pardini, M., Pulaski, S. J., Soloman, J., & Grafman, J. (2012). Damage to the left ventromedial prefrontal cortex impacts affective theory of mind. *Scan*, *7*, 871-880.

McDonald, S. (2013). Impairments in social cognition following severe traumatic brain injury. *Journal of the International Neuropsychological Society*, *19*, 231-246.

McDonald, S., Togher, L., & Code, C. (1999). Communicastion disorders following traumatic brain injury. *Journal of Head Trauma Rehabilitation*, *16*, 17-29.

McLellan, T., & McKinlay, A. (2013). Sensitivity to emotion, empathy and theory of mind: Adult performance following childhood TBI. *Brain Injury*, *27*, 1032-1037.

Mehrabian, A. (2000). *Manual for the Balanced Emotional Empathy Scale (BEES)*. Available from A. Mehrabian, 1130 Alta Messa Road, Monterey, CA 93040, 2000.

Mehrabian, A., & Epstein, N. (1972). A measure of emotional empathy. Journal of Personality, 40, 525–543.

Menon, D. K., Schwab, K., Wright, D. W., & Mass Al. (2010). Demographics and clinical assessment working group of the International and Interagency Initiative towards Common Data Elements for Research on Traumatic Brain Injury and Psychological Health position statement: definition of traumatic brain injury. *Archives of Physical Medicine Rehabilitation*, *91*, 1637-1640.

Milders, M., Fuchs, S., & Crawford, J. R. (2003). Neuropsychological impairments and changes in emotional and social behaviour following

severe traumatic brain injury. *Journal of Clinical and Experimental Neuropsychology*, *25*, 157-172.

Miller, E. K., & Cohen, J. D. (2001). An integrative theory of prefrontal cortex function. *Annual Reviews of Neuroscience*, *24*, 167-202.

Muller, F., Simion, A., Reviriego, E., Galera, C., Mazaux, J. M., Barat, M., & Joseph, P. A. (2010). Exploring theory of mind after traumatic brain injury. *Cortex*, *47*, 1088-1099.

Neumann, D., Zupan, B., Malec, J. F., & Hammond, F. (2014). Relationships between alexithymia, affect recognition, and empathy after traumatic brain injury. *Journal of Head Trauma Rehabilitation*, *29*, E18-27.

Nummenmaa, L., Hirvonen, J., Parkkola, R., & Hietanen, J. K. (2008). Is emotional contagion special? An fMRI study on neural systems for affective and cognitive empathy. *NeuroImage*, *43*, 571–80.

Preston, S. D., & de Waal, F. B. (2002). Empathy: Its ultimate and proximate bases. *Behavioral and Brain Sciences*, *25*, 1–20.

Prigatano, G. P. (1992). Personality disturbance associated with traumatic brain injury. *Journal of Consulting and Clinical Psychology*, *60*, 360-368.

Rizzolatti, G., Fogassi, L., & Gallese, V. (2001). Neurophysiological mechanisms underlying the understanding and imitation of action. *Nature Reviews of Neuroscience*, *2*, 661–670.

Rushby, J. A., McDonald, S., Randall, R., de Sousa, A., Trimmer, E., & Fisher, A. (2013). Impaired emotional contagion following severe traumatic brain injury. *International Journal of Psychophysiology*, *89*, 466-474.

Shamay, S. G., Aharon-Peretz, J., Berger, B. D., & Tomer, R. (2001). Impairment in Cognitive and Affective Empathy in Patients with Prefrontal

Lesions: Correlations with cognitive performance. *Brain and Cognition*, *47*, 353-356.

Shamay-Tsoory, S. G., Aharon-Peretz, J., & Perry, D. (2009). Two systems for empathy: a double dissociation between emotional and cognitive empathy in inferior frontal gyrus versus ventromedial prefrontal lesions. *Brain*, *132*, 617-627.

Spikman, J. M., Timmerman, M. E., Milders, M. V., Veestra, W. S., & van der Naalt, J. (2012). Social cognition deficits in relation to general cognitve deficits, injury severity, and prefrontal lesions in traumatic brain injury patients. *Journal of Neurotrauma*, *29*, 101-111.

Tagliaferri, F., Cimpagnone, C., Korsic, M., Servadei, F., & Kraus, J. (2006). A systematic review of brain injury epidemiology in Europe. *Acta Neurochir (Wien)*, *148*, 255-268.

Tasker, R. C., Salmond, C. H., Westland, A. G., Pena, A., Gillard, J. H., Sahakian, B. J, & Pickard, J. D. (2005). Head circumference and brain and hippocampal volume after severe traumatic brain injury in childhood. *Pediatric Research*, *58*, 302–308.

Tate, R.L., & Broe, G.A. (1999). Psychosocial adjustment after traumatic brain injury: What are the important variables. *Psychological Medicine*, *29*, 713–725.

Teasdale, G., & Jennett, B. (1974). Assessment of coma and impaired consciousness. A practical scale. *The Lancet*, *2*, 81-84.

Vollm B. A., Taylor, A. N. W., Richardson, P., Corcoran, R., McKie, S., Deakin, J. F. W. … & Elliot, R. (2006). Neuronal correlated of theory of mind and empathy: a functional magnetic resonance imaging study in a non-verbal task. *NeuroImage*, *29*, 90-98.

Wicker, B., Keysers, C., Plailly, J., Royet, J.-P., Gallese, V., & Rizzolatti, G. (2003). Both of us disgusted in my insula: The common neuron basis of seeing and feeling disgust. *Neuron*, *40*, 655–664.

Williams, C., & Wood, R. L. (2010). Alexithymia and emotional empathy following traumatic brain injury. *Journal of Clinical and Experimental Neuropsychology*, *32*, 259-267.

Wood, R. L. (2001). Understanding neurobehavioural disability. In R. L. Wood & T.M. McMillan (Eds.), *Neurobehavioural Disability and Social Handicap following Traumatic Brain Injury* (pp. 1–28). Hove, UK: Psychology Press.

Wood, R. L. L., & Williams, C. (2008). Inability to empathise following traumatic brain injury. *Journal of the International Neuropsychological Society*, *14*, 289-296.

Appendix A – Data Extraction Form

Reference Number:

Title:

Author(s):

Source:

Date: **Volume:** **Pages:**

Aim(s) of the study:

Setting & Geographical Location:

Study Design:

<u>Population</u>

Population Characteristics (N, TBI severity):

Method of TBI classification:

Sampling method:

Power calculation presented: Y/N Outcome:

Inclusion Criteria:

Exclusion Criteria:

Control group characteristics:

Measures

Measures used:

Were measures validated?

Results

Method(s) of analysis:

Adequate reporting of data, parametric assumptions:

Emotional Empathy specific results:

Conclusions

Emotional empathy related conclusions:

Strengths of the Study:

Limitations of the Study:

Assessment of Study Quality/Sources of Bias:

Relevant blinding procedures (if applicable):

Incomplete outcome data:

Selective outcome reporting:

Other threats to validity (e.g. bias from design or recruitment):

Appendix B – The Cochrane Collaboration risk of bias tool

The Cochrane Collaboration's tool for assessing risk of bias

Domain	Description	Review authors' judgement
Sequence generation	Describe the method used to generate the allocation sequence in sufficient detail to allow an assessment of whether it should produce comparable groups.	Was the allocation sequence adequately generated?
Allocation concealment	Describe the method used to conceal the allocation sequence in sufficient detail to determine whether intervention allocations could have been foreseen in advance of, or during, enrolment.	Was allocation adequately concealed?
Blinding of participants, personnel and outcome assessors *Assessments should be made for each main outcome (or class of outcomes)*	Describe all measures used, if any, to blind study participants and personnel from knowledge of which intervention a participant received. Provide any information relating to whether the intended blinding was effective.	Was knowledge of the allocated intervention adequately prevented during the study?
Incomplete outcome data *Assessments should be made for each main outcome (or class of outcomes)*	Describe the completeness of outcome data for each main outcome, including attrition and exclusions from the analysis. State whether attrition and exclusions were reported, the numbers in each intervention group (compared with total randomized participants), reasons for attrition/exclusions where reported, and any re-inclusions in analyses performed by the review authors.	Were incomplete outcome data adequately addressed?
Selective outcome reporting	State how the possibility of selective outcome reporting was examined by the review authors, and what was found.	Are reports of the study free of suggestion of selective outcome reporting?
Other sources of bias	State any important concerns about bias not addressed in the other domains in the tool. If particular questions/entries were pre-specified in the review's protocol, responses should be provided for each question/entry.	Was the study apparently free of other problems that could put it at a high risk of bias?

Possible approach for *summary assessments* outcome (across domains) within and across studies

Risk of bias	Interpretation	Within a study	Across studies
Low risk of bias	Plausible bias unlikely to seriously alter the results.	Low risk of bias for all key domains.	Most information is from studies at low risk of bias.
Unclear risk of bias	Plausible bias that raises some doubt about the results	Unclear risk of bias for one or more key domains.	Most information is from studies at low or unclear risk of bias.
High risk of bias	Plausible bias that seriously weakens confidence in the results.	High risk of bias for one or more key domains.	The proportion of information from studies at high risk of bias is sufficient to affect the interpretation of the results.

Criteria for judging risk of bias in the 'Risk of bias' assessment tool

SEQUENCE GENERATION **Was the allocation sequence adequately generated? [Short form: *Adequate sequence generation*?]**	
Criteria for a judgement of 'YES' (i.e. low risk of bias).	The investigators describe a random component in the sequence generation process such as: ▪ Referring to a random number table; Using a computer random number generator; Coin tossing; Shuffling cards or envelopes; Throwing dice; Drawing of lots; Minimization*. *Minimization may be implemented without a random element, and this is considered to be equivalent to being random.
Criteria for the judgement of 'NO' (i.e. high risk of bias).	The investigators describe a non-random component in the sequence generation process. Usually, the description would involve some systematic, non-random approach, for example: ▪ Sequence generated by odd or even date of birth; ▪ Sequence generated by some rule based on date (or day) of admission; ▪ Sequence generated by some rule based on hospital or clinic record number. Other non-random approaches happen much less frequently than the systematic approaches mentioned above and tend to be obvious. They usually involve judgement or some method of non-random categorization of participants, for example: ▪ Allocation by judgement of the clinician; ▪ Allocation by preference of the participant; ▪ Allocation based on the results of a laboratory test or a series of tests; ▪ Allocation by availability of the intervention.
Criteria for the judgement of 'UNCLEAR' (uncertain risk of bias).	Insufficient information about the sequence generation process to permit judgement of 'Yes' or 'No'.
ALLOCATION CONCEALMENT **Was allocation adequately concealed? [Short form: *Allocation concealment*?]**	
Criteria for a judgement of 'YES' (i.e. low risk of bias).	Participants and investigators enrolling participants could not foresee assignment because one of the following, or an equivalent method, was used to conceal allocation: ▪ Central allocation (including telephone, web-based, and pharmacy-controlled, randomization); ▪ Sequentially numbered drug containers of identical appearance; ▪ Sequentially numbered, opaque, sealed envelopes.
Criteria for the judgement of 'NO' (i.e. high risk of bias).	Participants or investigators enrolling participants could possibly foresee assignments and thus introduce selection bias, such as allocation based on: ▪ Using an open random allocation schedule (e.g. a list of random numbers); ▪ Assignment envelopes were used without appropriate safeguards (e.g. if envelopes were unsealed or non-opaque or not sequentially numbered); ▪ Alternation or rotation; ▪ Date of birth; ▪ Case record number; ▪ Any other explicitly unconcealed procedure.

Criteria for the judgement of 'UNCLEAR' (uncertain risk of bias).	Insufficient information to permit judgement of 'Yes' or 'No'. This is usually the case if the method of concealment is not described or not described in sufficient detail to allow a definite judgement – for example if the use of assignment envelopes is described, but it remains unclear whether envelopes were sequentially numbered, opaque and sealed.
BLINDING OF PARTICIPANTS, PERSONNEL AND OUTCOME ASSESSORS **Was knowledge of the allocated interventions adequately prevented during the study? [Short form: *Blinding*?]**	
Criteria for a judgement of 'YES' (i.e. low risk of bias).	Any one of the following: ▪ No blinding, but the review authors judge that the outcome and the outcome measurement are not likely to be influenced by lack of blinding; ▪ Blinding of participants and key study personnel ensured, and unlikely that the blinding could have been broken; ▪ Either participants or some key study personnel were not blinded, but outcome assessment was blinded and the non-blinding of others unlikely to introduce bias.
Criteria for the judgement of 'NO' (i.e. high risk of bias).	Any one of the following: ▪ No blinding or incomplete blinding, and the outcome or outcome measurement is likely to be influenced by lack of blinding; ▪ Blinding of key study participants and personnel attempted, but likely that the blinding could have been broken; ▪ Either participants or some key study personnel were not blinded, and the non-blinding of others likely to introduce bias.
Criteria for the judgement of 'UNCLEAR' (uncertain risk of bias).	Any one of the following: ▪ Insufficient information to permit judgement of 'Yes' or 'No'; ▪ The study did not address this outcome.
INCOMPLETE OUTCOME DATA **Were incomplete outcome data adequately addressed? [Short form: *Incomplete outcome data addressed*?]**	
Criteria for a judgement of 'YES' (i.e. low risk of bias).	Any one of the following: ▪ No missing outcome data; ▪ Reasons for missing outcome data unlikely to be related to true outcome (for survival data, censoring unlikely to be introducing bias); ▪ Missing outcome data balanced in numbers across intervention groups, with similar reasons for missing data across groups; ▪ For dichotomous outcome data, the proportion of missing outcomes compared with observed event risk not enough to have a clinically relevant impact on the intervention effect estimate; ▪ For continuous outcome data, plausible effect size (difference in means or standardized difference in means) among missing outcomes not enough to have a clinically relevant impact on observed effect size; ▪ Missing data have been imputed using appropriate methods.
Criteria for the judgement of 'NO' (i.e. high risk of bias).	Any one of the following: ▪ Reason for missing outcome data likely to be related to true outcome, with either imbalance in numbers or reasons for missing data across intervention groups; ▪ For dichotomous outcome data, the proportion of missing outcomes compared with observed event risk enough to induce clinically relevant bias in intervention effect estimate; ▪ For continuous outcome data, plausible effect size (difference in means or standardized difference in means) among missing outcomes enough to induce clinically relevant bias in observed effect size; ▪ 'As-treated' analysis done with substantial departure of the intervention received from that assigned at randomization; ▪ Potentially inappropriate application of simple imputation.

Criteria for the judgement of 'UNCLEAR' (uncertain risk of bias).	Any one of the following: ▪ Insufficient reporting of attrition/exclusions to permit judgement of 'Yes' or 'No' (e.g. number randomized not stated, no reasons for missing data provided); ▪ The study did not address this outcome.
SELECTIVE OUTCOME REPORTING **Are reports of the study free of suggestion of selective outcome reporting? [Short form: *Free of selective reporting*?]**	
Criteria for a judgement of 'YES' (i.e. low risk of bias).	Any of the following: ▪ The study protocol is available and all of the study's pre-specified (primary and secondary) outcomes that are of interest in the review have been reported in the pre-specified way; ▪ The study protocol is not available but it is clear that the published reports include all expected outcomes, including those that were pre-specified (convincing text of this nature may be uncommon).
Criteria for the judgement of 'NO' (i.e. high risk of bias).	Any one of the following: ▪ Not all of the study's pre-specified primary outcomes have been reported; ▪ One or more primary outcomes is reported using measurements, analysis methods or subsets of the data (e.g. subscales) that were not pre-specified; ▪ One or more reported primary outcomes were not pre-specified (unless clear justification for their reporting is provided, such as an unexpected adverse effect); ▪ One or more outcomes of interest in the review are reported incompletely so that they cannot be entered in a meta-analysis; ▪ The study report fails to include results for a key outcome that would be expected to have been reported for such a study.
Criteria for the judgement of 'UNCLEAR' (uncertain risk of bias).	Insufficient information to permit judgement of 'Yes' or 'No'. It is likely that the majority of studies will fall into this category.
OTHER POTENTIAL THREATS TO VALIDITY **Was the study apparently free of other problems that could put it at a risk of bias? [Short form: *Free of other bias*?]**	
Criteria for a judgement of 'YES' (i.e. low risk of bias).	The study appears to be free of other sources of bias.
Criteria for the judgement of 'NO' (i.e. high risk of bias).	There is at least one important risk of bias. For example, the study: ▪ Had a potential source of bias related to the specific study design used; or ▪ Stopped early due to some data-dependent process (including a formal-stopping rule); or ▪ Had extreme baseline imbalance; or ▪ Has been claimed to have been fraudulent; or ▪ Had some other problem.
Criteria for the judgement of 'UNCLEAR' (uncertain risk of bias).	There may be a risk of bias, but there is either: ▪ Insufficient information to assess whether an important risk of bias exists; or ▪ Insufficient rationale or evidence that an identified problem will introduce bias.

Appendix C – Guidance for authors from target journal

JOURNAL OF THE INTERNATIONAL NEUROPSYCHOLOGICAL SOCIETY

Instructions for Contributors

Aims and Scope

The Journal of the International Neuropsychological Society is the official journal of the International Neuropsychological Society, an organization of over 4,500 international members from a variety of disciplines. The Journal of the International Neuropsychological Society welcomes original, creative, high quality research papers covering all areas of neuropsychology. The focus of articles may be primarily experimental, applied, or clinical. Contributions will broadly reflect the interest of all areas of neuropsychology, including but not limited to: development of cognitive processes, brain-behavior relationships, adult and pediatric neuropsychology, neurobehavioral syndromes (such as aphasia or apraxia), and the interfaces of neuropsychology with related areas such as behavioral neurology, neuropsychiatry, genetics, and cognitive neuroscience. Papers that utilize behavioral, neuroimaging, and electrophysiological measures are appropriate.

To assure maximum flexibility and to promote diverse mechanisms of scholarly communication, the following formats are available in addition to Regular Research Articles: Brief Communications are shorter research articles; Rapid Communications are intended for ''fast breaking'' new work that does not yet justify a full length article and are placed on a fast review track; Neurobehavioral Grand Rounds are theoretically important and unique case studies; Critical Reviews and Short Reviews are thoughtful considerations of topics of importance to neuropsychology, including associated areas, such as functional brain imaging, genetics, neuroepidemiology, and ethical issues; Dialogues provide a forum for publishing two distinct positions on controversial issues in a point-counterpoint format; Symposia consist of several research articles linked thematically: Letters to the Editor respond to recent articles in the Journal of the International Neuropsychological Society; and Book Reviews. Critical Reviews, Dialogues, and Symposia are typically invited by the Editor-in-Chief or an Associate Editor. Book Reviews are considered but are no longer solicited.

Originality and Copyright

To be considered for publication in the Journal of the International Neuropsychological Society, a manuscript cannot have been published previously nor can it be under review for publication elsewhere. Papers with multiple authors are reviewed with the assumption that all authors have approved the submitted manuscript and concur with its submission to the Journal of the International Neuropsychological Society. A Copyright Transfer Agreement, with certain specified rights reserved by the author, must be signed and returned to the Editor-in-Chief by the corresponding author of accepted manuscripts, prior to publication. This is necessary for the wide distribution of research findings and the protection of both author and the society under copyright law. If you plan to include material that has been published elsewhere and is under copyright of a third party, you will need to obtain permission to re-use this material in your article. A form may be provided for this purpose by the editorial office. Alternatively, many publishers use an online system for such requests. It is the responsibility of the authors to obtain permissions to re-use material from elsewhere. For information regarding rights and permissions concerning the Journal of the International Neuropsychological Society, please contact Marc Anderson (manderson@cambridge.org) or AdamHirschberg (ahirschberg@cambridge.org).

Disclosure

Potential conflicts of interest include funding sources for the reported study (e.g., a test validation study financially supported by a test publisher, a study supported by an insurance company), personal or family financial interest in a test or product or with a company that publishes a test that is being investigated in the manuscript or competes with a test that is being investigated in the manuscript. Other conflicts include employment, consultancies, stock ownership or medicolegal work. For the latter, information about whether the author's medicolegal work is largely for one side should be reported. This list of potential conflicts is not all inclusive, and it is the responsibility of each author to ensure that all of their ''potential conflicts'' are reported in the Acknowledgment section of the paper.

Manuscript Submission and Review

The Journal of the International Neuropsychological Society uses online submission and peer review. Paper submissions are not accepted. Authors who are not able to submit their manuscripts online are asked to contact the editorial office at: jins@cambridge.org. The website address for submissions is http://mc.manuscriptcentral. com/cup/jins; complete instructions are provided on the website. Prior to online submission, please consult http://www.nlm.nih.gov/mesh/ for 6 keywords or mesh terms that are different from words in the title. Accurate mesh terms will increase the probability that your manuscript will be identified in online searches. Please follow the instructions carefully to avoid delays. The menu will prompt the author to provide all necessary information, including the manuscript category, the corresponding author including postal address, phone and fax numbers, and e-mail address, and suggested reviewers.

The website will automatically acknowledge receipt of the manuscript and provide a manuscript reference number. The Editor-in-Chief will assign the manuscript for review to an action editor and at least two other reviewers. Every effort will be made to provide the author with a review within 6 to 10 weeks of manuscript assignment. Rapid Communications will be reviewed within 6 weeks. If the Editor requests that revisions be made to a manuscript before publication, a maximum of 3 months will be allowed for preparation of the revision, except in unusual circumstances.

Manuscript Length

In order to increase the number of manuscripts that can be published in the Journal of the International Neuropsychological Society, please adhere to the following length requirements. Please provide a word count on the title page for the abstract and manuscript (not including abstract, tables, figures, or references). Manuscripts will be returned if they exceed length requirements.

Regular Research Article: Maximum of 5,000 words (not including abstract, tables, figures, or references) and a 250 word abstract. Regular Research Articles are original, creative, high quality papers covering all areas of neuropsychology; focus may be experimental, applied or clinical.

Brief and Rapid Communications: Maximum of 2,500 words (not including abstract, tables, figures, or references) and a 200 word abstract, with a maximum of two tables or two figures, or one table and one figure, and 20 references. Brief and Rapid Communications are shorter research articles.

Neurobehavioral Grand Rounds: Maximum of 3,500 words with an informative literature review (not including abstract, tables, figures, or references) and a 200 word abstract. Neurobehavioral Grand Rounds are unique case studies that make a significant theoretical contribution.

Critical Review: Maximum of 7,000 words (not including abstract, tables, figures, or references) and a 250 word abstract. Critical Reviews will be considered on any important topic in neuropsychology. Quantitative meta-analyses are encouraged. Critical Reviews must be preapproved by the Editor-in-Chief. For consideration, please e-mail your abstract to jins@cambridge.org.

Short Review: Maximum of 2,500 words (not including abstract, tables, figures, or references) and a 150 word abstract. Short Reviews are conceptuallyoriented snapshots of the current state of a research area by experts in that area. Short Reviews must be preapproved by the Editor-in-Chief. For consideration, please e-mail your abstract to jins@cambridge.org.

Dialogues: Maximum of 2,000 words for each segment (not including abstract, tables, figures, or references) and a 150 word abstract, with a maximum of two tables or two figures, or one table and one figure and 20 references. Dialogues provide a forum for two distinct positions on controversial issues in a pointcounterpoint form. Dialogues must be preapproved by the Editor-in-Chief. For consideration, please e-mail your abstract to jins@cambridge.org.

Symposia: Maximum of 5,000 words (not including abstract, tables, figures, or references) and a 250 word abstract for each article (same as Regular Research Articles). Symposia consist of several thematically linked research articles which present empirical data. Symposia must be pre-approved by the Editor-in- Chief. For consideration, e-mail your proposal to jins@cambridge.org to receive prior approval.

Letters to the Editor: Maximum of 500 words (not including table, figure, or references) with up to five references and one table or one figure. Letters to the Editor respond to recent articles in Journal of the International Neuropsychological Society

Book Reviews: Maximum of 1000 words in length. Include name and affiliations, a title for the review, the author(s)/editor(s), title, publisher, date of publication, number of pages and price. For consideration, e-mail jins@cambridge.org.

Manuscript Preparation and Style

The entire manuscript should be typed double-spaced throughout using a word processing program. Unless otherwise specified, the guideline for preparation of manuscripts is the Publication Manual of the American Psychological Association (6th edition) except for references with 3 or more authors (see References section). This manual may be ordered from: APA Order Dept., 750 1st St. NE, Washington, DC 20002-4242, USA.

Pages should be numbered sequentially beginning with the Title Page. The Title Page should contain the full title of the manuscript, the full names and institutional affiliations of all authors; mailing address, telephone and fax numbers, and e-mail address for the corresponding author; and the word count for the abstract and manuscript text (excluding title page, abstract, references, tables, and figures). At the top right provide a short title of up to 45 characters preceded by the lead author's last name. Example: Smith-Memory in Parkinson's Disease. This running head should be repeated at the top right of every following page. Page 2 should include an Abstract and a list of at least six keywords or mesh terms. Note: structured abstracts must be included with papers submitted after January 1, 2014. A structured abstract must include four header labels: Objective, Method, Results, and Conclusions. A total of six mesh terms (http://www.nlm.nih.gov/mesh/) or keywords should be provided and should not duplicate words in the title. The full text of the manuscript should begin on page 3. For scientific articles, including Regular Research Articles, Brief Communications, Rapid Communications, and Symposia, the format should include a structured Abstract, Introduction, Method, Results, and Discussion. This should be followed by Acknowledgments, References, Tables, Figure Legends, Figures, and optional Appendices and Supplemental Material.

The Acknowledgements Section should include a disclosure of conflicts of interest (see above) and all sources of financial support for the paper. In documenting financial support, please provide details of the sources of financial support for all authors, including grant numbers. For example, ''This work was supported by the National Institutes of Health (grant number XXXXXXX)''. Multiple grant numbers should be separated by a comma and space and where research was funded by more than one agency, the different agencies should be separated by a semicolon with ''and'' before the final funding agency. Grants held by different authors should be identified using the authors' initials. For example, ''This work was supported by the Wellcome Trust (A.B., grant numbers XXXX, YYYY), (C.D., grant number ZZZZ); the Natural Environment Research Council (E.F., grant number FFFF); and the National Institutes of Health (A.B., grant number GGGG), (E.F., grant number HHHH).''

Tables and Figures should be numbered in Arabic numerals. Figures should be numbered consecutively as they appear in the text. Figures should be twice their intended final size and authors should do their best to construct figures with notation and data points of sufficient size to permit legible photo reduction to one column of a two-column format. Please upload figure(s) in either a .doc or .pdf format. There is no additional cost for publishing color figures. When uploading figures (color or black and white) they need only be a high enough resolution for the reviewers and editors to identify the information you are trying to convey.

The approximate position of each table and figure should be provided in the manuscript: [INSERT TABLE 1 HERE]. Tables and figures should be on separate pages. Tables should have short titles and all figure legends should be on separate pages. References should be consistent with the Publication Manual of the American Psychological Association (6th Edition). In-text references should be cited as follows: ''y Given the critical role of the prefrontal cortex (PFC) in working memory (Cohen et al., 1997; Goldman-Rakic, 1987; Perlstein et al., 2003a, 2003b)y'' with multiple references in alphabetical order. Another example: ''yCohen et al. (1994, 1997), Braver et al. (1997), and Jonides and Smith (1997) demonstrated'' References cited in the text with two authors should list both names. References cited in the text with three, four, or five authors, list all authors at first mention; with subsequent citations, include only the first author's last name followed by et al. References cited in the text with six or more authors should list the first author et al. throughout. In the reference section, for works with up to seven authors, list all authors. For eight authors or more, list the first six, then ellipses followed by the last author's name.

EMPIRICAL PAPER COVER SHEET

TITLE: The Association between Traumatic Brain Injury, Behavioural Factors and Facial Emotion Recognition Skills in Delinquent Youth

TRAINEE NAME: Sarah Cook

SUPERVISORS

PRIMARY:
Prof. Huw Williams, Associate Professor, University of Exeter

SECONDARY:
Dr Nick Moberly, Senior Lecturer, University of Exeter

TARGET JOURNAL: Journal of Head Trauma Rehabilitation
WORD COUNT: 7, 983 (excluding headings, tables, figures and references)
DATE OF SUBMISSION: Resubmission - 15th August 2014

DECLARATION:
"I certify that all material in this research paper which is not my own work has been identified and properly attributed. I have conducted the work in line with the BPS and DCP Professional Practice Guidelines."

Abstract

Objectives: To examine the association between traumatic brain injury (TBI) in delinquent youth and facial emotion recognition (FER) abilities, offending, behavioural difficulties, aggression, empathic sadness and parenting. **Participants & Setting:** Forty-eight delinquent youth, aged 14 to 19 years, recruited from Youth Offending Teams and Targeted Youth Support. **Main Measures:** A cross sectional case-control design compared individuals in a TBI versus a non-TBI group on a forced-choice, FER paradigm assessing recognition accuracy to six basic emotions. Self-reported measures of TBI, behavioural difficulties, experience of parenting, reactive and proactive aggression, and empathic sadness. **Results:** History of TBI was reported by 68.7% of the sample, with 94% including a loss of consciousness. No significant differences were found between TBI and non-TBI groups on FER accuracy. Participants in the TBI group self-reported significantly higher proactive and reactive aggression and lower levels of parental supervision as compared to the non-TBI group. Tendency to incorrectly give 'anger' as a response on the FER task was strongly positively associated with proactive and reactive aggression. **Conclusions:** Future research requires larger samples recruited across settings to further investigate the association between FER abilities and TBI in this population. Findings highlight the need for TBI to be appropriately assessed and managed in delinquent youth, and highlights important aggression differences.

KEYWORDS: delinquent youth/adolescents, facial emotion recognition, TBI, aggression.

Introduction

Traumatic brain injury (TBI) is defined as “an alteration in brain function, or other evidence of brain pathology, caused by external force” (Menon, Schwab, Wright & Mass, 2010 p. 1638), and this alteration can be defined as any change in mental state, a loss of consciousness (LoC), loss of memory immediately after or before the incident, or neurological deficits. TBI can be ‘open’, where the skull is penetrated typically leading to focal damage, or ‘closed’, where the external mechanical force can lead to lacerations and bruising of brain structures leading to diffused damage. Diffuse axonal injury (DAI) is a common mechanism of injury whereby acceleration and deceleration forces disrupt and damage axons in the brainstem, the white parasagittal matter of the cerebral cortex and the corpus collosum, leading to global cognitive deficits and impaired memory and processing (see Meythaler, Pedizzi, Eleftherious, & Novack, 2001).

TBI is a leading cause of death and disability in children and young people, representing a major public health problem (Langlois, Rutland-Brown & Thomas, 2006), and affecting approximately 30 % of the general youth population (McKinlay et al., 2008). In 2006, the National Centre for Injury Prevention and Control reported that youths aged 15-19 years and children under the age of 4 were the most at risk of TBIs (Langlois et al., 2006). Recovery from childhood TBI depends on a number of factors, with early developmental models debating early plasticity and early vulnerability in terms of recovery (i.e. the ability of the brain’s neural circuitry to respond dynamically and adapt leading to good outcome versus the brains vulnerability and the cumulative effect of damage during ongoing brain development leading to poor

outcome). Anderson, Spencer-Smith & Wood (2011) however highlight that neither of these models fully explains the variation of functional outcome seen, and rather represent extremes along a 'recovery continuum'. Typically, however, TBI in childhood is associated with elevated risk for long-term social impairment and psychosocial difficulties (Rosema, Crowe & Anderson, 2012; Yeates et al., 2007). Mild TBIs, defined as a LoC of less than 30 minutes, are not usually associated with persistent difficulties however when these injuries are "complicated" or cumulative there can be neuropsychological sequelae (Collins et al., 2002; Davies, Williams, Hinder, Burgess, & Mounce, 2012; Williams, Potter, & Ryland, 2010). Moderate and severe TBI however, is typically associated with neuropsychological deficits, behavioural difficulties and poor social outcome (Stambrook, Moore, Peters, Deviaene, & Hawryluk, 1990). Long term, social and psychiatric difficulties are of most concern including social maladjustment, poor quality of life, depression and family problems (Anderson, Brown, Newitt, & Hoile, 2009; Cattelani, Lombadi, Brianti, & Mazzucchi, 1998), with family function and parent psychopathology linked to post-injury function (Yeates, Taylor, Walz, Stancin & Wade, 2010).

Adolescence, in addition to being an at-risk period for TBI, is also a risk period for offending behaviour (Forrest, Tambor, Riley, Ensminger, & Starfield, 2000). Interestingly many of the psychosocial difficulties (e.g., lack of empathy, aggression, impulsivity, risk taking) associated with delinquent youths, defined as a person under 18 years whose behaviour is illegal or immoral, are also found in those who have experienced TBI (Tonks, Slater, Frampton, Wall, Yates, & Williams, 2008; Williams Cordan, Mewse, Tonks, & Burgess, 2010). Furthermore, TBI has been identified as a risk factor for offending with

associations shown between untreated TBI in adolescence and sentencing for violent offending in adults (Leon-Carrion & Ramos, 2003), and between childhood TBI and mental health disorder with coexisting offending in adult men (Timonen et al., 2002). TBI has also been shown longitudinally to be associated with increased delinquency in youths (Rantakallio, Koiranen, & Mottonen, 1992), is a moderate risk factor for violence (Fazel, Litchenstein, Grann, & Langstrom, 2011), and is associated with increased risk of committing serious violent crime (Fazel, Philipson, Gardiner, Merritt, & Grann, 2009).

There is therefore an emerging link between childhood TBI and criminality, and studies have begun to examine the prevalence of TBI in young delinquents. Hux, Bong, Skinner, Belau and Sanger (1998) reported that 50% of delinquent youth they studied had experienced a TBI (as defined by a blow to the head), and 30% of these had long-lasting adverse TBI-effects as reported by their parents. Whereas non-delinquent youths tended to have TBI resulting from sporting incidents, delinquent youths suffered their TBIs in fights, vehicle accidents or falls (Hux et al., 1998). Similarly, Williams et al. (2010) found that 46% of their young offender sample reported a TBI with LoC, and multiple injuries were associated with greater violence in offences. In a related study, Davies et al. (2012) reported that over 70% of studies incarcerated youth had a TBI history, and those with more serious mild injuries reported greater ongoing problems that interfere with their ability to engage in forensic rehabilitation.

Prevalence rates of TBI in youth however vary significantly depending on the classification of head injury and possible cross-cultural differences. In contrast to Hux and colleagues, Miura, Fujiki, Shibata and Ishikawa (2005), reported just 4% of their 1336 sample of delinquent youths in Japan had head

injury, as measured by “head injury requiring neurological assessment and/or treatment operation”. Perron and Howard (2008) found that 1 in 5 of their delinquent youth sample in the USA reported a potentially clinically important head injury, and TBI was most strongly correlated with psychiatric, substance use problems, and delinquency measures. Youths with TBI had significantly earlier onset of criminal and substance use activity, more substance misuse problems and suicidality, and more frequent criminality in the last year (Perron & Howard, 2008). Despite this, accurate estimates are difficult to establish when there may also be under reporting of injuries due to abuse, violence, intoxication and implications of reporting on family and peers. However, a meta-analysis conducted by Farrer, Frost and Hedges (2012) showed the rate of TBI across studies was approximately 30% and this is consistently high relative to the general population. Although TBI appears to be elevated in delinquent youths, the causal links are unclear. Possible reasons for the association could be that TBI causes antisocial behaviour, or that antisocial behaviour causes TBI, or that there are a range of other psychosocial factors contributing to both (e.g., cognition, poor parenting).

Social Cognition and TBI

TBI commonly involves pathology to the anterior brain regions which are involved in ‘social cognition’ (Tasker et al., 2005), defined as one of many higher order cognitive functions required for effective social interaction (Beauchamp & Anderson, 2010). There are a number of models which provide a framework for understanding the development of social competence through childhood and adolescence (The Socio-Cognitive Integration of Abilities Model,

SOCIAL, Beauchamp & Anderson, 2010; Social Information Processing Model, Dodge, 1986; The Integrative Heuristic Model of Social Competence, Yeates et al., 2007), and these have been important in highlighting developmental principles and the unique characteristics of early disruption.

The brain regions involved in social cognition are referred to as the 'social brain' network (Johnson et al., 2005), which help us to engage a set of functions that allow humans to understand and interact with each other, through recognising and understanding others' mental states, recognising faces and gestures, making predictions about behaviour and supporting communication. The 'social brain' network, involving the superior temporal sulcus, fusiform gyrus, temporal pole, medial prefrontal cortex, orbitofrontal cortex, amygdala, temporoparietal junction and inferior parietal cortex (Beauchamp & Anderson, 2010), undergo structural and functional changes throughout development. Johnson and colleagues suggest an 'interactive specialisation' process occurs, in which the cortex has organising patterns of interregional interactions (Johnson, 2001; Johnson et al., 2005) that during development sharpen the functions of the region such that their activity becomes more specific to a set of circumstances. This regional specialisation is an outcome of postnatal brain development and therefore as the social brain is a product of development it can fail to emerge for a number of reasons. Atypical development can result in a lack of or deviant pattern of specialisation and account for some of the cognitive and behavioural symptoms observed in certain developmental disorders and TBI. It has been suggested that these regions of the 'social brain' are susceptible to the effects of TBI in adults, and that in the immature social brain, they are particularly vulnerable to disruption (Johnson et al., 2005) and social

impairment following childhood TBI may reflect a failure to develop skills at an appropriate age (Beauchamp & Anderson, 2010).

Facial Emotion Recognition (FER): Development & Impairment

The recognition of facial expressions of emotion is a key part of social cognition and serves an important communication function, helping us to understand social cues, and reinforce social behaviours (Blair, 2003). Many clinical groups have been shown to have facial emotion recognition (FER) impairments, including antisocial populations (Fairchild, Van Goozen, Calder, Stollery & Goodyer, 2009; Marsh & Blair, 2008), however few studies have explored the development of FER abilities, how these may increase social competence, and how TBI may impair the development of these skills.

The perceptual task of reading and identifying emotions can be traced back as early as infancy (Charlsworth & Kreutzer, 1973) and it has been suggested that there are six universal facial expressions: surprise, anger, happiness, sadness, anger, disgust and fear (Ekman, 1972). Accurate emotion recognition is thought to be vital for successful emotional development, social competence and the successful resolution of conflict (Denham, 1998; Parke, Cassidy, Burkes, Carson & Boyum, 1992; Saarni, 1999). Tonks et al. (2008) propose a developmental framework of three distinct levels of processing that are involved in recognising and responding to emotion in others, whereby there is processing in subcortical and cortical structures which increases in complexity as the child develops and becomes more skilful in their social responses via improved cognitive functioning and growth of the prefrontal cortex (Tonks et al., 2008).

Facial affect processing relies on a network of structures within the social brain particularly the fusiform gyrus and superior temporal gyrus (Adolphs, 2006), whilst the recognition of fearful expressions relies heavily on the amygdala and disgust on the insula and basal ganglia (Adolphs, 2002).The recognition of angry expressions also involves the activation of the prefrontal cortex (Blair, Morris, Frith, Perrett, & Dolan, 1999). Whilst behavioural models have tried to explain differences in FER, for example the social information processing model posits that aggressive children ignore relevant social cues whilst selectively attending to aggressive ones and interpret ambiguous cues as hostile or humiliating (Crick & Dodge, 1994), the majority of research into the development of FER skills comes from neurodevelopmental studies, which have attempted to track development through childhood. Contrary to the initial opinion that FER skills are established in mid-childhood and then remain stable (Bowers, Blonder & Heilman, 1999; Tremblay, Kirouac, & Dore, 2001), recent evidence shows that brain areas important in FER continue to develop structurally through childhood, into adolescence and adulthood, and show corresponding functional differences. Kolb, Wilson and Taylor (1992) found improvement in FER abilities at age 10 and 14 years, which closely matches periods of maturation associated with brain growth spurts and Piagetian periods of development (Kolb & Whishaw, 2003). Furthermore Tonks, Williams, Frampton, Yates, and Slater (2007a) note a significant improvement in FER at age 11 years. Additionally, the prefrontal cortex is one of the latest areas of the brain to mature (Casey, Giedd, & Thomas, 2000), suggesting that anger may have a later developmental trajectory. Thomas and colleagues found support for this, showing that anger sensitivity increased from adolescence to adulthood,

suggesting this are not fully developed (Thomas, De Bellis, Graham, & LaBar, 2007).

Research examining FER abilities in children who have sustained TBI is much less established in comparison to the adult literature, and consists of few studies with small, heterogeneous samples. Taken together however, there is evidence for general FER impairments in children with TBI (Pettersen, 1991; Schmidt, Hanten, Li, Orsten, & Levin, 2010; Snodgrass & Knot, 2006; Tonks, Williams, Frampton, Yates, & Slater, 2007b; Tonks et al., 2008; Tukstra, McDonald & DePompei, 2001) although few have compared recognition accuracy for individual emotions. This is in contrast to the adult TBI literature, where there is evidence that adults are significantly worse at recognising fear, anger, disgust and sadness, than the positive emotions like happiness and surprise (Croker & McDonald, 2005; Green et al., 2004; Milders, 2003).

In the adolescent antisocial populations, studies have shown that those with behavioural and emotional disorders (Walker & Leister, 1994; Zabel, 1979) and conduct disorder (Fairchild et al., 2009; Strand & Nowicki, 1999) have poorer accuracy when distinguishing facial affect as compared to non-disordered peers. It has been suggested that the recognition of fearful expressions play an important role in inhibiting antisocial behaviour (Blair, 2001), and many studies have found impairments in the processing of distress cues in antisocial populations. However the evidence is not clear cut, with others finding no impairment, possibly due to different samples, methodologies, or the absence of a strong association between these factors. A meta-analysis by Marsh and Blair (2008), however, analysed 20 studies and concluded that there was a robust link between anti-social behaviour in adults and specific

deficits in recognising fearful expressions that could not be attributed to task difficulty. It remains unclear however about the FER abilities of adolescents.

Given the prevalence of TBI in delinquent youth and evidence of FER impairments in childhood TBI, it is surprising how very few studies have considered these relationships when researching FER abilities in antisocial groups. Many studies take into account factors such as age, IQ, attention and motivation (factors deemed to influence FER; Herba & Phillips, 2004; Moore, 2001) however few studies have screened for a history of TBI when assessing FER skills. Although discussed in relation to mental health (e.g. ADHD, conduct disorder), the acknowledgement of antisocial populations having previous TBI is under-recognised in terms of possible impact on performance.

Although there has been much research into the emotion recognition abilities of delinquent youth and brain-injured youth independently, to date there has been little research that has examined the links between these factors. Typically, the study of social cognition has been neglected when compared to neurocognitive research, and many studies examining deficits in social cognition in delinquents have neglected the role of head injury. This is surprising given the significant long-term implications of social competence which is a predictor of psychological adjustment, academic performance and health status (Cacioppo, 2002; Rubin, Bukowski, & Parker, 2006). This begins to provide the rationale for the current study. The current study is also interested in examining any associations of empathy and parenting, since empathy is a central concept in prosocial development (Hoffman, 1982) shown to reduce aggression in childhood (Eisenberg & Miller, 1987), and research has shown that children with TBI are more vulnerable to the effects of negative

parent-child interactions (Wade et al., 2003) and parenting practices can impact on children's social competence (Yeates et al., 2010).

Furthermore, in this study we are interested in examining aggression in this sample since this can be one of the most serious psychiatric consequences of childhood TBI (Tateno, Jorge & Robinson, 2003) and is a risk factor for delinquency (Loeber & Dishion, 1983). Aggression is universally defined as any behaviour directed towards another which is intended to cause harm, and aggression is usually replaced during development by more prosocial behaviours through the process of socialisation (Tremblay et al., 2004). In an attempt to better understand aggression, subtypes have been identified by theorists which have generally distinguished between the 'impulsiveness' and 'thoughtfulness' of the aggression, including hostile vs. instrumental, affective vs. predatory, and reactive vs. proactive. The reactive and proactive aggression distinction has been widely used clinically and in research, where reactive aggression is defined as affective, defensive angry outbursts in response to perceived threat (Dodge, 1991) and proactive aggression is defined as instrumental, not requiring provocation or anger (Dodge, 1991). These types of aggression have been consistently shown via factor analysis to be separable and meaningful in children and adolescents (Poulin & Boivin, 2000; Salmivalli & Nieminen, 2002), and are therefore a focus of the current study.

Aims and Hypotheses.

The main aim of the current study is therefore to examine the association between TBI and FER in delinquent youths. It will also examine the relationships between TBI and offending, parenting, behavioural difficulties,

aggression and empathic sadness. Based on the review of the literature, the following hypotheses are made:

1. The primary hypothesis is that both the TBI and non-TBI groups will have poorest accuracy for the negative emotions (anger, fear, disgust & sadness) as compared to positive emotions (happy & surprise). The TBI group will demonstrate poorer accuracy on the negative emotions, but not the positive emotions compared to the non TBI group.
2. Delinquent youths in the TBI group will be more likely to incorrectly perceive anger in the emotion recognition task as compared to the non-TBI group.
3. Delinquent youths in the TBI group will report higher levels of difficulty as measured by the Strengths & Difficulties Questionnaire (SDQ), higher levels of aggression and less parental supervision as compared to the non-TBI group.
4. Poorer performance on the facial emotion recognition task and tendency to incorrectly perceive anger will be associated with higher difficulties on the SDQ, increased violence in their criminal history, lower levels of self-reported empathic sadness and lower parenting scores.

Method

Participants

Participants were recruited for the study at two time-points using the same inclusion and exclusion criteria. Participants had to be (a) aged between 14 and 19 years, and (b) hold a current or previous criminal conviction or be in contact with Targeted Youth Support (TYS; a service for young people in the community with antisocial and criminal tendencies). Exclusion criteria included

severe language difficulties, learning disability, and those deemed as high risk to themselves or others. Although consideration was given to excluding those with other neuro-developmental disabilities, in order to keep the sample representative these were included. Twenty-seven participants were recruited at time-point one in May 2013 by another researcher using a limited number of measures (see Table 1), and twenty-three participants were recruited at time-point two by the author and another researcher between October 2013 and March 2014. Participants were recruited opportunistically from four YOTs, across two counties, to take part in the study. The study was approved by the University of Exeter Psychology Ethics Committee (see appendix A) and the local council's research governance officers. Participants were given a £5 high street voucher for taking part. Two participants were tested at both time-points of recruitment, leaving a total sample of 48 once duplicates were removed. The sample consisted of 38 males and 10 females, with an average age of 16.4 years.

Design

The study used a cross sectional case-control design comparing individuals in a TBI versus a non-TBI group. The primary independent variable was TBI group. The primary dependant variable was FER accuracy.

Materials

Participants recruited at time-point one completed some different measures to those recruited at time-point 2 (see Table 1).

Table 1.

Measures administered at each time-point of recruitment

Measure type	Time-point one measures (collected May 2013)	Time-point two measures (Collected October 2013-March 2014)
Emotion Recognition Task	Facial Emotion Recognition Task (Bamford, Penton-Voak, Pinkney, Baldwin, Munafo & Garner, 2013)	Facial Emotion Recognition Task (Bamford, Penton-Voak, Pinkney, Baldwin, Munafo & Garner, 2013)
Neuropsychological Tests	- WASI Block Design subtest - WASI Vocabulary subtest - Stroop - Trail Making A and B	- *WASI Matrix Reasoning subtest* - WASI Vocabulary subtest
Background questionnaire including:	- Neurodisability section of the CHAT - Demographics (age, gender, ethnicity)	- Neurodisability section of the CHAT - Demographics (age, gender, ethnicity) *- Detailed substance misuse history* *- Education level* *- Self-reported criminal history* *- Mental health screen*
ASSET Data	- Offence History (including offences, seriousness score of primary offence, age of first conviction, number of previous convictions, risk of reoffending) - Substance Misuse - Mental Health Diagnosis	- Offence History (including offences, seriousness score of primary offence, age of first conviction, number of previous convictions, risk of reoffending) - Substance Misuse - Mental Health Diagnosis *- Living arrangements*
Other Questionnaires	None.	*- Alabama Parenting Questionnaire* *- Strengths and Difficulties Questionnaire* *- Proactive Reactive Aggression Questionnaire* *- Empathic Sadness Questionnaire*

Note: Italics highlight measures which were unique to time-point two participants (*N*=23)

Facial Emotion Recognition Task (Bamford, Penton-Voak, Pinkney, Baldwin, Munafo, & Garner, 2013; completed by all 48 participants; see appendix B). The FER task is a six-alternative forced choice paradigm which assesses sensitivity to six primary emotions: happy, sad, surprised, fearful, disgusted and angry, as defined by Ekman (1972), which is currently undergoing a large validity and reliability study. In this task (presented on E-Prime software) each trial began with a centrally-displayed fixation cross, shown on-screen for between 1,500 ms and 2,500 ms. The 350 × 457 pixel face

stimulus was presented for 150 ms, followed by a noise mask for 250 ms in order to prevent after-image effects (Cooper, Rowe, & Penton Voak, 2008). There were 15 face stimuli for each emotion, generated by morphing images so expression varied on a continuum from an ambiguous, neutral face to fully expressive. Participants were required to identify the emotion represented in each face as quickly and as accurately as possible, by using the mouse to click on the most appropriate descriptor from an array displayed on-screen (fearful, angry, happy, sad, disgusted and surprised). These appeared on-screen for 10,000 ms, or until the participant responded. Each image was presented once, giving 90 trials in total.

The Reactive-Proactive Aggression Questionnaire (RPQ; Raine et al., 2006; completed by 23 participants; see appendix C). The RPQ is a 23-item questionnaire measuring proactive and reactive aggression, to which the participants must respond (0 = never, 1 = sometimes, 2 = often) to a series of statements. It generates separate scores for reactive aggression, proactive aggression and overall aggression. Internal consistency was calculated using the study sample, finding an alpha of .85 for the proactive subscale and .88 for the reactive subscale.

Strengths & Difficulties Questionnaire (SDQ; Goodman, Meltzer & Bailey, 1998; completed by 23 participants; see appendix D). The SDQ is a 25-item self-rated questionnaire that provides a measure of emotional and behavioural difficulties. Participants must respond (0= 'Not true', 1 = 'Somewhat True' or 2 = 'Certainly True') to the series of statements, providing scores for five subscales (emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems & prosocial behaviour), and

a total score of overall distress. Cronbach's alpha was calculated for the SDQ using the study sample and ranged from .34 (peer relationships) to .66 (emotional distress).

Alabama Parenting Questionnaire – short version (APQ-9, Elgar, Waschbusch, Dadds, & Sigvaldason, 2007; completed by 23 participants; see appendix E). The APQ-9 is a 9-item questionnaire that assesses self-report parenting practices in three areas: positive parenting, inconsistent discipline, and poor supervision. There are three items per subscale and items are scored from 1 (Never) to 5 (Always). A reliable, valid measure with a simple factor structure (Elgar et al., 2007). Cronbach's alpha was calculated using the study sample and indicated .95 for positive parenting, .82 for inconsistent discipline and .77 for poor supervision.

Empathic Sadness Questionnaire (Adapted from Bryant's Empathy Index for Children & Adolescents, Bryant, 1982; completed by 23 participants; see appendix F). A 7-item self-report measure of empathic sadness, derived from Bryant's 22-item measure. Factor analysis of Bryant's Empathy Index indicated that the empathy component was multidimensional, consisting of both attitudes and empathic sadness, seriously questioning the validity of the questionnaire as a measure of emotional empathy. The empathic sadness dimension was therefore selected to remove the attitudes (cognitive) section of the questionnaire. The 7 items had good reliability in two large samples (.71 - .76) and were thought to best reflect emotional empathy (deWied et al., 2007). Items were scored as 1 = 'true' or 2 = 'false'.

Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999; completed by all 48 participants). This paper-and-pencil battery of

tasks yields an estimate of general intelligence. All participants completed the Vocabulary subtest and either the Matrix Reasoning or Block Design (i.e. FSIQ-2). Verbal and non-verbal T scores are therefore reported, as it is not possible to calculate IQ from Block Design scores. The WASI is a well-established, reliable IQ assessment with reliability coefficients ranging from .87- .92 in children and the average reliability of .93 for the FSIQ-2 (Strauss & Sherman, 2006). Furthermore, it has high inter-rater reliability (>0.9) and correlates highly with the WISC-III (.81; Strauss & Sherman, 2006).

Background Questionnaire. (Completed by all 48 participants; see appendix G). Developed by the researcher, this questionnaire asks about the participant's offending history, demographics, drug and alcohol use and TBI history (based on the neuro-disability section of the Comprehensive Health Assessment Tool, CHAT; Shaw et al., 2014). Participants are asked 'Have you ever had an injury to the head that caused you to be knocked out and/or dazed and confused?' If responding 'yes', then additional questions are asked regarding frequency, age at injury, cause, medical attention, and duration of LoC.

The duration of LoC of their most severe injury was taken as a measure of TBI severity, and the frequency of their injuries recorded. Categories included no history of TBI, dazed and confused without LoC (concussion), LoC up to 10 minutes (mild TBI), LoC 10-30 minutes (complicated mild TBI), LoC 30-60 minutes (moderate TBI), and LoC more than 60 minutes (severe TBI). These distinctions were based on classifications of TBI in the CHAT (Shaw et al., 2014).

Procedure

YOT caseworkers were given information about the study (see appendix H) and contacted eligible young people on their caseload to invite them to take part. If the young person was interested, they were booked to see the researcher for a testing session, where informed consent was obtained. If the young person was aged 14 or 15 years, parent/guardian consent was obtained by the caseworkers prior to scheduling the participant. Participants were seen for a one-off testing session lasting between 45 and 60 minutes either in the YOT offices or at the participant's home.

On attending the testing session, participants were given an information sheet (2 versions based on age and reading ability; see appendix I) and a consent form (3 consent version; one for over 16s, and two for under 16s, a parental form and assent form; see appendix J) . Measures were administered, with the background questionnaire given last to avoid 'expectation as etiology' effects (Gunstad & Suhr, 2001) where responses may have been differentially provided depending on associations with impairment. Participants were thanked for their participation, awarded a £5 high-street voucher and offered a verbal debrief of the study. With participant consent, further background information about the participant was extracted from the ASSET screen (a structured assessment tool used by Youth Offending Teams; see appendix K for extraction proforma) and anonymously added to the data set.

Data Analysis

Two participants' data for the FER task were excluded from the analysis, one due to a corrupt data file and another due to a mean performance of more

than three standard deviations below the mean (non-TBI *n*=24). Data were examined to check for normality and homogeneity of variance by examining histograms and Levene's test. All the data met the assumptions for parametric tests except for false alarms, so a series of independent samples *t*-test, mixed design ANOVAs and a Mann Whitney U test were conducted. Although consideration was given to the addition of covariates to the analysis, namely verbal T-scores and age, assumptions were not met meaning that ANCOVA was not suitable**.** One-tailed bivariate correlations were also conducted based on initial hypotheses. One-tailed tests were used since a priori predictions about the direction of the effects were used, however the author is aware that one-tailed tests have more power to detect differences in the predicted direction and therefore inflate the chance of type I error.

Results

Sample characteristics

The sample consisted of 48 young people, with an age range of 14 to 19 years. The mean age of participants was 16.4 years (SD=1.27). The majority of the sample was male (79%) and White British (90%). Information regarding education and developmental difficulties was collected for participants recruited during time-point two only (*n*=23). Of these, 56.5% were still in education, 52% had achieved GCSEs, 21.7% had achieved other qualifications (i.e. BTEC, NVQ, or vocational qualifications), 13% had no qualifications, and 13% were yet to take any exams. A diagnosis of ADHD had been given to 21.7% of the sample, and 30.4% self-reported other developmental disorders including dyslexia, dyscalculia, literacy support needs and oppositional defiant disorder.

Of the total sample (*n*=48), 69% had a history of substance misuse. Alcohol was currently being consumed by 83% of the time-point two sample, most commonly beer (33%) and spirits (33%) and mostly on weekends (55%).

Offence characteristics

A previous and/or current criminal conviction was held by 87.5% of the sample. The remaining 12.5% were seen by TYS, a service for at-risk young people who have not received formal convictions. One third of the offences committed were assault (see Table 2). Following this, most common were theft and burglary. Of those who had received a conviction, 71% had a history of or current violent offence. See appendix L for full breakdown of offence and TBI history for each participant.

Table 2.

Summary of offences committed in the sample

Primary Offence Type	Seriousness Score*	*n*	Percentage of sample
Assault	3	14	33.3%
Theft	3	6	14.6%
Burglary	6	6	14.6%
Rape	8	3	7.1%
Criminal Damage	2	3	7.1%
Possession	4 or 6**	3	7.1%
GBH	6	2	4.7%
Attempted Robbery	6	1	2.3%
Aggravated Vehicle Taking	5	1	2.3%
Drunk & Disorderly	1	1	2.3%
Fraud	3	1	2.3%
Supply	4	1	2.3%

*Seriousness score is on a scale of 1-8 derived by the Youth Justice Board and relates to the individuals most serious offence. This score came from the young person's ASSET. **Score depends on drug

Head injury characteristics

As can be seen in Table 3, 68.7% of the whole sample reported experiencing a blow to the head where there was a loss of consciousness or concussion. A LoC of up to 5 minutes was the most commonly reported worst injury, followed by a LoC of 5-10 minutes and a LoC of over 60 minutes. The average age of worst injury was 12.3 years, with a range of 3-17 years.

Table 3.

Self-reported severity of worst head injury

TBI Severity	Definition*	*n*	Percentage of sample
No history of TBI		15	31.3%
Minor concussion	dazed & confused (no LoC)	2	4.2%
Mild TBI	LoC <5 minutes	14	29.1%
	LoC 5-10 minutes	7	14.5%
	LoC 10-20 minutes	0	0%
	LoC 20–30 minutes	3	6.3%
Moderate TBI	LoC 30–60 minutes	1	2.1%
Severe TBI	LoC > 60 minutes	6	12.5%

*Classification and severity based on the CHAT (Shaw, 2014).

Of those who reported experiencing a head injury, the majority of the sample had experienced five or more injuries (see Table 4). The most common cause of most severe head injury was fights (20.8%), followed by non-criminal activity (12.5%), falls when sober (10.4%), road traffic accidents (8.3%), abuse (4.2%), sports injuries (4.2%) and falls whilst under the influence of drugs or alcohol (4.2%). No detail for the cause of head injury was available for 2 cases (4.2%).

Table 4.

Frequency of self-reported head injury

TBI Frequency	*n*	Percentage of sample
No history of TBI	15	31.3%
1	7	14.6%
2	9	18.8%
3	5	10.4%
4	2	4.1%
5 or more	10	20.8%

Characteristics of the TBI and non-TBI groups

Based on predetermined criteria, participants were allocated to either the TBI or non-TBI group based on the severity and frequency of their reported injuries. Given the lack of consensus on the classifications of TBI severity in the clinical and research field, close consideration was given to the groups for the study (see Appendix M). Due to growing evidence of the cumulative effect of mild head injuries (Davies et al., 2012; Collins et al., 2002; Effgen, Gill, & Morrison, 2012; Williams et al., 2010), the severity groups were collapsed into two groups for the analysis; a non-TBI group (*N*=26) consisting of no history and up to 2 mild TBIs, and a TBI group (*N*=22) consisting of 3 or more mild TBIs, and/or moderate and severe cases. Concussions were included as mild injuries based on the definition of mild TBI by the Mild Traumatic Brain Injury Committee of the American Congress of Rehabilitation Medicine (1993).

Within the TBI group, 19 were male and 3 were female, and within the non-TBI group 19 were male and 7 were female. There were no significant differences between the groups on factors presented in table 5, apart from age.

The TBI group was significantly older than the non TBI group, however the relative difference here is small (less than one year; see Table 5).

Table 5.

Demographic information for the TBI and non-TBI groups

Variable	**Non-TBI**			**TBI**			***t***	***p***
	n	**Mean**	**SD**	***n***	**Mean**	**SD**		
Age	26	16.04	1.31	22	16.86	0.99	-2.42	0.02*
Verbal T Score	26	35.88	11.62	22	38.50	8.43	-0.88	0.39
Non-Verbal T Score	26	40.03	9.92	22	42.95	10.21	-1.00	0.32
Age of first conviction	20	14.25	1.48	17	14.64	1.41	0.66	0.41
Seriousness Score of Offence	24	4.20	2.04	18	3.80	1.42	0.67	0.51
Number of previous convictions	22	1.64	2.08	18	2.67	3.75	-1.10	0.28
Risk of Reoffending	24	14.2	6.0	17	11.41	4.21	1.60	0.12

*Significant at $p<0.05$

TBI and Facial Emotion Recognition

Parametric tests were carried out on the FER task data after examination of histograms. The mean overall accuracy for the groups can be found in Table 6. Both groups performed best for the emotion ‘happy’ and worst on the emotion ‘fear’. Both groups made fewest false alarms (FAs) for the emotion ‘angry’ and most FAs for the emotion ‘surprise’.

Table 6.

Facial Emotion Recognition performance for the TBI and non-TBI groups

FER Variable	Non-TBI Group (*n*=24)		TBI group (*n*=22)		Total Sample (*n*=46)	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Overall accuracy	54.16	11.09	50.20	9.26	52.2	10.35
Hits						
Happy	73.61	16.62	70.30	14.79	72.03	15.69
Angry	42.78	18.22	37.87	15.31	40.43	16.89
Sad	65.00	14.87	56.97	15.90	61.16	15.73
Fear	26.67	16.33	26.06	13.16	26.38	14.74
Surprise	65.5	17.65	66.06	14.97	65.80	16.25
Disgust	51.38	19.50	43.94	19.26	47.83	19.54
False alarms						
Happy	6.55	5.4	7.45	6.35	6.99	5.87
Angry	2.94	2.72	3.63	2.88	3.28	2.79
Sad	7.89	5.39	8.66	6.68	8.26	5.99
Fear	12.77	6.17	12.55	7.22	12.67	6.62
Surprise	13.66	4.45	15.09	5.58	14.35	5.02
Disgust	9.88	5.24	10.66	5.78	10.26	5.46
No Response	1.46	2.22	1.27	1.54	1.37	1.91
Positive Hits	69.58	13.63	68.18	12.07	68.91*	12.79
Negative Hits	46.45	12.75	41.21	10.45	43.94	11.88

*Significantly higher at $p<0.01$ than negative emotions for total sample

Hypothesis 1: Both the TBI and non-TBI groups will have poorest accuracy for the negative emotions (anger, fear, disgust & sadness) as compared to positive emotions (happy & surprise). The TBI group will demonstrate poorer accuracy on the negative emotions, but not the positive emotions compared to the non TBI group.

A 2 x 2 mixed ANOVA was conducted to examine the differences between the within subjects variable of emotion (positive vs. negative) and the between subjects variable of group (TBI vs. non-TBI) on facial emotion recognition accuracy. There was a significant main effect of emotion, $F(1, 44)=153.73$, $p<0.01$, $d=9.84$; see Table 6 for means & standard deviations. There was no main effect of group ($F(1, 44)= 1.207$, $p>0.05$) and no interaction

($F(1, 44)=0.97$, $p>0.05$). Therefore, groups did not differ significantly on either emotional valence, but across the whole sample participants did better on recognising positive vs. negative emotions.

Hypothesis 2: Delinquent youths in the TBI group will be more likely to incorrectly perceive anger in the emotion recognition task as compared to the non-TBI group.

Angry false alarm data was not normally distributed (Shapiro-Wilk test; $p<0.01$) so a non-parametric one-tailed Mann Whitney U test was conducted to examine the differences between the TBI and non-TBI groups. There was no significant difference between the groups for angry false alarms ($U=299.50$, $p=0.43$).

Hypothesis 3: Delinquent youths in the TBI group will report higher levels of difficulty as measured by the SDQ, higher levels of aggression and less parental supervision as compared to the non-TBI group.

Means, standard deviations, *t* statistics and *p* values for the AQP-9, SDQ, Reactive-Proactive Aggression Questionnaire and Empathic Sadness Questionnaire can be found in Table 7 for both groups.

A one-tailed independent samples t-test revealed no significant differences between TBI and non-TBI groups for SDQ total score. A one-tailed independent samples t-test revealed those in the TBI group reported significantly poorer levels of parental supervision as compared to the non TBI groups. An independent samples t-test revealed that the TBI group reported significantly higher levels of aggression as compared to the non TBI group. When considering the reactive and proactive aggression scales within this measure, the TBI group had significantly higher scores for both reactive and

proactive aggression as compared to the non-TBI group, with highest scores for reactive than proactive aggression. There were no significant differences between the groups for a history of previous aggression.

Table 7.

Means, standard deviations, *t*-statistic and significance for the AQP-9, SDQ, Reactive-Proactive Aggression Questionnaire and Empathic Sadness Questionnaire for the TBI and non-TBI groups

Variable	Non-TBI Group (*n*=11)		TBI group (*n*=12)		*t*	*p*
	Mean	SD	Mean	SD		
APQ-9						
Positive Parenting	11.82	3.28	11.33	2.93	0.37	0.71
Inconsistent Discipline	8.55	3.67	8.17	3.78	0.24	0.81
Poor Supervision	7.73	3.35	12.58	2.02	-4.25	<0.01*
SDQ						
Emotional	3.00	2.09	3.00	2.21	0.00	1.0
Conduct	3.82	1.84	4.08	1.93	-0.34	0.79
Hyperactivity	5.91	2.3	5.42	1.73	0.58	0.57
Peer	2.82	1.6	2.42	1.31	0.66	0.52
Prosocial	6.91	2.02	7.42	1.57	-0.68	0.51
Total	15.36	5.81	15.75	5.69	-0.16	0.87
Reactive-Proactive Aggression						
Reactive Aggression	10.09	4.7	15.08	4.62	-2.57	0.02*
Proactive Aggression	4.55	3.48	8.92	4.70	-2.52	0.02*
Total Aggression	14.64	5.81	24.00	8.89	-2.96	0.01*
Empathic Sadness	3.09	1.3	4.00	2.13	-1.22	0.24

*Significant at p<0.05

Hypothesis 4: Poorer overall accuracy on the facial emotion recognition task and a tendency to incorrectly perceive anger will be associated with

higher difficulties on the SDQ, increased violence (self-reported aggression & in their criminal history), lower levels of self-reported empathic sadness & lower parenting scores.

Parametric one-tailed bivariate correlations were run comparing variables for which hypotheses were made (see Table 8). There were no significant correlations between overall FER accuracy and total difficulties on the SDQ, aggression, previous violence, self-reported empathic sadness, poor supervision or inconsistent discipline. Positive parenting was strongly negatively correlated with overall FER accuracy.

Angry FAs were strongly positively correlated with SDQ total, reactive aggression, proactive aggression, and aggression total (see Table 8). Therefore there is a moderate relationship between psychosocial difficulties and angry FAs, and aggression and a tendency to give angry FAs.

Table 8.

Bivariate correlations for overall FER accuracy and angry false alarms, behavioural difficulties, aggression, empathic sadness and parenting measures (n=23 for all variables except violent history, n=42)

	SDQ total	**R. Agg.**	**P. Agg.**	**Total Agg.**	**Violent History**	**Empathic Sadness**	**APQ-9 PP**	**AQP-9 ID**	**AQP-9 PS**
Overall emotion accuracy	-.25	.20	-.18	.03	.06	-.22	-.42*	-.12	-.31
Angry False Alarm	.42*	.55**	.45*	.56**	-.16	-.07	-.03	.11	.03

(R. Agg. = reactive aggression; P Agg. = proactive aggression, Total Agg. = total aggression; APQ-9 PP = positive parenting; AQP-9 ID = inconsistent discipline; AQP-9 PS = poor supervision)
*Significant at 0.05 level
**Significant at 0.01 level

Discussion

The study aimed to examine the association between TBI in delinquent youth and FER abilities, offending, behavioural difficulties, aggression, empathic sadness and parenting. A total of 68.7% of the sample reported a TBI history, with 94% of these including a LoC. This is line with previous research which has found prevalence rates of between 46-72% (Davies et al., 2012; Hux et al., 1998; Williams et al., 2010) of TBI in delinquent youth, however is slightly higher than rates found by Perron et al. (2008) and Muria et al. (2005). It is likely that the variation is a result of the multiple classification systems of TBI and methods of assessment. The lack of clarity regarding the diagnosis of TBI makes research in this area challenging as it becomes difficult to make sound comparisons between groups and provides a dilemma for researchers when designing methodology. Alteration in brain function after TBI can be measured in a number of ways including LoC (e.g as defined by the Glasgow Coma Scale; Teasdale & Jennett, 1974), loss of memory for events immediately before (retrograde amnesia) or after the injury (post-traumatic amnesia), neurological deficits or any alteration in mental state at the time of the injury (e.g. confusion/concussion; Menon et al., 2010). Even with these methods, categories of severity can vary, for example Bodin et al. (2012) define moderate TBI as a LoC of over 24 hours, whereas Williams et al. (2010) define it as 10 minutes to 6 hours. One classification system which attempts to integrate these indicators is the Mayo Classification System for TBI (Friedland, 2013). However this also has limitations in so far as it does not differentiate between moderate and severe injuries. Although there are a few international consensus documents for the classification of TBI (e.g. Menon et al., 2010;

Servadei,Teasdale & Merry 2001), after systematically reviewing these and others, Chung and Khan (2013) highlight that still a lack of consensus is problematic and moving forward more needs to be done in the clinical and research communities for a united consensus on classification. Importantly, however, the prevalence of TBI identified in the current study is higher than what would be expected for adolescents in the general population (McKinlay et al., 2008; average prevalence 30%), supporting the hypothesis that this group are particularly at-risk of TBI.

Association between TBI and FER abilities

The study did not find support for its primary hypothesis that the TBI group would be significantly worse at negative but not positive emotions as compared to the non-TBI group. It is possible that the authors failed to reject the null hypothesis for a number of reasons. One possibility is the way in which participants were assigned to TBI and non-TBI groups. For example, grouping people who had experienced more than three mild injuries with those who had experienced severe injuries with a LoC over 60 minutes, could have diluted the effects of the more severe injuries and inflated type II error. Although this distinction was based on the evidence base of the impact of multiple mild injuries and taking into consideration multiple classification systems, in a future larger study it may be better to subdivide the groups beyond the currently presented dichotomy in order to increase sensitivity. Furthermore, although efforts were made to obtain a large sample size for the study based on a priori power calculations (large effect size and 0.8 power), the study was slightly underpowered to detect differences. For example, the primary hypothesis had

0.8 power to detect only a large Cohen's d effect size of 0.75. Furthermore, the t-tests for hypothesis 3 had 0.8 power to detect only very large Cohen's d effect sizes of 1.07 and the correlations in hypothesis 4 had 0.8 power to detect large correlations of r = .50 only. Therefore it is possible that parts of the analysis were underpowered, which represents a limitation in the study, and would need a larger sample if these factors were to be investigated in future research.

Although no significant differences were found between the TBI and non-TBI groups, the delinquent sample as a whole did significantly differ on their ability to accurately recognise positive and negative emotions, in line with the author's original hypothesis. Compared to Tonks et al. (2007a) who found their healthy sample of 14-15 year olds had expression naming accuracy of 80%, both TBI and non-TBI groups were impaired with an overall FER accuracy of 52.2%, supporting the evidence for impairment in antisocial populations (Marsh & Blair, 2008), although it is difficult to draw firm conclusions in the absence of a formal statistical comparison. The result is also in keeping with the finding that happiness is the most accurately recognised emotion, and negative emotions like fear and disgust are least accurately recognised in the general population (Elfenbein & Ambady, 2002). Both groups performed worst on the emotion 'fear'. Normative data for the FER task has been collected for a sample of university students (n=131, average age 20.8 years; Penton Voak, unpublished), who also performed worst on the emotion fear but to a lesser extent (mean accuracy = 39.4%; current sample mean accuracy = 26.4%). Although caution is advised when comparing these unmatched groups, this does lend some support to the view that anti-social groups may have impairment in processing distress cues (Blair, 2001) and support findings of

impaired fear recognition in antisocial populations (Marsh & Blair, 2008). Without a control group, however, it is difficult to draw firm conclusions. An alternative explanation is that this pattern fits with the developmental trajectories of FER more generally, whereby the recognition of fear and anger (areas of poorest accuracy) are not yet fully developed due to their dependence on neuroanatomical structures which are still developing in adolescence (Thomas et al., 2007).

It was hypothesised that the TBI group may have a tendency towards incorrectly perceiving anger as compared to the non-TBI group, since aggression is a common consequence of TBI (Tateno, Jorge, & Robinson, 2003) and the social information processing model (Crick & Dodge, 1994) would predict that young people would have a tendency to interpret ambiguous cues, in this case more neutral face morphs, as threatening. No support however was found for the hypothesis. Interestingly though, angry false alarms had a large correlation with aggression, indicating that those who had a tendency to incorrectly label a face as angry self-reported higher levels of aggression and had more difficulties as measured by the SDQ. Therefore, perhaps those with a bias are more likely to get themselves into difficult situations where aggression may play a role, as the social information processing model may suggest. The direction of causality here is unclear however, and further examination of the interplay between aggression, behaviour and an angry bias would be interesting.

Association between TBI and Behaviour

No support was found for significant differences between groups on empathic sadness, history of previous violence or the SDQ. The latter is in contrast to other research indicating that children with TBI have greater total difficulties as measured by the SDQ, mainly related to the subscales emotional problems and hyperactivity, as compared to children without TBI (Ross, McMillan, Kelly, Sumpter & Dorris, 2011). As discussed, it is possible that the study was underpowered to find such differences, that the measures were not sensitive enough to pick up on subtle differences between the groups, or that there is a true absence of a relationship in this population.

Support was found for the hypothesis that young people in the TBI group would report higher levels of aggression as compared to the non-TBI group. Those who were in the TBI group reported significantly higher levels of proactive and reactive aggression (large effect size) and were more likely to have sustained their TBI through violence. Aggression is one of the most serious psychiatric consequences of childhood TBI (Tateno, Jorge, & Robinson, 2003) which can lead to self-injury, property damage, isolation from family, peers and community and placement in more restrictive environments (Rojahn, Matson, Lott, Esbensen, & Smalls, 2001; Swan & Alderman, 2004). Developmental models of aggression suggest that aggression diminishes as the socialisation process replaces aggressive behaviour with more pro-social responses, and therefore the persistence of aggression is a deviation from typical development (Tremblay et al., 2004). TBI in adolescence can be seen as a risk factor for the persistence of aggression into adulthood, since the timing of the injury creates cognitive and neural instability at a crucial time in

development when certain skills (i.e. social skills) are emerging (McKinlay et al., 2008). Furthermore, aggression is one of the most concerning behavioural consequences of TBI given its detrimental effects on peer and family relationships and criminal activity, which can have long-term negative implications (Brendgen, Vitaro, Tremblay, & Lavoie, 2001; Pulkkinen, 1996). In this study, the TBI group self-reported significantly higher levels of both proactive and reactive aggression, indicating that not only are they more likely to respond 'hotly' to perceived threat, but are also more likely to use instrumental aggression. Brendgen et al. (2001) found that proactive aggression in boys predicted delinquency-related violence and reactive aggression predicted violence towards a dating partner. Interestingly, the relationship between proactive aggression and delinquency-related violence was found to be moderated by parental supervision, where low levels of supervision increased the likelihood of violence. In the current study it was not possible to examine a moderation effect due to low statistical power, however it was found that those in the TBI group reported significantly lower levels of parental supervision. Although this is self-report of parenting practice and so may not be reliable, the direction of causality here is unclear with poor parental supervision perhaps contributing to the probability of sustaining a TBI, but also possibly being a consequence of psychosocial difficulties presented by the young person as a result of TBI (e.g. impulsivity, behavioural difficulties). However, importantly, the evidence seems to show that this combination of factors (proactive aggression and low parental supervision) in the TBI group places them at further risk of perpetrating violence. This has implications for the

treatment and management of TBI in adolescents, particularly in terms of parenting strategies as intervention in the treatment of aggression after TBI.

Taking together the high prevalence of TBI in this sample and the indication of long-lasting psychosocial difficulties found in the evidence base for individuals with TBI, the study provides support for the recommendations provided by Williams (2012) regarding better screening and assessment of young people in the Criminal Justice System, training for professionals and provision of appropriate services for this population.

Strengths and Limitations of the Study

The study had a few limitations which should be noted. Firstly the study lacked statistical power for some of its hypotheses, so further research with larger sample sizes is required. There was a very high non-attendance rate to testing sessions (see appendix N) and therefore there may have been a sampling bias with regards to the "type" of delinquent youth who agreed to participate, i.e., those with less severe psychosocial and behavioural problems more likely to attend testing. In addition, the majority of the sample had mild TBIs, and it is possible that those with more severe injuries are in other settings, e.g. offender institutes, so findings are only generalizable to the community. In order to increase the chance of finding significant associations between offending and TBI, future studies should sample a greater variation in severity of delinquency by also recruiting from incarceration sites. A strength of the current study however was that it was multi-site and had a thorough recruitment strategy at all four geographical locations.

Another limitation of the study was that it had no control group which, in addition to a dearth of normative population data, made it difficult to draw conclusions about relative performance levels. Furthermore, the majority of the sample was male (79%), although it is known that sex differences for FER abilities exist (Killgore & Yurgelun-Todd, 2001). Due to small numbers in the sample it was not possible to look at gender differences, but this should be an area of interest for future research. Although only 21% of the sample was female, this was representative of the YOT caseloads, which had an average of 15% females. Taken together with the range of offences, TBIs, age and psychosocial difficulties, although the author did not match pairs due to the small sample size, the sample was fairly representative of delinquent youth. The TBI group was significantly older than the non TBI group, however given that the difference between means were relatively small and that age was not significantly correlated with any of the main measures, it is unlikely to be a strong confound.

It should be noted that FER is a complex task that requires visual scanning, attention, working memory, visuospatial skills and semantic processing. These are abilities that can be impaired in TBI and it is difficult to exclude all confounding variables with a limited testing protocol. Additionally mental health status and substance misuse were also possible confounds, but to exclude them would create an unrepresentative sample. Interestingly, none of the participants had any mental health information recorded on their ASSET; however this is likely representative of poor assessment and recording rather than an absence of diagnoses, since it is estimated that 20% of youth in the criminal justice system have a serious mental health diagnosis and historically

these needs have been neglected (Cocozza & Skowyra, 2000). Further research examining the neuropsychological correlates in this population and the association with FER abilities would be helpful. Whilst the FER task used provided a sensitive measure due to its range of face morphs, there is not yet any evidence for its reliability and validity as it is a relatively newly developed measure, and since it was a forced-choice paradigm using static images, it lacked some ecological validity since it is not really known whether mistaking one category of emotion for another impacts on social communication ability (Fairchild et al., 2009). Furthermore the SDQ, used to measure behavioural difficulties, had very low alpha indicating it was not a very reliable measure in this population.

Finally, although the self-report of TBI may be seen as a limitation of the study in comparison to the gold standard of examining medical records, there is evidence that self-reported head injury in antisocial populations is generally accurate. For example, Schofield, Butler, Hollis, and D'Este (2010) found 70% of their incarcerated sample had accurate self report of TBI when this was compared to their medical records, with less agreement associated with more than 7 TBIs and lower education levels. Furthermore, the dichotomisation of head injury in this study is relatively crude and may lose sensitivity which compromises statistical power to detect associations. Despite this, there is no consensus in the research community on classifying TBI and multiple methods can have both a theoretically and statistically sound basis (see appendix M for considerations), like the dichotomy presented in the current study.

Conclusion

This study is one of few that has taken TBI into account when examining FER abilities in delinquent youth, and therefore provides a contribution to the evidence base in an area that is under-researched. Although no significant differences were found between the TBI groups on FER abilities, further investigation of these hypotheses is warranted with larger sample sizes that cover incarcerated as well as community samples and will allow for a greater level of sensitivity in the division of TBI groups for comparison. Aside from FER, a key finding in the study was the high prevalence of TBI in the sample, highlighting the need for better screening and assessment in this population and the provision and access to appropriate services. The delinquent youth studied also showed possible impairment in fear recognition, so further research is required that has matched control groups in order to delineate some of the hypotheses around performance variation. Finally, a key finding in relation to TBI was that those who had experienced a significant dosage of head injury reported higher levels of self-reported reactive and proactive aggression and lower levels of parental supervision, and since these factors have implications for the perpetration of future violence and possible criminality, this represents an area for further research and is possibly a promising area for preventative intervention to be explored.

References

Adolphs, R. (2002). Neural systems for recognising emotion. *Current Opinion in Neurobiology*, *12*, 169-177.

Adolphs, R. (2006). Perception and emotion: how we recognise facial expressions. *Current Directions in Psychological Science*, *15*, 222-226.

Anderson, V., Brown, S., Newitt, H., & Hoile, H. (2009). Educational, vocational, psychosocial and quality of life outcomes for adult survivors of childhood traumatic brain injury. *Journal of Head Trauma Rehabilitation*, *24*, 303-312.

Anderson, V., Spencer-Smith, M., & Wood, A. (2011). Do children really recover better? Neurobehavioural plasticity after early brain insult. *Brain*, *134*, 2197-2221.

Bamford, S., Penton-Voak, I., Pinkney, V., Baldwin, D. S., Munafo, M. R., & Garner, M. *Effects of Duloxetine on Emotion Recognition in Healthy Volunteers*. Manuscript submitted for publication.

Beauchamp, M. H., & Anderson, V. (2010). SOCIAL: an integrative framework for the development of social skills. *Psychological Bulletin*, *136*, 39-64.

Blair, R. J. (2001). Neurocognitive models of aggression, the antisocial personality disorders, and psychopathy. *Journal of Neurology Neurosurgery and Psychiatry*, *71*, 727–731.

Blair, R. J. (2003). Facial expressions, their communicatory functions and neurocognitive substrates. *Philosophical Transactions of the Royal Society of London*, *358*, 561-572.

Blair, R. J. R., Morris, J. S., Frith, C. D., Perrett, D. I., & Dolan, R. J. (1999). Dissociable neural responses to facial expressions of sadness and anger. *Brain*, *122*, 883-893.

Bodin, D., Yeates, K. O., & Klamar, K. (2012). Definition and classification of concussion. In J. N. Apps & K. D. Walter (Eds.), *Pediatric and Adolescent Concussion: Diagnosis, Management and Outcomes.* New York: Springer.

Bowers, D., Blonder, L. X., & Heilman, K. M. (1999). *Florida Affect Battery: a manual*. Florida, USA: University of Florida, Centre for Neuropsychological Studies.

Brendgen M., Vitaro, F., Tremblay, R. R., & Lavoie, F. (2001). Reactive and proactive aggression: predictions to physical violence in different contexts and moderating effects of parental monitoring and caregiving behaviour. *Journal of Abnormal Child Psychology*, *29*, 293-304.

Bryant, B. (1982). An Index of Empathy for Children and Adolescents. *Child Development*, *53*, 413-425.

Cacioppo, J. T. (2002). Social neuroscience: Understanding the pieces fosters understanding the whole and vice versa. *American Psychologist*, *57*, 819-831.

Cattelani, R., Lombardi, F., Brianti, R., Mazzucchi, A. (1998). Traumatic brain injury in childhood: Intellectual, behavioural and social outcome into adulthood. *Brain Injury*, *12*, 283-296.

Casey, B. J., Giedd, J. N., & Thomas, K. M. (2000). Structural and functional brain development and its relation to cognitive development. *Biological Psychology, 54*, 241-257.

Charlesworth, W. R., & Kreutzer, M. A. (1973). Facial expressions of infants and children. In P. Ekman (Ed.), *Darwin and facial expression*. New York: Academic Press.

Chung, P., & Khan, F. (2013). Traumatic Brain Injury (TBI): Overview of diagnosis and treatment. *Journal of Neurology & Neurophysiology*, *5*, 182.

Cocozza, J. J., & Skowyra, K. R. (2000). Youth with mental health diagnoses: issues and emerging responses. *Juvenile Justice*, *7*, 3-13.

Collins, M. W., Lovell, M. R., Iverson, G. L., Cantu, R. C., Maroon, J. C., & Field, M. (2002). Cumulative effects of concussion in high school athletes. *Neurosurgery*, *51*, 1175-1181.

Cooper, R. M., Rowe, A. C., & Penton-Voak, I. S. (2008). The role of trait anxiety in the recognition of emotional facial expressions. *Journal of Anxiety Disorders*, *22*, 1120–1127.

Crick, N. R., & Dodge, K. A. (1994). A review and reformulation of social information-processing mechanisms in children's social adjustment. *Psychological Bulletin*, *115*, 74-101.

Davies, R. C., Williams, W. H., Hinder, D., Burgess, C. N., & Mounce, L. T. (2012). Self-reported traumatic brain injury and post-concussion symptoms in incarcerated youth. *Journal of Head Trauma Rehabilitation*, *27*, 21-27.

Denham, S. (1998). *Emotional development in young children*. New York: Guildford Press.

deWied, M., Maas, C., van Goozen, S., Vermande, M., Engels, R., Meeus, W., … Goudena, P. (2007). Bryant's Empathy Index: a closer examination of its internal structure. *European Journal of Psychological Assessment*, *23*, 99-104.

Dodge, K. (1986). A social information processing model of social competence in children. In M. Perlmuyyrt (Ed.), *The Minnesota symposium on child psychology* (Vol. 18, pp. 77-125). Hillsdale, NJ: Erlbaum.

Dodge, K. (1991). The structure and function of reactive and proactive aggression. In D. J. Pepler & K. H. Rubin (Eds.), *The development and treatment of childhood aggression*, (pp. 201-218). Hillsdale, NJ: Erlbaum.

Effgen, G. B., Gill, E., & Morrison III, B. (2012). A Model of Repetitive, Mild Traumatic Brain Injury and a Novel Pharmacological Intervention to Block Repetitive Injury Synergy. In *Proceedings of the International Research Council on the Biomechanics of Injury conference* (Vol. 40, pp. 455-466). International Research Council on Biomechanics of Injury.

Elfenbein, H.A., & Ambady, N., (2002). On the universality and cultural specificity of emotion recognition: a meta-analysis. *Psychological Bulletin*, *128*, 203–235.

Eisenberg, N., & Miller, P. A. (1987). The relation of empathy to prosocial and related behaviours. *Psychological Bulletin*, *101*, 91-119.

Ekman, P. A. (1972). Universals and cultural differences in facial expressions of emotion. In J. Cole (Ed.), *Nebraska symposium on motivation 1971* (pp. 207-283). Lincoln: University of Nebraska Press.

Elgar, F. J., Waschbusch, D. A., Dadds, M. R., & Sigvaldason, N. (2007). Development and validation of a short form of the Alabama Parenting Questionnaire. *Journal of Child and Family Studies*, *16*, 243-259.

Fairchild, G., Van Goozen, S. H. M., Calder, A. J., Stollery, S. J., & Goodyer, I. M. (2009). Deficits in facial expression recognition in male adolescents

with early-onset or adolescence-onset conduct disorder. *The Journal of Child Psychology and Psychiatry*, *50*, 627-636.

Farrer, T.J., Frost, R. B., & Hedges, D. W. (2012). Prevalence of traumatic brain injury in juvenile offenders: A meta-analysis. *Child Neuropsychology*, *19*, 225-234.

Fazel, S., Lichtenstein, P., Grann, M., & Langstrom, N. (2011). Risk of violent crime in individuals with epilepsy and traumatic brain injury: A 35 year Swedish population study. *PLOS Med*, *8*, e1001150.

Fazel, S., Philipson, J., Gardiner, L., Merritt, R., & Grann, M. (2009). Neurological disorders and violence: a systematic review and meta-analysis with a focus on epilepsy and traumatic brain injury. *Journal of Neurology, 256*, 1591-1602.

Forrest, C. B., Tambor, E., Riley, A. W., Ensminger, M. E., & Starfield, B. (2000). The Health Profile of Incarcerated Male Youths. *Pediatrics*, *105*, 286-291.

Friedland, D. P. (2013). Improving the classification of traumatic brain injury: The Mayo Classification System for Traumatic Brain Injury. *Brain and Spinal Cord Injury*, *S4*:005*,* doi: 10.4172/2165-7939.

Goodman, R., Meltzer, H., & Bailey, V. (1998). The Strengths and Difficulties Questionnaire: A pilot study on the validity of the self-report version. *European Child and Adolescent Psychiatry*, *7*, 125-130.

Gunstad, J., & Suhr, J. A. (2004). Cognitive factors in postconcussion syndrome symptom report. *Archives of Clinical Neuropsychology*, *19*(3), 391-405.

Herba, C., & Phillips, M., (2004). Annotation: Development of facial expression recognition from childhood to adolescence: behavioural and neurological perspectives. *Journal of Child Psychology and Psychiatry*, *45*, 1185–1198.

Hoffman, M. L. (1982). Development of prosocial motivation: Empathy and guilt. In N. Eisenberg, (Ed.), *The development of prosocial behaviour.* New York: Academic Press.

Hux, K., Bong, V., Skinner, S., Belau, D., & Sanger, D. (1998). Parental report of occurrences and consequences of traumatic brain injury among delinquent and non-delinquent. *Brain Injury*, *12*, 667-681.

Johnson, M. H. (2001). Functional brain development in humans. *Nature Reviews*, *2*, 475-483.

Johnson, M. H., Griffin, R., Csibra, G., Halit, H., Farroni, T., De Haan, M., … Richards, J. (2005). The emergence of the social brain network: Evidence from typical and atypical development. *Developmental Psychopathology*, *17*, 599-619.

Killgore, W. D.S., & Yugelun-Todd, D. A. (2001). Sex differences in amygdala activation during the perception of facial affect. *NeuroReport*, *12*, 2543-2547.

Kolb, B., Wilson, B., & Taylor, L. (1992). Development changes in the recognition and comprehension of facial expressions: Implications for frontal lobe function. *Brain and Cognition*, *20*, 74-84.

Kolb, B., & Whishaw, I. W. (2003). *Fundamentals of Human Neuropsychology*. New York: Worth Publishing.

Langlois, J., Rutland-Brown, W., Thomas, K. (2006). *Traumatic Brain Injury in the United States: Emergency department visits, hospitalisations and*

deaths. Atlanta, GA: Centres for Disease Control and Prevention, National centre for Injury Prevention.

Leon-Carrion, J., & Ramos, F. (2003). Blows to the head during development can predispose to violent criminal behaviour: rehabilitation of consequences of head injury is a measure for crime prevention. *Brain Injury*, *15*, 207-216.

Loeber, R., & Dishion, T. (1983). Early predictors of male delinquency: a review. *Psychological Bulletin*, *94*, 68-99.

Marsh, A. A., & Blair, R. J. R. (2008). Deficits in facial affect recognition among anti-social populations: a meta-analysis. *Neuroscience and Biobehavioural Reviews, 32*, 454-465.

McKinlay, A., Grace, R. C., Horwood, L. J., Fergusson, D. M., Riddler, 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*, 175-181.

Menon, D. K., Schwab, K., Wright, D. W., & Mass Al. (2010). Demographics and clinical assessment working group of the International and Interagency Initiative towards Common Data Elements for Research on Traumatic Brain Injury and Psychological Health position statement: definition of traumatic brain injury. *Archives of Physical Medicine Rehabilitation*, *91*, 1637-1640.

Mild Traumatic Brain Injury Committee, American Congress of Rehabilitation Medicine (1993). Definition of mild traumatic brain injury. *The Journal of Head Trauma Rehabilitation*, *8*, 86-87.

Meythaler, J. M., Peduzzi, J. D., Eleftheriou, E., & Novack, T. A. (2001). Current concepts: Diffuse axonal injury-associated traumatic brain injury. *Archive of Physical Medicine Rehabilitation*, *82,* 1461-1471.

Moore, D.G., (2001). Reassessing emotion recognition performance in people with mental retardation: a review. *American Journal of Mental Retardation*, *106*, 481–502.

Miura, H., Fujiki, M., Shibata, A., & Ishikawa, K. (2005). Influence of history of head trauma and epilepsy on delinquents in a juvenile classification home. *Psychiatry and Clinical Neurosciences*, *59*, 661-665.

Parke, R., Cassidy, J., Burks, V., Carson, J., & Boyum, L. (1992). Familial contribution to peer competence among young children: The role of interactive and affective processes. In R. Parke, & G. Ladd (Eds.), *Family-peer relationships: Modes of linkage* (pp. 107-134). Hillsdale, NJ: Erlbaum.

Penton Voak, I. (2013). Unpublished norms for the Facial Emotion Recognition Task 6AFC. University of Bristol.

Perron, B. E. & Howard, M. O. (2008). Prevalence and correlates of traumatic brain injury among delinquent youths. *Criminal Behaviour and Mental Health*, *18*, 243-255.

Pettersen, L. (1991). Sensitivity to emotional cues and social behaviour in children and adolescents after head injury. *Perceptual and Motor Skills, 73*, 1139-1150.

Poulin, F., & Boivin, M. (2000). Reactive and proactive aggression: evidence of a two factor model. *Psychological Access*, *12*, 115-122.

Pulkkinen, L. (1996). Proactive and reactive aggression in early adolescence as precursors to anti- and prosocial behaviour in young adults. *Aggressive Behaviour*, *22*, 241-257.

Raine, A., Dodge, K., Loeber, R., Gatzke-Koop, L., Lynam, D., Reynolds, C., Strouthamer-Loeber, M., et al. (2006). The Reactive-Proactive Aggression Questionnaire: Differential correlates of reactive and proactive aggression in adolescent boys. *Aggressive Behaviour*, *32*, 159-171.

Raine, M. A., Moffit, T. E., Caspi, A., Loeber, R., Stouthamer-Loeber, M., & Lynam, D. (2005). Neurocognitive impairments in boys on the life-course persistent anti-social path. *Journal of Abnormal Psychology*, *114*, 38-49.

Rantakallio, P., Koiranen, M., & Mottonen, J. (1992). Association of prenatal events, epilepsy, and central nervous system trauma with juvenile delinquency. *Archives of Disease in Childhood*, *67*, 1459-1461.

Rojahn, J., Matson, J. L., Lott, D., Esbensen, A. J., & Smalls, Y. (2001). The Behaviour Problems Inventory: an instrument for the assessment of self-injury, stereotyped behaviour, and aggression/destruction in individuals with developmental disorders. *Journal of Autism and Developmental Disorder*, *31*, 577-588.

Rosema, S., Crowe, L., & Anderson, V. (2012). Social function in children and adolescents after traumatic brain injury: A systematic review 1989-2011. *Journal of Neurotrauma*, *29*, 1277-1291.

Ross, K.A., McMillan, T., Kelly, T., Sumpter, R., & Dorris, L. (2011). Friendship, loneliness and psychosocial functioning in children with traumatic brain injury. *Brain Injury, 25,* 1206-1211.

Rubin, K. H., Bukowski, W., & Parker, J. (1998). Peer interactions, relationships and groups. In N. Eisenberg (Ed.) *Handbook of child psychology: Social, emotional and personality development* (5th Ed., pp. 619-700). New York Wiley.

Saarni, C. (1999). *The development of emotional competence.* New York: Guildford Press.

Salmivelli, C., & Neiminen, E. (2002). Proactive and reactive aggression among school bullies, victims and bully-victims. *Aggressive Behaviour*, *28*, 30-44.

Servadei, F., Teasdale, G., & Merry, G. (2001). Neurotraumatology Committee of the World Federation of Neurosurgical Societies: Defining acute mild head injury in adults: a proposal based on prognostic factors, diagnosis, and management. *Journal of Neurotrauma*, *18*, 657-664.

Schmidt, A. T., Hanten, G. R., Li, X., Orsten, K. D., & Levin, H. S. (2010). Emotion recognition following paediatric traumatic brain injury: longitudinal analysis of emotional prosody and facial emotion recognition.

Schofield, P., Butler, T., Hollis, S., & D'Este, C. (2011). Are prisoners reliable survey respondents? A validation of self-reported traumatic brain injury (TBI) against hospital medical records. *Brain Injury*, *25*, 74-82.

Shaw, J., Bailey, S., Chitsabesan, P., Theodosiou, L., Lennox, C., Sweeny, P., & Tariq, O. (2014). *Manual for the Comprehensive Health Assessment Tool (CHAT): Young people in contact with the Youth Offending Service (YOS)*. The Offender Health Research Network.

Snodgrass, C., & Knott, G. (2006). Theory of mind in children with traumatic brain injury. *Brain Injury*, *20*, 825-833.

Stambrook, M., Moore, A. D., Peters, L. C., Deviaene, C., & Hawryluk, G. A. (1990). Effects of mild, moderate and severe closed head injury on long-term vocational status. *Brain Injury*, *4*, 183-190.

Strand, K., & Nowicki, S, Jr. (1999). Receptive nonverbal processing ability and locus of control orientation in children and adolescents with conduct disorder. *Behavioural Disorders*, *24*, 102-108.

Strauss, E., & Sherman, E. M. S. (2006). *A Compendium of Neuropsychological Tests: Administration, Norms & Commentary* (3rd edition). New York: Oxford University Press.

Swan, L., & Alderman, N. (2004). Measuring the relationship between overt aggression and expectations: a methodology for determining clinical outcomes. *Brain Injury*, *18*, 143-160.

Tasker, R. C., Salmond, C. H., Westland, A. G., Pena, A., Gillard, J. H., Sahakian, B. J, & Pickard, J. D. (2005). Head circumference and brain and hippocampal volume after severe traumatic brain injury in childhood. *Pediatric Research*, *58*, 302–308.

Tateno, A., Jorge, R. E., & Robinson, R. G. (2003). Clinical correlates of aggressive behaviour after traumatic brain injury. *Journal of Neuropsychiatry and Clinical Neurosciences*, *15, 155-160.*

Teasdale, G., & Jennett, B. (1974). Assessment of coma and impaired consciousness. A practical scale. *Lancet*, *2*, 81-84.

Thomas, L. A., De Bellis, M. D., Graham, R., & LaBar, K. S. (2007). Development of emotional facial recognition in late childhood and adolescence. *Developmental Science*, *10*, 547-558.

Timonen, M., Miettunen, J., Hakko, H., Zitting, P., Veijola, J., von Wendt, L., & Rasanen, P. (2002). The association of preceding traumatic brain injury with mental disorders, alcoholism, and criminality, the Northern Finland 1966 Birth Cohort Study. *Psychiatry Research*, *133*, 217-226.

Tremblay, R. E., Nagin, D. S., Seguin, J. R., Zoccolillo, M., Zelazo, P. D., Boivin, M., … Japel, C. (2004). Physical aggression during early childhood: trajectories and predictors. *Canadian Journal of Child and Adolescent Psychiatry*, *14*, 3-9.

Tonks, J., Slater, A., Frampton, I., Wall, S. E., Yates, P., & Williams, W. H. (2008). The development of emotion and empathy skills after childhood brain injury. *Developmental Medicine and Child Neurology*, *51*, 8-16.

Tonks, J., Williams, W. H., Frampton, I., Yates, P., & Slater, A. (2007a). Assessing emotion recognition in 9-15 years olds: Preliminary analysis of abilities in reading emotions from faces,, voices are eyes. *Brain Injury*, *21*, 623-629.

Tonks, J., Williams, W. H., Frampton, I., Yates, P., & Slater, A. (2007b). Reading emotions after child brain injury: A comparison between children with brain injury and non-injured controls. *Brain Injury*, *21*, 731-739.

Tremblay, C., Kirouac, G., & Dore, F. Y. (2001). The recognition of adults' and children's facial expressions of emotions. *The Journal of Psychology*, *121* 341-350.

Tukstra, L. S., McDonald, S., & DePompeii, R. (2001). Social information processing in adolescents: Data from normally developing adolescents and preliminary data from their peers with traumatic brain injury. *Journal of Head Trauma Rehabilitation*, *16*, 469-483.

Wade, S. L., Taylor, H. G., Drotar, D., Stancin, T., Yeates, K. O., & Minich, N. M. (2003). Parent-adolescent interactions after traumatic brain injury: their relationship to family adaptation and adolescent adjustment. *Journal of Head Trauma Rehabilitation*, *18*, 164-176.

Walker, D., & Leister, C. (1994). Recognition of facial cues by adolescents with emotional and behavioural disorder, *Behavioural disorder*, *19*, 269-276.

Wechsler, D. (1999). Wechsler Abbreviated Intelligence Scale. TX: Pearson Education.

Williams, H. (2012). *Repairing Shattered Lives: Brain injury and its implications for criminal justice*. London, UK: Barrow Cadbury Trust, Transition to Adulthood.

Williams, W. H., Cordan, G., Mewse, A. J., Tonks, J., & Burgess, C. N. W. (2010). Self-reported traumatic brain injury in male young offenders: A risk factor for reoffending, poor mental health and violence? *Neuropsychological Rehabilitation*, *20*, 801-812.

Williams, W. H., Potter, D., & Ryland, H. (2010). Mild traumatic brain injury and post concussion symptoms: A neuropsychological perspective. *Journal of Neurology, Neurosurgery & Psychiatry*, *81*, 1116-1122.

Yates, P. J., Williams, W. H., Harris, A., Round, A., & Jenkins, R. (2006). An epidemiological study of head injuries in a UK population attending an emergency department. *Journal of Neurology, Neurosurgery & Psychiatry*, *77*, 699-701.

Yeates, K. O., Bigler, E. D., Dennis, M., Gerhardt, C. A., Rubin, K. H., Stancin, T., … Vannatta, K. (2007). Social outcomes in childhood brain disorder: A

heuristic integration of social neuroscience and developmental psychology. *Psychological Bulletin*, *133*, 535-556.

Yeates, K. O., Taylor, H. G., Walz, N., Stancin, T., & Wade, S. (2010). The family environment as a moderator of psychosocial outcomes following traumatic brain injury in young children. *Neuropsychology*, *24*, 345-356.

Zabel, R. H. (1979). Recognition of emotions in facial expressions by emotionally disturbed and nondisturbed children. *Psychology in the Schools*, *16*, 119-126.

Appendix A – Ethics Documentation

Relevant excerpt of ethics application:

Assessing the prevalence and impact of traumatic brain injury in young offending populations

Dear Dr. Cris Burgess,

RE: Extension to ethical approval of project 2013/289

Please note, this is an urgent application following a previous study falling through. We would appreciate it if you could respond to us as soon as possible.

We are writing to you to request an extension to the ethical approval given to project 2013/289, which was an MSc project for Miriam Cohen in 2012 (supervised by Huw Williams). We are DClinPsy trainees whose research is building on the initial work carried out by Miriam. We will, therefore, also be recruiting from a young offending population. Our research supervisors are Huw Williams and Nick Moberly.

The procedure for recruitment remains unchanged, other than we are expanding the recruitment to include Dorset Youth Offending Teams (YOT) and Targeted Youth Support (TYS) as well as the equivalent services in Somerset and Devon. Although we have received provisional agreement from the managers of the YOTs, formal approval is contingent on the project receiving ethical approval from the University's Psychology Ethics Board.

There have been some changes to the measures used, so I have provided the new list of measures below. These measures build on those used in the initial application and measure socio-emotional processing and emotional empathy as well as impulsivity and risk taking in this population.The measures do not impose any additional ethical issues to those raised in the initial ethics application. There is no realistic risk of participants experiencing physical or psychological distress. We will be seeking informed consent from all participants aged above 16 years old and from the parents/guardians of those aged below 16 years old. We will also be seeking the assent of young people aged below 16 years old in order to ensure that they understand their rights and what is involved in participation. The ethical considerations therefore remain unchanged to the initial application.

Recruitment and data collection is scheduled to occur between October 2013 and February 2014. The data will then be analysed and the participants who have requested to receive feedback on the findings of the study would receive these in written format, either by email or post, in summer 2014. The findings will also be presented to the teams who participated in the recruitment.

Please see the research overview, below, for a summary of the rationale, procedure and measures to be used in this study. Please also see the table, below, for an outline of the key similarities and differences between the previous project and the proposed one.

Similarities	Differences
Exploring socio-emotional and executive processing in young offenders.	The proposed study is placing greater emphasis on executive processing than the previous study did. This is reflected in the measures proposed to be used.
The procedure is the same. o The researchers will make contact with the YOTs and TYS to introduce the research. o The researchers will provide the practitioners with a written summary of the research (see appendices) and ask them to identify and contact young offenders who may be appropriate. o Participants will be seen in the YOT offices, in the presence of their caseworker	The measures have been slightly amended. The proposed project includes the following measures, which Miriam's project did not: o Bryant Empathy Scale (abbreviated version) o Strengths and Difficulties Questionnaire o Alabama Parenting Scale (short form) o Proactive and Reactive Aggression Questionnaire o Stoplight task o UPPS impulsive Behaviour Scale (abbreviated version) Trails A and B, which were used in the original study, will not be used in the proposed study.
The same inclusion and exclusion criteria apply	The consent forms and information forms reflect the slight differences in the measures
Some of the measures are the same o WASI-II o Stroop Test o Traumatic brain injury screen (based on the Comprehensive Health Assessment Tool (CHAT)) o Emotion recognition task o Demographic questionnaire and criminal and substance abuse background	An assent form has been created in order to ensure that young people under the age of 16 fully understand their rights as well as what is involved in participation.
Recruitment will occur in Somerset YOT and TYS	The proposed project has expanded the geographical recruitment region, to include both Dorset and Devon YOTs and TYS
Ethical considerations are the same. o There are not identified risks other than the possibility of fatigue or loss of interest. This will be managed with breaks. o We are working only with offenders displaying low levels of risk of harm towards themselves and others o Informed consent and assent will be sought from the young people and their parents/guardians if they are under 16 years if age o The data will be anonymised and confidential.	The participants will be given the option to receive feedback about the overall study's findings. If they want this information, they will be asked to provide an email or postal address through which we can send it to them. Please note, no participants, parents, guardians or YOT workers will be provided with feedback about an individual participant's performance on the tests and questionnaires.
At the end of the testing session, the participants will be	

thanked by being given a £5 high street voucher.

Summary of measures and administration times

Measure	**Administration Time**
Background questionnaire, brain injury screen	7 min
Emotion Recognition Task	6 min
Bryant's Emotional Empathy Index	2 min
Strengths and Difficulties Questionnaire	3 min
Stoplight Task	7 min
Stroop	5 min
Abbreviated UPPS Impulsivity Behaviour Scale	3 min
Reactive-Proactive Aggression Questionnaire	3 min
Alabama Parenting Questionnaire	2 min
WASI	10 min
TOTAL:	48 min

We hope this information is sufficient to gain ethical approval for the new study.

Please do not hesitate to contact us if you require any further information.

Yours sincerely,

Sarah Cook and Heloise Hunt

Supervisors: Huw Williams and Nick Moberly

Psychology Research Ethics Committee

Psychology, College of Life & Environmental Sciences

Washington Singer Laboratories
Perry Road
Exeter
EX4 4QG

Telephone +44 (0)1392 724611
Fax +44 (0)1392 724623
Email Marilyn.evans@exeter.ac.uk

To: **Heloise Hunt & Sarah Cook**

From: **Cris Burgess**

CC:

Re: **Application 2013/289 Ethics Committee**

Date: **September 1, 2014**

The School of Psychology Ethics Committee has now discussed your application, ***2013/289.*** The amendments to the application, submitted on 27th September 2013, have been approved by the Psychology REC.

The agreement of the Committee is subject to your compliance with the British Psychological Society Code of Conduct and the University of Exeter procedures for data protection (http://www.ex.ac.uk/admin/academic/datapro/). In any correspondence

with the Ethics Committee about this application, please quote the reference number above.

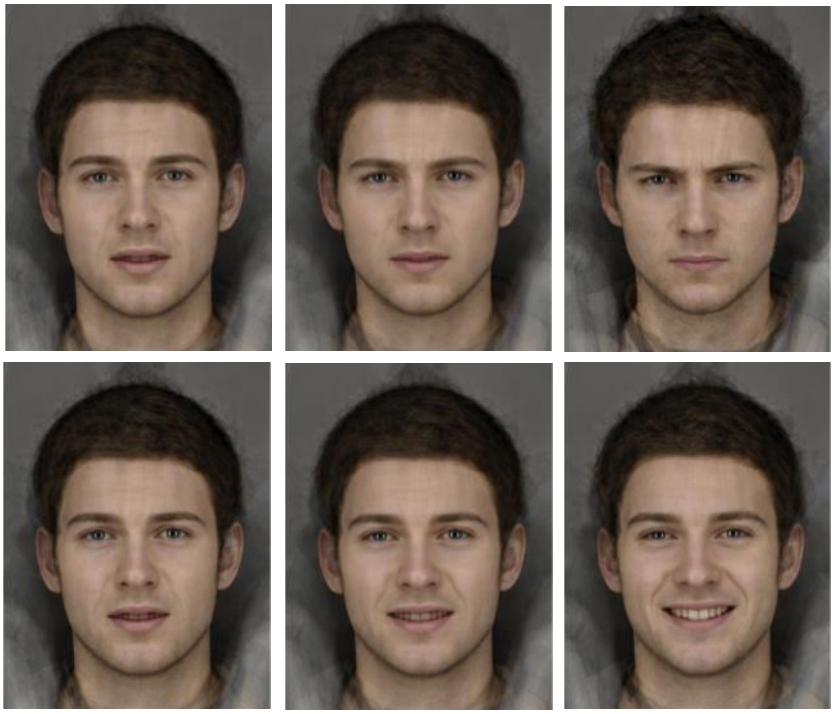
I wish you every success with your research.

Cris Burgess

Chair of Psychology Research Ethics Committee

Appendix B - Facial Emotion Recognition Task

Facial Emotion Recognition Task



Examples of ‘angry’ (upper row) and ‘happy’ (lower row) facial expression stimuli used in the facial emotion recognition task (Bamford, Penton-Voak, Pinkney, Baldwin, Munafo & Garner, 2013)

Appendix C – The Reactive-Proactive Aggression Questionnaire

Reactive Proactive Aggression Questionnaire (Raine et al, 2006)

Instructions: There are times when most of us feel angry, or have done things we should not have done. Rate each of the items below by putting a circle around 0 (never), 1 (sometimes), or 2 (often). Do not spend a lot of time thinking about the items – just give your first response. Make sure you answer all the questions.

How often have you...

		Never	Sometimes	Often
1.	…yelled at others when they have annoyed you	0	1	2
2.	…had fights with others to show who was on top	0	1	2
3.	…reacted angrily when provoked by others	0	1	2
4.	…taken things from other people	0	1	2
5.	…gotten angry when frustrated	0	1	2
6.	…vandalised something for fun	0	1	2
7.	…had temper tantrums	0	1	2
8.	…damaged things because you felt mad	0	1	2
9.	…had a gang fight to be cool	0	1	2
10.	…hurt others to win a game	0	1	2
11.	…become angry or mad when you don't get your way	0	1	2
12.	…used physical force to get others to do what you want	0	1	2
13.	…gotten angry or mad when you lost a game	0	1	2
14.	…gotten angry when others threatened you	0	1	2
15.	…used force to obtain money or things from people	0	1	2
16.	…felt better after hitting or yelling at someone	0	1	2
17.	…threatened and bullied someone	0	1	2
18.	…made obscene phone calls for fun	0	1	2
19.	…hit others to defend yourself	0	1	2
20.	…gotten others to gang up on someone else	0	1	2
21.	…carried a weapon to use in a fight	0	1	2
22.	…gotten angry or mad or hit others when teased	0	1	2
23.	…yelled at others so they would do things for you	0	1	2

Appendix D – Strengths and Difficulties Questionnaire (SDQ)

For each item, please mark the box for Not True, Somewhat True or Certainly True. It would help us if you answered all items as best you can even if you are not absolutely certain or the item seems daft! Please give your answers on the basis of how things have been for you over the last six months.

Your Name ..... Male/Female

Date of Birth.....

	Not True	Somewhat True	Certainly True
I try to be nice to other people. I care about their feelings	☐	☐	☐
I am restless, I cannot stay still for long	☐	☐	☐
I get a lot of headaches, stomach-aches or sickness	☐	☐	☐
I usually share with others (food, games, pens etc.)	☐	☐	☐
I get very angry and often lose my temper	☐	☐	☐
I am usually on my own. I generally play alone or keep to myself	☐	☐	☐
I usually do as I am told	☐	☐	☐
I worry a lot	☐	☐	☐
I am helpful if someone is hurt, upset or feeling ill	☐	☐	☐
I am constantly fidgeting or squirming	☐	☐	☐
I have one good friend or more	☐	☐	☐
I fight a lot. I can make other people do what I want	☐	☐	☐
I am often unhappy, down-hearted or tearful	☐	☐	☐
Other people my age generally like me	☐	☐	☐
I am easily distracted, I find it difficult to concentrate	☐	☐	☐
I am nervous in new situations. I easily lose confidence	☐	☐	☐
I am kind to younger children	☐	☐	☐
I am often accused of lying or cheating	☐	☐	☐
Other children or young people pick on me or bully me	☐	☐	☐
I often volunteer to help others (parents, teachers, children)	☐	☐	☐
I think before I do things	☐	☐	☐
I take things that are not mine from home, school or elsewhere	☐	☐	☐
I get on better with adults than with people my own age	☐	☐	☐
I have many fears, I am easily scared	☐	☐	☐
I finish the work I'm doing. My attention is good	☐	☐	☐

Your signature ..... Today's date .....

Thank you very much for your help

Appendix E – Alabama Parenting Questionnaire

Alabama Parenting Questionnaire-Short Form (APQ-9; Elgar et al, 2007)

In your childhood how would you describe the way in which you have been parented (whether by parents, guardians or other members)?

Please tick one box in each row

	Never	Almost never	Sometimes	Often	Always
You go out with friends your parents don't know					
Your parent lets you out of a punishment early (e.g. lifts restrictions earlier than they originally said)					
Your parent lets you know when you are doing a good job with something					
You talk your parent out of punishing you after you have done something wrong					
You fail to leave a note or to let your parent know where you are going					
Your parent threatens to punish you and then does not actually punish you					
Your parent compliments you after you have done something well					
You stay out in the evening after the time you are supposed to be home					
Your parent praises you if you behave well					

Appendix F – Empathic Sadness Questionnaire

Empathy Questionnaire

Please circle whether these statements are true or false about you.

It makes me sad to see a girl who can't find anyone to play with	TRUE	FALSE
Seeing a boy who is crying makes me feel like crying	TRUE	FALSE
I get upset when I see a girl being hurt	TRUE	FALSE
It makes me sad to see a boy who can't find anyone to play with	TRUE	FALSE
Some songs make me so sad I feel like crying	TRUE	FALSE
I get upset when I see a boy being hurt	TRUE	FALSE
Seeing a girl who is crying makes me feel like crying	TRUE	FALSE

Appendix G – Background Questionnaire

Background Questionnaire

Head Injury Information

1. Have you ever had a head injury to the head that caused you to be knocked out and/or dazed and confused for a period of time? (E.g. from a fall, blow to the head, road traffic accident?

YES NO

If no, please go to the next section, 'offending behaviour'.

2. How many times have you been knocked out and/or dazed or confused?

Once Twice Three Times Four Times More than Four Times

	Dazed or confused	Unconscious for up to 5 minutes	Unconscious for 5 to 10 minutes	Unconscious for 10 to 20 minutes	Unconscious for 20 – 30 minutes	Unconscious for 30 to 60 minutes	Unconscious for over 60 minutes (please indicate duration of unconsciousness)
Road Accident							
Road accident in stolen car							
Fall when sober							
Fall when under the influence of drugs/alcohol							
Sports injury							
Fight							
Other non-criminal activity							
Other criminal activity							

3. Please tick the boxes that describe the worst time you have been knocked out and/or dazed and confused.

If more than 4 then how many? _____

4. How old were you when you had your first injury?

   _____

5. How old were you when you had your worst injury?

   _____

6. Did you see a Doctor or Nurse after your accident?

YES NO

7. Compared with before the accident, do you now suffer from:

	Not experienced at all	No more of a problem	A mild problem	A moderate problem	A severe problem
Headaches					
Feelings of Dizziness					
Nausea and/or vomiting					
Forgetfulness, poor memory					
Poor concentration					
Confusion					
Fogginess (groggy feeling)					
Difficulty recalling everyday events					

8. Are you experiencing any other difficulties?

YES NO

9. Please specify these difficulties here:

Symptom 1: _____

Symptom 2: _____

10. Please rate these other difficulties as previously:

	A mild problem	A moderate problem	A severe problem
Symptom 1			
Symptom 2			

Offending Behaviour

1. What are you currently convicted for?

	None	Once	Twice	Three times	More than three
Burglary					
Shoplifting/theft					
Violent Offences					
Joyriding					
Fraud/deception					
Drug offences					
Sexual Offences					
Other					

If other, please specify: _____

2. If your conviction was for a violent offence, please tick the boxes describing the injuries caused to the other party: (tick all that apply)
    - Assault without injury
    - Minor injury (e.g. bruises etc that require minor medical treatment)
    - Serious injury, requiring hospital treatment (e.g. broken limb, stabbing, gunshot wound)
    - Severe injury (e.g. lasting impairment, life-threatening injury)
    - Murder/manslaughter
    - Murder/manslaughter of multiple victims

3. Please use the options below to record any previous convictions:

	None	Once	Twice	Three times	More than three
Burglary					
Shoplifting/theft					
Violent Offences					
Joyriding					
Fraud/deception					
Drug offences					
Sexual Offences					
Other					

If other, please specify: _____

4. If you have been previously convicted for a violent offence(s) please tick the boxes describing the injuries caused to the other party and on how many separate occasions you have been convicted for these injuries:

	Never	Once	Twice	Three Times	More than three (specify)
Assault without injury					
Minor Injury (e.g. bruises – minor or no medical treatment)					
Serious injury, requiring hospital treatment (e.g. broken limb, stabbing, gunshot wound).					
Severe Injury (e.g. lasting impairment, life-threatening injury)					
Murder/Manslaughter					
Murder/Manslaughter of multiple victims					

5. If you have previous convictions then please record your age at the time of each of them

_____

6. What is your current estimated sentence length in months and years? _____

Drug and Alcohol Use

1. If you have ever used illicit drugs then please record which and how frequently you used them during your most intense period of use.

	Never	Once a year	Once per month	Weekends	Most Days	Everyday
Heroin						
Non-prescribed drugs						
Cocaine						
Crack-Cocaine						
Amphetamine						
Ecstacy						
Cannabis						

2. Please record which of the below forms of alcohol you have drunk and how frequently on average:

	Never	Once a year	Once per month	Weekends	Most Days	Everyday
Beer						
Wine						
Spirits						
Alco-pops						
Cider						

Demographics

1. What is your age? _____

2. Please enter the first three digits of your postcode: _____

3. To which ethic group do you belong?

   - White
   - Black-Carribean
   - Black-African
   - Black-Other
   - Asian-Indian
   - Asian-Pakistani
   - Asian-Bangladeshi
   - Asian-Chinese
   - Asian-Other
   - Other – please specify _____

4. Are you still in education?

YES NO

5. At what age did you leave school?
   _____

6. What is the highest level of qualification you obtained?

   - GCSE
   - AS Level
   - A Level
   - None of these
   - Other: _____

7. How many GCSE's have you obtained?
   _____

8. Have you got any developmental difficulties (e.g. Autism, ADHD, Learning Disability, etc)?

YES NO

If yes, please specify:

Appendix H - Information about the study for YOT caseworkers

Study: Socio-Emotional and Executive Processing in Juvenile Offenders with Traumatic Brain Injury

PRACTITIONER'S ABSTRACT

Purpose: Recent research has shown Traumatic brain injury (TBI) is highly prevalent in offending populations. TBI has also been linked to earlier and more violent offending. We're aiming to investigate why this is by exploring how TBI disrupts socio-emotional and executive processing abilities in juvenile offending populations. This will hopefully inform the development of more effective screening and interventions.
Aims: We're aiming to recruit approximately 60 young offenders, both male and female, with and without TBI. These participants will complete a collection of questionnaires, computer and pen-and-paper tasks measuring executive functions and facial expression recognition.
Where: The testing session should take around an hour to complete, and will take place in the YOT offices. One researcher will administer the tests, under supervision of a practitioner. The participant will receive £5 worth of high street vouchers as a thank-you for their participation.
How to get involved: If you are currently working with young offenders, between the ages of 14-18, who might be interested in participating, please provide them with an information sheet or verbally describe the study to them. If they would like to be involved, please contact the researchers (Sarah Cook and Heloise Hunt) to arrange a time convenient for both you and the participant for the testing session to take place.
If the young offender is younger than 16, a consent form will also be provided to be signed by the participant's carer/guardian in advance of the testing session.

Thank you for your time and assistance!

If you have any questions, or would be interested in receiving more information on the study, please contact:

Sarah Cook & Heloise Hunt
Email: sc496@exeter.ac.uk & hh304@exeter.ac.uk
Tel: XXX

Appendix I – Information sheets

Version 1: Detailed Information Sheet

Participant Information Sheet

We are inviting you to participate in a research study run by the School of Psychology at the University of Exeter. The aim is to investigate how well you recognise other people's emotions by looking at their faces as well as how you respond on tasks where you need to make a decision. Please read this sheet to find out what taking part would involve. If, after reading this, you have any questions, please feel free to contact us.

Thank you for taking the time to read this.

What is this research about?

This research aims to look at how young offenders process information and whether this is affected by brain injury.

Why are we interested in this?

There is a relatively small amount of research investigating emotional empathy and decision making in young offenders, and how this is affected by brain injury. However, these are both important skills which contribute to socially appropriate daily functioning. Identifying and understanding any weaknesses in these two skills will help professionals to understand what they can do to help.

Why have I been invited?

You have been invited to take part in this study because you are in contact with a Youth Offending Team (YOT) and your caseworker has identified you as someone who may want to take part.

Do I have to take part?

It is up to you whether or not to take part. If you do decide to take part, you are still free to withdraw from the study at any time without giving a reason. A decision to stop at any time, or not to take part, will not affect the care you receive from the YOT.

What will happen if I do take part? What will I have to do?

If you choose to take part, you will be asked to fill out a few questionnaires and to complete some computer-based tasks. Both the questionnaires and the computer tasks we will ask you to complete are straightforward and will take no longer than 1 hour.
If you are under 16: your parent/guardian will have to sign a consent form prior to you taking part.
If you are over 16: you will have to sign a consent form at the beginning of the session.

What are the possible disadvantages and risks of taking part?

In order to take part in this research, you will have to give up some time to answer some questionnaires and complete some tasks. These tasks are not designed to be difficult, to trick you, or to make you feel bad. However, it is possible that you may find some of them tiring, or that you may lose interest in them. If you do, we can have a break, or

discuss other options which may make participating more enjoyable for you. Should you need to contact the researchers after having completed the tasks, you are welcome to do so. Please note, this research has been approved by the University of Exeter Ethics Board, who are satisfied that the research is safe.

What are the possible benefits?

Firstly, in order to say thank-you for taking part, we will give you a £5 high street voucher at the end of the session. A second benefit will be the contribution you will be making to research. The information we get from this study should help us better understand social, emotional and behavioural functioning in young offenders. This will add to existing research which ultimately informs the kind of help and support young people get in the future.

Will my responses be kept confidential?

Your participation in this research and any personal information you provide will be kept private. This includes your responses to the questionnaires and the computer tasks. Personal information will be stored in a locked filing cabinet in a secure location and separately from your results on the questionnaires and tasks. Your results on these tasks will be associated with a unique number, but not your name. When the research is written-up and presented at conferences, the data will be anonymised. This means that your participation and results will be confidential at all times.

What would happen if the researcher were concerned about your safety?

As previously stated, your participation and personal information will be kept confidential. However, if, during our contact, we become concerned that you or someone else is at risk of serious harm, we would need to take precautionary steps to ensure your and others' safety. In the first instance, we would discuss the situation with your Caseworker, who would decide whether any further steps should be taken. However, we would always endeavour to discuss this with yourself first so that you knew that such concerns were being raised.

What will happen to the results of the study?

This research is being conducted as an educational project in part-completion of a Doctorate in Clinical Psychology. The study findings will, therefore, be written in a report (thesis) for the University of Exeter. We also aim to publish the results of this research in an academic journal and to present the findings at internal and national conferences. We will also provide you with information about the results, if you wish to receive them. As previously stated, your identity will not be revealed in any reports or publications resulting from this study.

What now?

If you would like to take part, please read and sign the consent form that comes with this information sheet and return it to your Caseworker. We will then contact you to make an appointment to complete the tasks.

Contact for further information

If you have any further questions, please feel free to contact you Caseworker or Sarah and Heloise, the principal researchers:

Sarah Cook and Heloise Hunt
Clinical Psychology Department
School of Psychology
University of Exeter
Exeter EX4 4QG

E-mail: youthoffendingresearch@gmail.com

What's the impact of brain injury on children?

Who are we?

Our names are Sarah and Heloise and we are studying to be psychologists. We are doing this research as part of our course, but also because we are interested in this topic.

What is the project about?

We are interested to find out how young people who commit crimes:

1. understand emotions
2. think about things before they do them

and whether brain injury affects this. This information could then influence the kind of help that young offenders receive.

Why me?

You have been invited to take part in this research because your Caseworker thought you might be interested.

What are we asking you to do?

We will ask you to answer some questions and to complete some tasks. Some of these tasks will involve simple computer games and other tasks will involve completing some puzzles.

Your answers on all the tasks and on the questionnaires will be private. I will not tell you, your parents or your teachers how you did.

We will keep your results safe in a locked cabinet at our university.

You are free to ask to stop taking part in the tasks at any time. Nothing bad will happen if you do this. You can also ask to have a break at any time. It should take no more than 1 hour altogether.

If you do want to take part, you will complete the tasks in a room at the Youth Offending Team's offices. One of us (Sarah or Heloise) will be present as well as a member of the Youth Offending Team. We can help you with any questions you might have.

At the end of the testing session, we will give you a £5 high street vouher. This is our way of saying thank-you for helping with this research.

What now?

It is up to you whether you take part. You can say yes or no. If you would like to take part, please sign the 'Assent form'. One of your parents/guardians will also need to sign a similar form.

If you would like to know more about the project, please contact the Youth Offending Team or us, Sarah and Heloise, for more information. Our contact details are at the end of this letter.

Thank you for taking the time to read this letter!

Sarah and Heloise

Please contact us if you have any queries: youthoffendingresearch@gmail.com

Appendix J – Consent forms

Version: 16+ years of age

Consent Form

Study: Socio-emotional and executive processing in young people

If you agree with the statement, please tick the box.

		Please tick
1.	I have read and understood the study information sheet.	
2.	I am satisfied with the amount of information I have been given about this research.	
3.	Any questions I had have been answered to my satisfaction.	
4.	I allow the researcher to access my Asset information (understanding all information used will be kept anonymous and confidential).	
5.	I understand I am free to withdraw from this study at any time, without giving a reason.	
6.	I agree to take part in this research.	

Name (please print clearly in block capital letters)

……
……

Signature……Date……
……

If you would like to participate in the research study, but would rather information from the Asset assessment is not included please indicate this by ticking this box: ☐

If you would like to receive feedback about the overall findings of the research (in approximately summer 2014), please provide us with an email or postal address:……..

Version: under 16 years of age/ caregiver

Consent Form

Study: Socio-emotional and executive processing in young people

If you agree with the statement, please tick the box.

		Please tick
1.	My child and I have read and understood the study information sheet.	
2.	My child and I are satisfied with the amount of information we have been given about this research.	
3.	Any questions my child and I had have been answered to our satisfaction.	
4.	My child and I allow the researcher to access Asset information (understanding all information used will be kept anonymous and confidential).	
5.	My child and I understand we are free to withdraw from this study at any time, without giving a reason.	
6.	I agree for my child to take part in this research.	

Name of child (please print clearly in block capital letters)
……

Name of caregiver (please print clearly in block capital letters)
……

Caregiver's signature……Date……

If you would like to participate in the research study, but would rather information from the Asset assessments is not included please indicate this by ticking this box: ☐

If you would like to receive feedback about the overall findings of the research (in approximately summer 2014), please provide us with an email or postal address:

Participant number:

Version 1: Assent form <16

Assent form

If you agree with the statement, please tick the box:

- I understand that it is up to me and my parents whether to take part. ☐
- I understand that the information I give will be private. ☐
- I understand that I can stop at any time. ☐

If you understand the statements above, you now need to decide whether you would like to take part in the project.

I have decided that I would like to take part in the project (Please put a tick in the 'yes' or 'no' box):

Yes	No
☐	☐

Please print your name……

Signed…… Date……..

Appendix K – ASSET data extraction form

ASSET information sheet

Participant number: _____

Criminal history

Primary offence:

Additional offence(s):

Seriousness score:

Age at first conviction:

Number of previous convictions:

Risk of reoffending (summed score calculated from assessment of risk areas including living conditions, physical and mental health, motivation to change, etc):

Have any offences been violent?

Yes	No

Substance abuse (past and present):

Mental health disorder(s) diagnosed (please specify)**?**

Living arrangements (please circle):

Living with parent(s)	Looked after Child	Living independently	Other (please specify):

Appendix L - Summary of participant TBI and offence history

		Brain Injury Characteristics				Offence characteristics			
Participant	**Age**	**Number of injuries**	**Age at worst injury**	**LOC of worst injury**	**Cause of worst injury**	**Primary offence (additional offences)**	**Seriousness score**	**Age at first conviction**	**History of or current violent offences**
1	17	15	12	Up to 5 min	Non-criminal activity	Assault by beating	3	16	Yes
2	14	1	12	Up to 5 min	Fall when sober	Theft from a shop (criminal damage under £2000)	3	14	No
3	18	0	N/A	N/A	N/A	Theft (possession of class b drugs)	3	16	No
4	14	2	14	Up to 5 min	Fall when sober	Rape (rape)	8	13	Yes
5	17	8	16	5-10min	Fall whilst under influence	Theft and handling stolen goods (criminal damage, harassment)	3	14	No
6	16	20	16	20-30min	Fight	Criminal damage	2	15	Yes
7	15	3	14	Up to 5 min	Fight	Criminal damage (burglary from a dwelling, theft from a vehicle)	3	14	No
8	17	10	17	5-10min	Fight	Attempted robbery (possessing a firearm, aggravated bodily harm, causing affray, threatening behaviour)	6	11	Yes
9	17	3	17	Up to 5min	Fight	Assault by beating	3	16	Yes
10	17	3	13	Up to 5min	Non-criminal activity	Burglary from a dwelling (burglary from a dwelling)	6	14	Yes
11	14	2	14	Up to 5min	Sports injury	Criminal damage under £2000	2	13	No
12	18	2	17	Up to 5min	Non-criminal activity	Burglary from a dwelling (burglary from a dwelling)	6	15	Yes
13	17	0	N/A	N/A	N/A	Assault by beating	3	13	Yes
14	17	0	N/A	N/A	N/A	Aggravated vehicle taking (breach of order, assault by beating)	5	12	Yes
15	16	0	N/A	N/A	N/A	Assault by beating (assault, resisting arrest)	3	17	Yes
16	15	2	15	Dazed or confused	Road traffic accident	Assault by beating (criminal damage)	3	14	Yes
17	18	4	14	Dazed or confused	Fall whilst under influence	Gross bodily harm with intent (assault occasioning actual bodily harm)	6	15	Yes

18	17	0	N/A	N/A	N/A	Burglary from a dwelling (burglary from a dwelling)	6	11	Yes
19	16	3	14	5-10min	Fight	Possession of class B drugs with intent to supply	4	16	No
20	17	2	6	5-10min	Non-criminal activity	Drunk and disorderly	1	16	Yes
21	18	4	15	Up to 5min	Fight	Fraud	3	16	Yes
22	17	6	16	Up to 5min	Fight	Assault by beating	3	16	No
23	17	6	14	Up to 5min	Fight	Possession of class A drugs with intent to supply (possession of class B & C drugs with intent to supply)	6	15	Yes
24	16	2	13	Up to 5min	Fall when sober	Theft (theft)	3	14	No
25	16	0	N/A	N/A	N/A	Robbery	6	15	Yes
26	16	3	7	60minutes	Non-criminal activity	Assault	3	15	Yes
27	16	1	7	20-30min	Abuse	Assault (arson)	3	15	Yes
28	17	1	5	>60min	Abuse	Assault	3	12	Yes
29	16	0	N/A	N/A	N/A	Rape (other sexual offences)	8	13	Yes
30	17	1	12	>60min	Road traffic accident	Theft (assault)	3	14	Yes
31	14	0	N/A	N/A	N/A	Rape	8	Not known	Yes
32	16	0	N/A	N/A	N/A	Assault	3	Not known	Yes
33	18	0	N/A	N/A	N/A	Theft	3	14	No
34	18	5	8	>60min	Road traffic accident	None	N/A	N/A	N/A
35	15	2	9	Up to 5min	No detail available	None	N/A	N/A	N/A
36	15	2	14	5-10min	Fall when sober	Burglary	6	Not known	No
37	18	1	9	>60min	Fall when sober	None	N/A	N/A	N/A
38	16	30-40	15	>60min	Sports injury	None	N/A	N/A	N/A
39	15	0	N/A	N/A	N/A	Assault	3	Not known	Yes
40	16	0	N/A	N/A	N/A	Supply (Burglary, ABH)	4	15	Yes
41	17	0	N/A	N/A	N/A	Burglary	6	15	No
42	15	1	14	5-10min	Fight	Assault	3	14	Yes
43	17	10	14	5-10min	Road traffic accident	Assault	3	15	Yes
44	15	9	13	20-30min	Fight	Grievous Bodily Harm	6	Not known	Yes

45	16	2	16	Up to 5min	Non-criminal activity	Possession	2	15	No
46	17	0	N/A	N/A	N/A	None	N/A	N/A	N/A
47	19	1	3	>60min	No detail available	None	N/A	N/A	N/A
48	18	0	N/A	N/A	N/A	Assault (harassment)	3	16	Yes

Appendix M – Table of groupings considered for the analysis

Possible Groupings (*n* based on current study sample size)	Theoretical Pros and Cons	Statistical Pros and Cons	Ranked suitability of groupings
Split groups by severity category: No history (*n*=15) Concussions (*n*=2) Mild TBI (LoC<10min; *n*=21) Complicated Mild TBI (LoC 10-30min; *n*=3) Moderate TBI (LoC 30min-60min; *n*= 1) Severe TBI (LoC > 60min; *n*=6)	**Pros:** - Has good sensitivity to severity of injury, based on previous categories of classification (e.g. CHAT, Shaw et al., 2014 uses mild as <30min, moderate as 30min-60min and severe as >60min) - Takes into account complicated mild injuries which have been shown to affect neuropsychological ability. **Cons:** - Severe TBI elsewhere is defined as LoC>24 hours (e.g. Bodin & Yeates, 2010) or >6hours (Williams et al., 2010)	**Pros:** - Could simply make comparisons between groups **Cons** - Parametric statistical tests are less robust with unequal sample sizes and non-homogenous variances Unequal groups affects homogeneity of variance - Groups with few persons will be very unrepresentative of the population - Power will be low	5
Split groups by collapsing severity into 2 groups: TBI group = >3 mild injuries (LoC<30min) or moderate/severe cases (LoC>30min; *n*=22) NonTBI group = no history or less than 3 mild TBI (LoC<30min; *n*=26)	**Pros** - Takes into account both severity and frequency of TBI - Although slightly crude, it considers overall 'dosage' of TBI - Repeat LoC of 3 times as a cut off is based on that used in the neurodisability section CHAT (Shaw et al., 2014), which suggests further assessment and review of the individual is required for >3 injuries. Furthermore, evidence suggests there is a cumulative effect of TBI (Davies et al., 2012; Collins et al., 2002; Effgen, Gill, & Morrison, 2012; Williams et al., 2010) **Cons** - Dichotomising in this way loses some sensitivity e.g. someone with one LoC of 20min will be classified as non-TBI.	**Pros** - Fairly equal groups parametric tests will be more robust - Splitting between only two classification groups means the *n* in each group is more adequately powered to detect a difference as compared to multiple groupings with a small sample. - Could simply make comparisons between groups	1

Split groups according to the Mayo Classification System of severity: No History (*n*=15) Possible TBI (concussion, no LoC; *n*=2) Probable Mild TBI (LoC< 30 min; *n*=24) Definite Moderate-Severe TBI (LoC>30min; *n*=7)	**Pros:** - Based on an established, evidence based classification system in the literature (Friedland, 2013) **Cons:** - Does not account for the impact of multiple TBIs although could do separate frequency analysis to look at the impact of multiple injuries.	**Pros:** - Could simply make comparisons between groups or collapse concussions into no history group **Cons:** - Separate frequency analysis is very underpowered because splitting would result in small and uneven groups: 1xTBI=7; 2xTBI=9; 3xTBI=5; 4 or more TBI=12. - Only 2 participants in the possible TBI group and 7 in definite TBI is unreliable and unlikely to be representative of the population. - Definite and possible have low *n* so low power to detect even a large effect size.	2
Split groups according to Williams et al. (201): No history & LoC <10min (*n*=38) Complicated mild (LoC 10-30min; *n*=3) Moderate Severe (LoC>30min; *n*=7)	**Pros:** - Allows exploration of no TBI, mild and moderate/severe which spans the severity nicely - Takes into account 'complicated mild' as a category **Cons:** **-** The cut off of 10 mins is not recognised broadly in the classification systems or literature - Does not account for the impact of multiple TBIs although could do separate frequency analysis to look at the impact of multiple injuries.	**Cons:** - Very unequal groups. Even if collapsing complicated mild into the TBI group, groups would still be 38 and 10 respectively - *N* of 10 is underpowered and may not be representative of the sample - Separate frequency analysis is very underpowered because splitting would result in small and uneven groups: 1xTBI=7; 2xTBI=9; 3xTBI=5; 4 or more TBI=12.	4
Calculate TBI as a continuous variable using a formula to include frequency and severity (n=48) e.g. create a brain injury dosage score: (n x 1)+(n x 3)+(n x 5)+(n x 7) = score Where 1=concussion; 3=mild, 5=moderate and 7=severe. *N*=number of self-reported TBIs in that severity	**Pros:** - Takes into consideration both severity and frequency of TBI which the literature indicates is important. Allows a "dosage" to be calculated which may be more sensitive than categories. **Cons:** - No other published research has used this novel method. - Difficult to equate a score with a severity i.e. are three mild injuries (scoring 3x3=9) worse in neuropsychological terms than one severe (i.e. 1x7=7)? Very difficult to give TBI, a diverse condition with varying impact on individuals, a score.	**Pros:** - Allows bivariate correlations to be drawn - The sample size could be used for multiple regression to examine relationships with other important measures	3

Appendix N – Non-attendance record during recruitment

Recruitment from the YOTs was extremely challenging due to high non-attendance, cancellations and difficulties in scheduling participants. This resulted in an average 36% uptake rate during time-point two of recruitment and 63% at time-point one.

Recruitment Site	No of participants booked	No of participants seen
Yeovil	23	14
Dorchester	10	4
Taunton	10	2
Bournemouth & Poole	12	3

Appendix O - Journal of Head Trauma Rehabilitation guidance for authors

Journal of Head Trauma Rehabilitation

Online Submission and Review System

Author Resources

Instructions for Authors (this page)

Copyright Transfer (PDF)

Reprint Ordering

Permissions Requests

SCOPE

The *Journal of Head Trauma Rehabilitation (JHTR)* is a bimonthly journal devoted to clinical management and rehabilitation of persons with traumatic brain injury. It is interdisciplinary and designed to provide the most current and relevant information for the practicing professional and researchers in the field. Three or 4 issues each year are devoted to single topics recommended to or solicited by the editors. The remaining issues consist primarily of unsolicited, empirical research reports. All articles, whether in a topical issue or not, receive masked peer review.

Authors are encouraged to submit to *JHTR* original manuscripts based on observations or experimentation that add new knowledge to the field of brain injury rehabilitation. Analytical reviews that codify existing knowledge or illuminate the present and future issues in the field are welcomed. In addition to topical articles, *JHTR* seeks manuscripts dealing with a variety of subjects that have current or future importance to all areas of brain injury rehabilitation, from acute medical management and clinical interventions to problems with reintegration into the community and long-term quality of life.

MANUSCRIPT SUBMISSION

Article types: Manuscripts reporting original research and systematic reviews are welcomed. Case studies may be published if they address a seminal clinical condition or procedure that has not been previously reported in the published literature. (Unless you have been invited by a topical issue editor to submit a manuscript for a topical issue, all manuscripts should be submitted as "Unsolicited (Focus on Clinical Research)".*JHTR* emphasizes research on *traumatic* brain injury. If participants included in a research manuscript are not exclusively individuals with traumatic brain injury, the proportion of each etiology must be described. Generally, to be published in *JHTR*, a majority of the participants must have incurred traumatic brain injury, or data analysis allows evaluation of the specific effect on those with a traumatic etiology.

Article length: Manuscripts should generally not exceed 4500 words excluding abstract, references, tables, and figures. Authors are encouraged to use Supplemental Digital Content (SDC) for manuscript details that supplement but are not central to the comprehension of the paper. SDC is linked to the article indefinitely via the *JHTR* Web site (for more information, see later)

Online manuscript submission: All manuscripts must be submitted online through the Web site at www.edmgr.com/jhtr, which can also be accessed through the journal's Web page.

First-time users: Please click the Register button from the menu above and enter the requested information. On successful registration, you will be sent an e-mail indicating your user name and password. *Note:* If you have received an e-mail from us with an assigned user ID and password, or if you are a repeat user, do not register again. Just log in. Once you have an assigned ID and password, you do not have to reregister, even if your status changes (ie, author, reviewer, or editor).

Authors: Please click the Log-in button from the menu at the top of the page and log-in to the system as an Author. Submit your manuscript according to the author instructions. You will be able to track the progress of your manuscript through the system. If you experience any problems, please contact John D. Corrigan, PhD, Editor-in-Chief at corrigan.1@osu.edu.

CONFLICTS OF INTEREST

Authors must state all possible conflicts of interest in the Title Page of the manuscript, including financial, consultant, institutional, and other relationships that might lead to bias or a conflict of interest. If there is no conflict of interest, this should also be explicitly stated as none declared. All relevant conflicts of interest and sources of funding should be included on the title page of the manuscript with the heading "Conflicts of Interest and Source of Funding:". For example:

Conflicts of Interest and Source of Funding: Author A has received honoraria from Company Z. Author B is currently receiving a grant (#12345) from Organization Y and is on the speaker's bureau for Organization X—the CME organizers for Company A. For the remaining authors none were declared.

In addition, each author must complete and submit the journal's copyright transfer agreement, which includes a section on the disclosure of potential conflicts of interest based on the recommendations of the International Committee of Medical Journal Editors, " Uniform Requirements for Manuscripts Submitted to Biomedical Journals."

- Each author must download the form in PDF format, complete the form electronically, and provide to the lead author for submission to the JHTR Editorial Manager site.
- All author forms must be completed by the time of revised manuscript submission.
- Each author will be expected to complete and sign the copyright transfer agreement form electronically. For help or more information about electronically signing this form, read our Steps for Creating a Digital Signature and other online FAQs.

LWW AUTHOR'S MANUSCRIPT CHECKLIST FOR JOURNALS

Authors should pay particular attention to the following items before submitting their manuscripts:

Manuscript Preparation

- *JHTR* uses the *American Medical Association Manual of Style*, 10th edition.
- *JHTR* requires authors to use person-first language—avoid phrasing such as "the brain-injured participant"or the "TBI patient"and replace with "participant with a brain injury" or "patient with a TBI."
- Manuscripts should be line numbered in their original format (eg, Microsoft Word line numbering).
- Manuscripts should be double-spaced, including quotations, lists, references, footnotes, figure captions, and all parts of tables. Do not embed tables in the text.
- Manuscripts should be ordered as follows: title page, abstracts, text, references, appendices, tables, and any illustrations.
- To maintain a masked review process, it is the author's responsibility to make every attempt to mask all information in the manuscript that would reveal the identity of the author to the reviewer. This version of the manuscript is referred to as the "masked" manuscript when uploading documents.
- Title page including (1) title of the article; (2) author names (with highest academic degrees) and affiliations (including titles, departments, and name and location of institutions of primary employment); (3) all possible conflicts of interest including financial, consultant, institutional, and other relationships that might lead to bias or a conflict of interest; (4) disclosure of funding received for this work including from any of the following organizations with public or open access policies: National Institutes of Health (NIH), Wellcome Trust, and the Howard Hughes Medical Institute; and (5) any acknowledgments, credits, or disclaimers.
- A structured abstract of no more than 200 words should be prepared. Authors should use telegraphic language where possible, including omission of introductory clauses. Headings should typically include the following: Objective, Setting, Participants, Design, Main Measures, Results, and Conclusion. The Conclusion section should encapsulate the clinical implications of the results, not merely restate the findings.
- Include up to 10 key words that describe the contents of the article such as those that appear in the Cumulative Index to Nursing and Allied Health Literature (CINAHL) or the National Library of Medicine's (NLM's) Medical Subject Headings (MeSH).
- There should be a clear indication of the placement of all tables and figures in text.
- The author is responsible for obtaining written permission for any borrowed text, tables, or figures.

References

- References must be cited in text and styled in the reference list according to the *American Medical Association Manual of Style*, 9th edition, copyright 1998 American Medical Association. They must be numbered consecutively in the order they are cited and listed in that sequence (not alphabetically); reference numbers may be used more than once throughout an article. Page numbers should appear with the text citation following a specific quote. References should be double-spaced and placed at the end of the text.
- References should not be created using Microsoft Word's automatic footnote/endnote feature.

Figures

A. Four Steps for Submitting Artwork

1. Learn about Digital Art creation. Visit www.lwwonline.com
    a. Click "For Authors"and go to the Artwork tab.
    b. Here you will also find specific Digital-Imaging Software Instructions to help support your efforts to create perfect images the first time.
2. Create, Scan, and Save your artwork according to the Digital Artwork Guideline Checklist.
3. Compare your final figure to the Target Digital-Imaging Results listed later.
4. Upload each figure to Editorial Manager in conjunction with your manuscript text and tables.

B. Color Figures

JHTR is a black and white publication and figures will be printed in black and white. It is possible, however, for figures to be printed in full color (4 color) either at the discretion of the editor or with a per-page fee of $650. If you would like to have your figures printed in color, please contact John Corrigan, Editor (e-mail: corrigan.1@osu.edu).

C. Digital Artwork Guideline Checklist Basics to have in place before submitting your digital art.

- Artwork saved as TIFF and EPS files. Do not save TIFFs as compressed files.
- Artwork created as the actual size (or slightly larger) than it will appear in the journal. (To get an idea of the size images should be when they print, study a copy of the journal. Measure the artwork typically shown and scale your image to match.)
- Crop out any white or black space surrounding the image.
- Text and fonts in any figure are one of the acceptable fonts: Helvetica, Times Roman, Symbol, Mathematical PI, and European PI.
- Color images are created/scanned and saved and submitted as CMYK only. Do not submit any figures in RGB mode because RGB is the color mode used for screens/monitors and CMYK is the color mode used for print.
- Line art saved at a resolution of at least 1200 dpi.
- Images saved at a resolution of at least 300 dpi.
- Each figure saved as a separate file and saved separately from the accompanying text file.
- For multipanel or composite figures only: Any figure with multiple parts should be sent as one file, with each part labeled the way it is to appear in print.

Remember:

- Artwork generated from office suite programs such as CorelDRAW, MS Word, Excel, and artwork downloaded from the Internet (JPEG or GIF files) cannot be used because the quality is poor when printed.
- Cite figures consecutively in your manuscript.
- Number figures in the figure legend in the order in which they are discussed.
- Upload figures consecutively to the Editorial Manager Web site and number figures consecutively in the Description box during upload.
- All electronic art that cannot be successfully uploaded must be submitted on a 31/2-inch high-density disk, a CD-ROM, or an Iomega Zip disk, accompanied by high-resolution laser prints of each image.

Tables Tables should be on a separate page at the end of the manuscript. Number tables consecutively and supply a brief title for each. Include explanatory footnotes for all nonstandard abbreviations. Cite each table in the text in consecutive order. If you use data from another published or unpublished source, obtain permission and acknowledge fully.

Supplemental Digital Content Authors may submit SDC that enhances their article's text to be considered for online posting. SDC may include standard media such as text documents, graphs, audio, video, etc. On the Attach Files page of the submission process, please select Supplemental Audio, Video, or Data for your uploaded file as the Submission Item. If an article with SDC is accepted, our production staff will create a URL with the SDC file. The URL will be placed in the call-out within the article. SDC files are not copyedited by LWW staff; they will be presented digitally as submitted. For a list of all available file types and detailed instructions, please visit the Checklist for Supplemental Digital Content.

SDC Call-outs: SDC must be cited consecutively in the text of the submitted manuscript. Citations should include the type of material submitted (Audio, Figure, Table, etc.), be clearly labeled as "Supplemental Digital Content," include the sequential list number and provide a description of the supplemental content. All descriptive text should be included in the call-out, as it will not appear elsewhere in the article.
Example:
We performed many tests on the degrees of flexibility in the elbow (see Video, Supplemental Digital Content 1, which demonstrates elbow flexibility) and found our results inconclusive.

List of Supplemental Digital Content: A listing of SDC items must be submitted at the end of the manuscript file. Includethe SDC number and file type. This text will be removed by our production staff and not be published.
Example:
Supplemental Digital Content 1. wmv

SDC File Requirements: All acceptable file types are permissible up to 10 MB. For audio or video files greater than 10 MB, authors should first query the journal office for approval. For a list of all available file types and detailed instructions, please visit the Checklist for Supplemental Digital Content.

Permissions
Authors are responsible for obtaining signed letters from copyright holders granting permission to reprint material being borrowed or adapted from other sources, including previously published material of your own. Authors must obtain written permission for material that has not been created and submitted to LWW for a specific publication (including forms, checklists, cartoons, text, tables, figures, exhibits, glossaries, and pamphlets); concepts, theories, or formulas used exclusively in a chapter or section; direct quotes from a book or journal that are more than 30% of a printed page; and all excerpts from newspapers or other short articles. Without written permission from the copyright holder, these items may not be used. Where permission has been granted, the author should follow any special wording stipulated by the granter when attributing the source in the manuscript. Letters of permission must be submitted before publication of the manuscript.

Open access
LWW's hybrid open access option is offered to authors whose articles have been accepted for publication. With this choice, articles are made freely available online immediately upon publication. Authors may take advantage of the open access option at the point of acceptance to ensure that this choice has no influence on the peer review and acceptance process. These articles are subject to the journal's standard peer-review process and will be accepted or rejected based on merit.

Authors of accepted peer-reviewed articles have the choice to pay a fee to allow perpetual, unrestricted, online access to their published article to readers globally, immediately upon publication. The article processing charge for the *Journal of Head Trauma Rehabilitation* is $3000US. The article processing charge for authors funded by the Research Councils UK (RCUK) is $3800US. The publication fee is charged on acceptance of the article and should be paid within 30 days by credit card by the author, funding agency or institution. Payment must be received in full for the article to be published open access. Any additional standard publication charges, such as those for color images, will also apply.

Appendix P – Dissemination statement

Dissemination Statement

I will use the following dissemination strategy to ensure that the findings of this research are shared with interested parties.

University of Exeter Doctorate in Clinical Psychology

This thesis will be submitted as part of the requirements of the doctorate programme.

Wider academic and clinical community

I will be presenting to Trainee Clinical Psychologists, staff and other interested parties at the University of Exeter in June 2014.

I will be presenting the findings to the sites used for recruitment of participants (i.e., Youth Offending Teams) in July 2014.

As per ethical approval, participants who provided an email address on their consent form and requested a copy of the results will be sent a summary of the study findings.

I intend on submitting a reduced research paper for publication in a peer-reviewed journal (Journal of Head Trauma Rehabilitation) in August 2014.

In addition, I intend on presenting a poster at an appropriate conference within the next 12 months.