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

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

Signature: .................................................................
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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

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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>
<thead>
<tr>
<th>Study</th>
<th>Study Aims</th>
<th>Design</th>
<th>Sample characteristics</th>
<th>Measures</th>
<th>Main EE findings &amp; estimated effect size ($d^*$)</th>
<th>Evaluation &amp; Risk of Bias</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bardenhagen et al., 1999</td>
<td>To examine two cases of severe TBI and the long term social and cognitive sequelae.</td>
<td>Case study design</td>
<td><strong>Place of study:</strong> Australia&lt;br&gt;<strong>TBI Group</strong> (n=2) - No demographic information given to ensure confidentiality. - Initially seen for routine neuropsychological assessment. - Severe TBI - 20 years post injury</td>
<td></td>
<td>- HB scored 1 SD above the mean on QMEE. Wife rated him closer to the mean for men.&lt;br&gt;- 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.</td>
<td><strong>Strengths:</strong> In depth exploration of cases with multiple neuropsychological measures.&lt;br&gt;<strong>Limitations:</strong> Very small sample with no comparison. Difficult to generalise. Cases were 20 years post injury which is significantly more than other studies.&lt;br&gt;<strong>Possible Sources of bias:</strong> Difficult to generalise these findings for a small and specific sample.&lt;br&gt;<strong>Risk of Bias:</strong> High. High with small sample. Cannot generalise.</td>
</tr>
</tbody>
</table>
| de Sousa, McDonald, Rushby, Dimoska & James, 2010 | To examine the relationship between self-reported emotional and cognitive empathy and psychophysiological responding to emotionally evocative pictures. | Case control, between groups design comparing TBI with matched controls. | **Place of study:** Australia<br>**TBI Group** (n=20) - Severe TBI (PTA >1 day) - At least one year post injury - Recruited from brain injury units - Exclusion: aphasia or agnosia, unable to comprehend instructions.<br>**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): Questionnaire Measure of Emotional Empathy (QMEE; self-report)<br>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 | - Based on norms/z scores in the BEES manual, participants in TBI and control groups were split into those with low, and normal empathy<br>- 70% of TBI showed low EE compared to 31.8% of controls on BEES.<br>- 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. | **Strengths:** Used multiple measures to assess EE. Describes excluded data clearly.<br>**Limitations:** Although multiple measures of EE used, these are all questionnaire and self-report and lack dynamism or ecological validity.<br>**Possible Sources of bias:** Well reported outcome data.<br>**Risk of Bias:** Low.
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 TBI (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.

Stimuli pictures of facial affect from Pictures of Facial Affect series
DASS-21 Facial EMG and skin conductance measured.

The authors do not make it 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.

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.

The TBI group had impaired facial contagion to both happy and negative film clips and lower arousal to negative clips as compared to controls.

Estimated effect size(s):
BEES d=0.90

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Risk of Bias: Low.

Strengths: Integrates questionnaire methods with psychophysiological recording. Limitations: Static images of faces used lack ecological validity. Relatively small sample. No power analysis.

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Estimated effect size(s):
BEES d=0.90

TBI group reported significantly lower EE scores as measured by BEES as compared to controls. Significant difference 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. 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

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.

7% 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)
To compare performance of patients with left, right and bilateral vmPFC lesions on two TOM tasks - cognitive and affective.

**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.

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To examine deficits in emotion perception in adults with TBI during childhood and investigate relationships between emotion perception skills, empathy and TOM.

**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

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(a) To identify impairments in expression recognition, understanding of situations and intentions,

**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

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**Strengths:**
- Considers neurological systems in emotional empathy.
- Reports effect sizes. Considers mild TBI as well as moderate/severe.
- Assessed multiple aspects of social cognition, understanding of situations and intentions.
- Exclusion criteria not reported. Sample aged below 30, so does not span all of adulthood.

**Limitations:**
- Unequal group sizes.
- Didn’t report subscale scores to differentiate between emotional and cognitive empathy.
- Does not report selection bias, with presumably most participants classified as severe TBI.

**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
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)

To Muller et 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.

**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.

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 psychophysiological responsivity in adults with TBI.

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.
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.

---

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.
**REVIEW: EMOTIONAL EMPATHY AFTER TBI**

**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

**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 sequelae. - 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 to 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.
- Considers impact of cognitive abilities of social cognition.

**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

**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 sequelae. - Exclusion: pre-accident history of personality disorder, LD, dysphagia or neurological disorder

**Control group** (n = 64) - Matched on age, gender, 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.
- Considered cognitive abilities of social cognition.
- Range of severity. Recruited over age 22 to account for ongoing brain development.

**Limitations:**

- 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 $\alpha=0.77$ (IRI; Davis, 1980) to $\alpha=0.90$ (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 for measuring 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


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


Appendix A – Data Extraction Form

Reference Number:

Title:

Author(s):

Source:

Date: Volume: Pages:

Aim(s) of the study:

Setting & Geographical Location:

Study Design:

Population

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

<table>
<thead>
<tr>
<th>Domain</th>
<th>Description</th>
<th>Review authors’ judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sequence generation</td>
<td>Describe the method used to generate the allocation sequence in sufficient detail to allow an assessment of whether it should produce comparable groups.</td>
<td>Was the allocation sequence adequately generated?</td>
</tr>
<tr>
<td>Allocation concealment</td>
<td>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.</td>
<td>Was allocation adequately concealed?</td>
</tr>
<tr>
<td>Blinding of participants, personnel and outcome assessors</td>
<td>Assessments should be made for each main outcome (or class of outcome)</td>
<td>Was knowledge of the allocated intervention adequately prevented during the study?</td>
</tr>
<tr>
<td>Incomplete outcome data</td>
<td>Assessments should be made for each main outcome (or class of outcome)</td>
<td>Were incomplete outcome data adequately addressed?</td>
</tr>
<tr>
<td>Selective outcome reporting</td>
<td>State how the possibility of selective outcome reporting was examined by the review authors, and what was found.</td>
<td>Were reports of the study free of suggestion of selective outcome reporting?</td>
</tr>
<tr>
<td>Other sources of bias</td>
<td>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.</td>
<td>Was the study apparently free of other problems that could put it at a high risk of bias?</td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>Criteria for the judgement of ‘YES’ (i.e. low risk of bias).</th>
<th>The investigators describe a random component in the sequence generation process such as:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Referring to a random number table.</td>
<td></td>
</tr>
<tr>
<td>Using a computer random number generator.</td>
<td></td>
</tr>
<tr>
<td>Coin tossing.</td>
<td></td>
</tr>
<tr>
<td>Shuffling cards or envelopes.</td>
<td></td>
</tr>
<tr>
<td>Throwing dice.</td>
<td></td>
</tr>
<tr>
<td>Drawing of lots.</td>
<td></td>
</tr>
<tr>
<td>Minimization.</td>
<td></td>
</tr>
</tbody>
</table>

*Minimization may be implemented without a random element, and this is considered to be equivalent to being random.

<table>
<thead>
<tr>
<th>Criteria for the judgement of ‘NO’ (i.e. high risk of bias).</th>
<th>The investigators describe a non-random component in the sequence generation process. Usually, the description would involve some systematic, non-random approach, for example:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sequence generated by odd or even date of birth.</td>
<td></td>
</tr>
<tr>
<td>Sequence generated by some rule based on date (or day) of admission.</td>
<td></td>
</tr>
<tr>
<td>Sequence generated by some rule based on hospital or clinic record number.</td>
<td></td>
</tr>
</tbody>
</table>

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 result of a laboratory test or a series of tests;
- Allocation by availability of the intervention.

### ALLOCATION CONCEALMENT
**Was allocation adequately concealed?** [Short form: Allocation concealment?]

<table>
<thead>
<tr>
<th>Criteria for the judgement of ‘YES’ (i.e. low risk of bias).</th>
<th>Participants and investigators enrolling participants could not foresee assignment because one of the following, or an equivalent method, was used to conceal allocation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central allocation (including telephone, web-based, and pharmacy-controlled, randomisation);</td>
<td></td>
</tr>
<tr>
<td>Sequentially numbered drug containers of identical appearance;</td>
<td></td>
</tr>
<tr>
<td>Sequentially numbered, opaque, sealed envelopes.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Criteria for the judgement of ‘NO’ (i.e. high risk of bias).</th>
<th>Participants or investigators enrolling participants could possibly foresee assignments and thus introduce selection bias, such as allocation based on:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using an open random allocation schedule (e.g. a list of random numbers);</td>
<td></td>
</tr>
<tr>
<td>Assignment envelopes were used without appropriate safeguards (e.g. if envelopes were unsealed or non-opaque or not sequentially numbered);</td>
<td></td>
</tr>
<tr>
<td>Alternation or rotation;</td>
<td></td>
</tr>
<tr>
<td>Date of birth;</td>
<td></td>
</tr>
<tr>
<td>Case record number;</td>
<td></td>
</tr>
<tr>
<td>Any other explicitly un concealed procedure.</td>
<td></td>
</tr>
<tr>
<td>Criteria for the judgement of 'UNCLEAR' (uncertain risk of bias).</td>
<td>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.</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>BLINDING OF PARTICIPANTS, PERSONNEL, AND OUTCOME ASSESSORS</strong></td>
<td><strong>Was knowledge of the allocated interventions adequately prevented during the study? [Short form: Blinding?]</strong></td>
</tr>
<tr>
<td>Criteria for a judgement of 'YES' (i.e. low risk of bias).</td>
<td>Any one of the following:</td>
</tr>
<tr>
<td></td>
<td>• No blinding, but the review authors judge that the outcome and the outcome measurement are not likely to be influenced by lack of blinding;</td>
</tr>
<tr>
<td></td>
<td>• Blinding of participants and key study personnel ensured, and unlikely that the blinding could have been broken;</td>
</tr>
<tr>
<td></td>
<td>• 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.</td>
</tr>
<tr>
<td>Criteria for the judgement of 'NO' (i.e. high risk of bias).</td>
<td>Any one of the following:</td>
</tr>
<tr>
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<td>• No blinding or incomplete blinding, and the outcome or outcome measurement is likely to be influenced by lack of blinding.</td>
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<td>• Blinding of key study participants and personnel attempted, but likely that the blinding could have been broken.</td>
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<td>• Either participants or some key study personnel were not blinded, and the non-blinding of others likely to introduce bias.</td>
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<td>Criteria for the judgement of 'UNCLEAR' (uncertain risk of bias).</td>
<td>Any one of the following:</td>
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<td>• Insufficient information to permit judgement of 'Yes' or 'No';</td>
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<td>• The study did not address this outcome.</td>
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<p>| 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 outcome not enough to have a clinically relevant impact on observed effect size. |
| 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. |</p>
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<th>Criteria for the judgement of ‘UNCLEAR’ (uncertain risk of bias)</th>
<th>Any one of the following:</th>
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<td>• Insufficient reporting of attrition/exclusions to permit judgement of ‘Yes’ or ‘No’ (e.g. number randomized not stated, no reasons for missing data provided);</td>
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<td>• The study did not address this outcome.</td>
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**SELECTIVE OUTCOME REPORTING**

Are reports of the study free of suggestion of selective outcome reporting? [Short form: Free of selective reporting?]

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<th>Criteria for a judgement of ‘YES’ (i.e. low risk of bias)</th>
<th>Any one of the following:</th>
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<td></td>
<td>• 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;</td>
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<td>• 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).</td>
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<th>Criteria for the judgement of ‘NO’ (i.e. high risk of bias)</th>
<th>Any one of the following:</th>
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<td>• Not all of the study’s pre-specified primary outcomes have been reported;</td>
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<td>• One or more primary outcomes is reported using measurements, analysis methods or subsets of the data (e.g. subscales) that were not pre-specified;</td>
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<td>• One or more reported primary outcomes were not pre-specified (unless clear justification for their reporting is provided, such as an unexpected adverse effect);</td>
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<td>• One or more outcomes of interest in the review are reported incompletely so that they cannot be entered in a meta-analysis;</td>
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<td>• The study report fails to include results for a key outcome that would be expected to have been reported for such a study.</td>
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| 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?]

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<th>Criteria for a judgement of ‘YES’ (i.e. low risk of bias)</th>
<th>The study appears to be free of other sources of bias.</th>
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<th>Criteria for the judgement of ‘NO’ (i.e. high risk of bias)</th>
<th>There is at least one important risk of bias. For example, the study:</th>
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<td>• Had a potential source of bias related to the specific study design used; or</td>
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<td>• Stopped early due to some data-dependent process (including a formal-stopping rule); or</td>
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<td>• Had extreme baseline imbalance; or</td>
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<td>• Has been claimed to have been fraudulent; or</td>
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<td>• Had some other problem.</td>
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<th>Criteria for the judgement of ‘UNCLEAR’ (uncertain risk of bias)</th>
<th>There may be a risk of bias, but there is either:</th>
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<td>• Insufficient information to assess whether an important risk of bias exists; or</td>
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<td>• Insufficient rationale or evidence that an identified problem will introduce bias.</td>
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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 Adam Hirschberg (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 conceptually oriented 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 point-counterpoint 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 XXXXXX)”. 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)" 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 dependent 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

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

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

**Facial Emotion Recognition Task** (Bamford, Penton-Voak, Pinkney, Baldwin, Munafó, & 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

<table>
<thead>
<tr>
<th>Primary Offence Type</th>
<th>Seriousness Score*</th>
<th>(n)</th>
<th>Percentage of sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assault</td>
<td>3</td>
<td>14</td>
<td>33.3%</td>
</tr>
<tr>
<td>Theft</td>
<td>3</td>
<td>6</td>
<td>14.6%</td>
</tr>
<tr>
<td>Burglary</td>
<td>6</td>
<td>6</td>
<td>14.6%</td>
</tr>
<tr>
<td>Rape</td>
<td>8</td>
<td>3</td>
<td>7.1%</td>
</tr>
<tr>
<td>Criminal Damage</td>
<td>2</td>
<td>3</td>
<td>7.1%</td>
</tr>
<tr>
<td>Possession</td>
<td>4 or 6**</td>
<td>3</td>
<td>7.1%</td>
</tr>
<tr>
<td>GBH</td>
<td>6</td>
<td>2</td>
<td>4.7%</td>
</tr>
<tr>
<td>Attempted Robbery</td>
<td>6</td>
<td>1</td>
<td>2.3%</td>
</tr>
<tr>
<td>Aggravated Vehicle Taking</td>
<td>5</td>
<td>1</td>
<td>2.3%</td>
</tr>
<tr>
<td>Drunk &amp; Disorderly</td>
<td>1</td>
<td>1</td>
<td>2.3%</td>
</tr>
<tr>
<td>Fraud</td>
<td>3</td>
<td>1</td>
<td>2.3%</td>
</tr>
<tr>
<td>Supply</td>
<td>4</td>
<td>1</td>
<td>2.3%</td>
</tr>
</tbody>
</table>

*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

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

*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

<table>
<thead>
<tr>
<th>TBI Frequency</th>
<th>n</th>
<th>Percentage of sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>No history of TBI</td>
<td>15</td>
<td>31.3%</td>
</tr>
<tr>
<td>1</td>
<td>7</td>
<td>14.6%</td>
</tr>
<tr>
<td>2</td>
<td>9</td>
<td>18.8%</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>10.4%</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>4.1%</td>
</tr>
<tr>
<td>5 or more</td>
<td>10</td>
<td>20.8%</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Variable</th>
<th>Non-TBI</th>
<th>TBI</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Mean</td>
<td>SD</td>
<td>n</td>
</tr>
<tr>
<td>Age</td>
<td>26</td>
<td>16.04</td>
<td>1.31</td>
<td>22</td>
</tr>
<tr>
<td>Verbal T Score</td>
<td>26</td>
<td>35.88</td>
<td>11.62</td>
<td>22</td>
</tr>
<tr>
<td>Non-Verbal T Score</td>
<td>26</td>
<td>40.03</td>
<td>9.92</td>
<td>22</td>
</tr>
<tr>
<td>Age of first conviction</td>
<td>20</td>
<td>14.25</td>
<td>1.48</td>
<td>17</td>
</tr>
<tr>
<td>Seriousness Score of Offence</td>
<td>24</td>
<td>4.20</td>
<td>2.04</td>
<td>18</td>
</tr>
<tr>
<td>Number of previous convictions</td>
<td>22</td>
<td>1.64</td>
<td>2.08</td>
<td>18</td>
</tr>
<tr>
<td>Risk of Reoffending</td>
<td>24</td>
<td>14.2</td>
<td>6.0</td>
<td>17</td>
</tr>
</tbody>
</table>

*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

<table>
<thead>
<tr>
<th>FER Variable</th>
<th>Non-TBI Group (n=24)</th>
<th>TBI group (n=22)</th>
<th>Total Sample (n=46)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Overall accuracy</td>
<td>54.16</td>
<td>11.09</td>
<td>50.20</td>
</tr>
<tr>
<td>Hits Happy</td>
<td>73.61</td>
<td>16.62</td>
<td>70.30</td>
</tr>
<tr>
<td>Angry</td>
<td>42.78</td>
<td>18.22</td>
<td>37.87</td>
</tr>
<tr>
<td>Sad</td>
<td>65.00</td>
<td>14.87</td>
<td>56.97</td>
</tr>
<tr>
<td>Fear</td>
<td>26.67</td>
<td>16.33</td>
<td>26.06</td>
</tr>
<tr>
<td>Surprise</td>
<td>65.5</td>
<td>17.65</td>
<td>66.06</td>
</tr>
<tr>
<td>Disgust</td>
<td>51.38</td>
<td>19.50</td>
<td>43.94</td>
</tr>
<tr>
<td>False alarms</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Happy</td>
<td>6.55</td>
<td>5.4</td>
<td>7.45</td>
</tr>
<tr>
<td>Angry</td>
<td>2.94</td>
<td>2.72</td>
<td>3.63</td>
</tr>
<tr>
<td>Sad</td>
<td>7.89</td>
<td>5.39</td>
<td>8.66</td>
</tr>
<tr>
<td>Fear</td>
<td>12.77</td>
<td>6.17</td>
<td>12.55</td>
</tr>
<tr>
<td>Surprise</td>
<td>13.66</td>
<td>4.45</td>
<td>15.09</td>
</tr>
<tr>
<td>Disgust</td>
<td>9.88</td>
<td>5.24</td>
<td>10.66</td>
</tr>
<tr>
<td>No Response</td>
<td>1.46</td>
<td>2.22</td>
<td>1.27</td>
</tr>
<tr>
<td>Positive Hits</td>
<td>69.58</td>
<td>13.63</td>
<td>68.18</td>
</tr>
<tr>
<td>Negative Hits</td>
<td>46.45</td>
<td>12.75</td>
<td>41.21</td>
</tr>
</tbody>
</table>

*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

<table>
<thead>
<tr>
<th>Variable</th>
<th>Non-TBI Group (n=11)</th>
<th>TBI group (n=12)</th>
<th>$t$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>APQ-9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive Parenting</td>
<td>11.82</td>
<td>3.28</td>
<td>11.33</td>
<td>2.93</td>
</tr>
<tr>
<td>Inconsistent Discipline</td>
<td>8.55</td>
<td>3.67</td>
<td>8.17</td>
<td>3.78</td>
</tr>
<tr>
<td>Poor Supervision</td>
<td>7.73</td>
<td>3.35</td>
<td>12.58</td>
<td>2.02</td>
</tr>
<tr>
<td>SDQ</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emotional</td>
<td>3.00</td>
<td>2.09</td>
<td>3.00</td>
<td>2.21</td>
</tr>
<tr>
<td>Conduct</td>
<td>3.82</td>
<td>1.84</td>
<td>4.08</td>
<td>1.93</td>
</tr>
<tr>
<td>Hyperactivity</td>
<td>5.91</td>
<td>2.3</td>
<td>5.42</td>
<td>1.73</td>
</tr>
<tr>
<td>Peer</td>
<td>2.82</td>
<td>1.6</td>
<td>2.42</td>
<td>1.31</td>
</tr>
<tr>
<td>Prosocial</td>
<td>6.91</td>
<td>2.02</td>
<td>7.42</td>
<td>1.57</td>
</tr>
<tr>
<td>Total</td>
<td>15.36</td>
<td>5.81</td>
<td>15.75</td>
<td>5.69</td>
</tr>
<tr>
<td>Reactive-Proactive Aggression</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reactive Aggression</td>
<td>10.09</td>
<td>4.7</td>
<td>15.08</td>
<td>4.62</td>
</tr>
<tr>
<td>Proactive Aggression</td>
<td>4.55</td>
<td>3.48</td>
<td>8.92</td>
<td>4.70</td>
</tr>
<tr>
<td>Total Aggression</td>
<td>14.64</td>
<td>5.81</td>
<td>24.00</td>
<td>8.89</td>
</tr>
<tr>
<td>Empathic Sadness</td>
<td>3.09</td>
<td>1.3</td>
<td>4.00</td>
<td>2.13</td>
</tr>
</tbody>
</table>

*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)

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

(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


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


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

- Exploring socio-emotional and executive processing in young offenders.

### Differences

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.

- The researchers will make contact with the YOTs and TYS to introduce the research.
- 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.
- 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:

- Bryant Empathy Scale (abbreviated version)
- Strengths and Difficulties Questionnaire
- Alabama Parenting Scale (short form)
- Proactive and Reactive Aggression Questionnaire
- Stoplight task
- 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.

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.

Some of the measures are the same

- WASI-II
- Stroop Test
- Traumatic brain injury screen (based on the Comprehensive Health Assessment Tool (CHAT))
- Emotion recognition task
- Demographic questionnaire and criminal and substance abuse background

The consent forms and information forms reflect the slight differences in the measures.

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.

- There are not identified risks other than the possibility of fatigue or loss of interest. This will be managed with breaks.
- We are working only with offenders displaying low levels of risk of harm towards themselves and others
- Informed consent and assent will be sought from the young people and their parents/guardians if they are under 16 years if age
- The data will be anonymised and confidential.

At the end of the testing session, the participants will be
Summary of measures and administration times

<table>
<thead>
<tr>
<th>Measure</th>
<th>Administration Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Background questionnaire, brain injury screen</td>
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</tr>
<tr>
<td>Emotion Recognition Task</td>
<td>6 min</td>
</tr>
<tr>
<td>Bryant’s Emotional Empathy Index</td>
<td>2 min</td>
</tr>
<tr>
<td>Strengths and Difficulties Questionnaire</td>
<td>3 min</td>
</tr>
<tr>
<td>Stoplight Task</td>
<td>7 min</td>
</tr>
<tr>
<td>Stroop</td>
<td>5 min</td>
</tr>
<tr>
<td>Abbreviated UPPS Impulsivity Behaviour Scale</td>
<td>3 min</td>
</tr>
<tr>
<td>Reactive-Proactive Aggression Questionnaire</td>
<td>3 min</td>
</tr>
<tr>
<td>Alabama Parenting Questionnaire</td>
<td>2 min</td>
</tr>
<tr>
<td>WASI</td>
<td>10 min</td>
</tr>
</tbody>
</table>

**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
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
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...

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

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

Your signature .............................................................................................................

Today's date ..............................................................................................................................

Thank you very much for your help

© Robert Goodman 2015
**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*

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

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

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:

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

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:

<table>
<thead>
<tr>
<th>Symptom</th>
<th>A mild problem</th>
<th>A moderate problem</th>
<th>A severe problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptom 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Symptom 2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Offending Behaviour

1. What are you currently convicted for?

<table>
<thead>
<tr>
<th></th>
<th>None</th>
<th>Once</th>
<th>Twice</th>
<th>Three times</th>
<th>More than three</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burglary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shoplifting/theft</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Violent Offences</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joyriding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fraud/deception</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug offences</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sexual Offences</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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)
   - o Assault without injury
   - o Minor injury (e.g. bruises etc that require minor medical treatment)
   - o Serious injury, requiring hospital treatment (e.g. broken limb, stabbing, gunshot wound)
   - o Severe injury (e.g. lasting impairment, life-threatening injury)
   - o Murder/manslaughter
   - o Murder/manslaughter of multiple victims

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

<table>
<thead>
<tr>
<th></th>
<th>None</th>
<th>Once</th>
<th>Twice</th>
<th>Three times</th>
<th>More than three</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burglary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shoplifting/theft</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Violent Offences</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joyriding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fraud/deception</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drug offences</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sexual Offences</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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:

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

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:

<table>
<thead>
<tr>
<th>Drug</th>
<th>Never</th>
<th>Once a year</th>
<th>Once per month</th>
<th>Weekends</th>
<th>Most Days</th>
<th>Everyday</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heroin</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-prescribed drugs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cocaine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crack-Cocaine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amphetamine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ecstasy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cannabis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Alcohol</th>
<th>Never</th>
<th>Once a year</th>
<th>Once per month</th>
<th>Weekends</th>
<th>Most Days</th>
<th>Everyday</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spirits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alco-pops</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cider</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Demographics

1. What is your age? __________________________

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

3. To which ethnic 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 voucher. 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
Consent Form

**Study:** Socio-emotional and executive processing in young people

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

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

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:..............................................................................................................................................................................................................
Consent Form

Study: Socio-emotional and executive processing in young people

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

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

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:
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):

<table>
<thead>
<tr>
<th>Living with parent(s)</th>
<th>Looked after Child</th>
<th>Living independently</th>
<th>Other (please specify):</th>
</tr>
</thead>
</table>

**Appendix L - Summary of participant TBI and offence history**

<table>
<thead>
<tr>
<th>Participant</th>
<th>Age</th>
<th>Number of injuries</th>
<th>Age at worst injury</th>
<th>LOC of worst injury</th>
<th>Cause of worst injury</th>
<th>Primary offence (additional offences)</th>
<th>Seriousness score</th>
<th>Age at first conviction</th>
<th>History of or current violent offences</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>17</td>
<td>15</td>
<td>12</td>
<td>Up to 5 min</td>
<td>Non-criminal activity</td>
<td>Assault by beating</td>
<td>3</td>
<td>16</td>
<td>Yes</td>
</tr>
<tr>
<td>2</td>
<td>14</td>
<td>1</td>
<td>12</td>
<td>Up to 5 min</td>
<td>Fall when sober</td>
<td>Theft from a shop (criminal damage under £2000)</td>
<td>3</td>
<td>14</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>18</td>
<td>0</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Theft (possession of class b drugs)</td>
<td>3</td>
<td>16</td>
<td>No</td>
</tr>
<tr>
<td>4</td>
<td>14</td>
<td>2</td>
<td>14</td>
<td>Up to 5 min</td>
<td>Fall when sober</td>
<td>Rape (rape)</td>
<td>8</td>
<td>13</td>
<td>Yes</td>
</tr>
<tr>
<td>5</td>
<td>17</td>
<td>8</td>
<td>16</td>
<td>5-10min</td>
<td>Fall whilst under influence</td>
<td>Theft and handling stolen goods (criminal damage, harassment)</td>
<td>3</td>
<td>14</td>
<td>No</td>
</tr>
<tr>
<td>6</td>
<td>16</td>
<td>20</td>
<td>16</td>
<td>20-30min</td>
<td>Fight</td>
<td>Criminal damage</td>
<td>2</td>
<td>15</td>
<td>Yes</td>
</tr>
<tr>
<td>7</td>
<td>15</td>
<td>3</td>
<td>14</td>
<td>Up to 5 min</td>
<td>Fight</td>
<td>Criminal damage (burglary from a dwelling, theft from a vehicle)</td>
<td>3</td>
<td>14</td>
<td>No</td>
</tr>
<tr>
<td>8</td>
<td>17</td>
<td>10</td>
<td>17</td>
<td>5-10min</td>
<td>Fight</td>
<td>Attempted robbery (possessing a firearm, aggravated bodily harm, causing affray, threatening behaviour)</td>
<td>6</td>
<td>11</td>
<td>Yes</td>
</tr>
<tr>
<td>9</td>
<td>17</td>
<td>3</td>
<td>17</td>
<td>Up to 5min</td>
<td>Fight</td>
<td>Assault by beating</td>
<td>3</td>
<td>16</td>
<td>Yes</td>
</tr>
<tr>
<td>10</td>
<td>17</td>
<td>3</td>
<td>13</td>
<td>Up to 5min</td>
<td>Non-criminal activity</td>
<td>Burglary from a dwelling (burglary from a dwelling)</td>
<td>6</td>
<td>14</td>
<td>Yes</td>
</tr>
<tr>
<td>11</td>
<td>14</td>
<td>2</td>
<td>14</td>
<td>Up to 5min</td>
<td>Sports injury</td>
<td>Criminal damage under £2000</td>
<td>2</td>
<td>13</td>
<td>No</td>
</tr>
<tr>
<td>12</td>
<td>18</td>
<td>2</td>
<td>17</td>
<td>Up to 5min</td>
<td>Non-criminal activity</td>
<td>Burglary from a dwelling (burglary from a dwelling)</td>
<td>6</td>
<td>15</td>
<td>Yes</td>
</tr>
<tr>
<td>13</td>
<td>17</td>
<td>0</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Assault by beating</td>
<td>3</td>
<td>13</td>
<td>Yes</td>
</tr>
<tr>
<td>14</td>
<td>17</td>
<td>0</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Aggravated vehicle taking (breach of order, assault by beating)</td>
<td>5</td>
<td>12</td>
<td>Yes</td>
</tr>
<tr>
<td>15</td>
<td>16</td>
<td>0</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Assault by beating (assault, resisting arrest)</td>
<td>3</td>
<td>17</td>
<td>Yes</td>
</tr>
<tr>
<td>16</td>
<td>15</td>
<td>2</td>
<td>15</td>
<td>Dazed or confused</td>
<td>Road traffic accident</td>
<td>Assault by beating (criminal damage)</td>
<td>3</td>
<td>14</td>
<td>Yes</td>
</tr>
<tr>
<td>17</td>
<td>18</td>
<td>4</td>
<td>14</td>
<td>Dazed or confused</td>
<td>Fall whilst under influence</td>
<td>Gross bodily harm with intent (assault occasioning actual bodily harm)</td>
<td>6</td>
<td>15</td>
<td>Yes</td>
</tr>
<tr>
<td>Case</td>
<td>Age</td>
<td>Gender</td>
<td>ID</td>
<td>Nature of Offence</td>
<td>Time</td>
<td>Nature of Activity</td>
<td>Offence</td>
<td>Duration</td>
<td>Injury</td>
</tr>
<tr>
<td>------</td>
<td>-----</td>
<td>--------</td>
<td>----</td>
<td>-------------------</td>
<td>------</td>
<td>--------------------</td>
<td>---------</td>
<td>----------</td>
<td>--------</td>
</tr>
<tr>
<td>18</td>
<td>17</td>
<td>M</td>
<td>N/A</td>
<td>Burglary from a dwelling (burglary from a dwelling)</td>
<td>5-10min</td>
<td>6</td>
<td>Non-criminal activity</td>
<td>Drunk and disorderly</td>
<td>1</td>
</tr>
<tr>
<td>19</td>
<td>16</td>
<td>M</td>
<td>3</td>
<td>Possession of class B drugs with intent to supply</td>
<td>Up to 5min</td>
<td>Fight</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>20</td>
<td>17</td>
<td>M</td>
<td>2</td>
<td>Non-criminal activity</td>
<td>5-10min</td>
<td>Fight</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>21</td>
<td>18</td>
<td>M</td>
<td>4</td>
<td>Fight</td>
<td>Up to 5min</td>
<td>Fight</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>22</td>
<td>17</td>
<td>M</td>
<td>6</td>
<td>Fight</td>
<td>Up to 5min</td>
<td>Fight</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>23</td>
<td>17</td>
<td>M</td>
<td>6</td>
<td>Fight</td>
<td>Up to 5min</td>
<td>Fight</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>24</td>
<td>16</td>
<td>M</td>
<td>2</td>
<td>Fall when sober</td>
<td>Up to 5min</td>
<td>Fraud</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>25</td>
<td>16</td>
<td>M</td>
<td>0</td>
<td>Robbery</td>
<td>60 minutes</td>
<td>Non-criminal activity</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>26</td>
<td>16</td>
<td>M</td>
<td>3</td>
<td>Assault by beating</td>
<td>Up to 5min</td>
<td>Fight</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>27</td>
<td>16</td>
<td>M</td>
<td>1</td>
<td>Run when sober</td>
<td>20-30min</td>
<td>Abuse</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>28</td>
<td>17</td>
<td>M</td>
<td>1</td>
<td>Run when sober</td>
<td>&gt;60min</td>
<td>Abuse</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>29</td>
<td>16</td>
<td>M</td>
<td>0</td>
<td>Rape</td>
<td>&gt;60min</td>
<td>Abuse</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>30</td>
<td>17</td>
<td>M</td>
<td>1</td>
<td>Road traffic accident</td>
<td>&gt;60min</td>
<td>Theft</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>31</td>
<td>14</td>
<td>M</td>
<td>0</td>
<td>Rape</td>
<td>&gt;60min</td>
<td>Rape</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>32</td>
<td>16</td>
<td>M</td>
<td>0</td>
<td>Assault</td>
<td>&gt;60min</td>
<td>Assault</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>33</td>
<td>18</td>
<td>M</td>
<td>0</td>
<td>Theft</td>
<td>&gt;60min</td>
<td>Assault</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>34</td>
<td>18</td>
<td>M</td>
<td>5</td>
<td>Road traffic accident</td>
<td>&gt;60min</td>
<td>None</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>35</td>
<td>15</td>
<td>M</td>
<td>2</td>
<td>Road traffic accident</td>
<td>&gt;60min</td>
<td>None</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>36</td>
<td>15</td>
<td>M</td>
<td>2</td>
<td>5-10min</td>
<td>Fall when sober</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>37</td>
<td>18</td>
<td>M</td>
<td>1</td>
<td>Fall when sober</td>
<td>&gt;60min</td>
<td>None</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>38</td>
<td>16</td>
<td>M</td>
<td>30-40</td>
<td>Sports injury</td>
<td>&gt;60min</td>
<td>None</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>39</td>
<td>15</td>
<td>M</td>
<td>0</td>
<td>Assault</td>
<td>&gt;60min</td>
<td>None</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>40</td>
<td>16</td>
<td>M</td>
<td>0</td>
<td>Supply (Burglary, ABH)</td>
<td>&gt;60min</td>
<td>None</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>41</td>
<td>17</td>
<td>M</td>
<td>0</td>
<td>Burglary</td>
<td>&gt;60min</td>
<td>None</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>42</td>
<td>15</td>
<td>M</td>
<td>1</td>
<td>Fight</td>
<td>5-10min</td>
<td>Fight</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>43</td>
<td>17</td>
<td>M</td>
<td>10</td>
<td>Fight</td>
<td>5-10min</td>
<td>Fight</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>44</td>
<td>15</td>
<td>M</td>
<td>9</td>
<td>Fight</td>
<td>20-30min</td>
<td>Fight</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>No.</td>
<td>Year</td>
<td>Code</td>
<td>Duration</td>
<td>Non-criminal Activity</td>
<td>Possession</td>
<td>Code</td>
<td>Duration</td>
<td>Non-criminal Activity</td>
<td>Possession</td>
</tr>
<tr>
<td>-----</td>
<td>------</td>
<td>------</td>
<td>----------</td>
<td>-----------------------</td>
<td>------------</td>
<td>------</td>
<td>----------</td>
<td>-----------------------</td>
<td>------------</td>
</tr>
<tr>
<td>45</td>
<td>16</td>
<td>2</td>
<td>16</td>
<td>Up to 5min</td>
<td>Non-criminal activity</td>
<td>Possession</td>
<td>2</td>
<td>15</td>
<td>No</td>
</tr>
<tr>
<td>46</td>
<td>17</td>
<td>0</td>
<td>N/A</td>
<td>N/A</td>
<td>None</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>47</td>
<td>19</td>
<td>1</td>
<td>3</td>
<td>&gt;60min</td>
<td>No detail available</td>
<td>None</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>48</td>
<td>18</td>
<td>0</td>
<td>N/A</td>
<td>N/A</td>
<td>Assault (harassment)</td>
<td>3</td>
<td>16</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>
### Possible Groupings (n based on current study sample size)

<table>
<thead>
<tr>
<th>Grouping Description</th>
<th>Theoretical Pros and Cons</th>
<th>Statistical Pros and Cons</th>
<th>Ranked suitability of groupings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Split groups by severity category:</strong></td>
<td><strong>Pros:</strong></td>
<td><strong>Cons:</strong></td>
<td>5</td>
</tr>
<tr>
<td>No history (n=15)</td>
<td>- Has good sensitivity to severity of injury, based on previous categories of classification (e.g. CHAT, Shaw et al., 2014 uses mild as &lt;30min, moderate as 30min-60min and severe as &gt;60min)</td>
<td>- Severe TBI elsewhere is defined as LoC&gt;24 hours (e.g. Bodin &amp; Yeates, 2010) or &gt;6hours (Williams et al., 2010)</td>
<td></td>
</tr>
<tr>
<td>Concussions (n=2)</td>
<td>- Takes into account complicated mild injuries which have been shown to affect neuropsychological ability.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild TBI (LoC&lt;10min; n=21)</td>
<td><strong>Cons:</strong></td>
<td><strong>Pros:</strong></td>
<td></td>
</tr>
<tr>
<td>Complicated Mild TBI (LoC 10-30min; n=3)</td>
<td>- Severe TBI elsewhere is defined as LoC&gt;24 hours (e.g. Bodin &amp; Yeates, 2010) or &gt;6hours (Williams et al., 2010)</td>
<td>- Could simply make comparisons between groups</td>
<td>5</td>
</tr>
<tr>
<td>Moderate TBI (LoC 30min-60min; n=1)</td>
<td><strong>Cons:</strong></td>
<td><strong>Pros:</strong></td>
<td></td>
</tr>
<tr>
<td>Severe TBI (LoC &gt; 60min; n=6)</td>
<td>- Takes into account complicated mild injuries which have been shown to affect neuropsychological ability.</td>
<td>- Parametric statistical tests are less robust with unequal sample sizes and non-homogenous variances Unequal groups affects homogeneity of variance</td>
<td></td>
</tr>
<tr>
<td><strong>Split groups by collapsing severity into 2 groups:</strong></td>
<td><strong>Pros:</strong></td>
<td><strong>Cons:</strong></td>
<td>1</td>
</tr>
<tr>
<td>TBI group = &gt;3 mild injuries (LoC&lt;30min) or moderate/severe cases</td>
<td>- Takes into account both severity and frequency of TBI</td>
<td>- Groups with few persons will be very unrepresentative of the population</td>
<td></td>
</tr>
<tr>
<td>(LoC&gt;30min; n=22)</td>
<td>- Although slightly crude, it considers overall ‘dosage’ of TBI</td>
<td>- Power will be low</td>
<td></td>
</tr>
<tr>
<td>NonTBI group = no history or less than 3 mild TBI (LoC&lt;30min; n=26)</td>
<td>- 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 &gt;3 injuries. Furthermore, evidence suggests there is a cumulative effect of TBI (Davies et al., 2012; Collins et al., 2002; Effgen, Gill, &amp; Morrison, 2012; Williams et al., 2010)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cons:</strong></td>
<td>- Dichotomising in this way loses some sensitivity e.g. someone with one LoC of 20min will be classified as non-TBI.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Pros:</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Fairly equal groups parametric tests will be more robust</td>
<td>- 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.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Could simply make comparisons between groups</td>
<td></td>
</tr>
</tbody>
</table>
Split groups according to the Mayo Classification System of severity:

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.

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:  
- 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.
- 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.

Split groups according to Williams et al. (201):

Pros:  
- Allows exploration of no TBI, mild and moderate/severe which spans the severity nicely
- Takes into account ‘complicated mild’ as a category
- 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:  
- 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.

No history & LoC <10min (n=38)  
Complicated mild (LoC 10-30min; n=3)  
Moderate Severe (LoC>30min; n=7)

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.

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

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.
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.

<table>
<thead>
<tr>
<th>Recruitment Site</th>
<th>No of participants booked</th>
<th>No of participants seen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yeovil</td>
<td>23</td>
<td>14</td>
</tr>
<tr>
<td>Dorchester</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Taunton</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Bournemouth &amp; Poole</td>
<td>12</td>
<td>3</td>
</tr>
</tbody>
</table>
Journal of Head Trauma Rehabilitation

Online Submission and Review System

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.

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- 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).
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- References should not be created using Microsoft Word’s automatic footnote/endnote feature.

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   b. Here you will also find specific Digital-Imaging Software Instructions to help support your efforts to create perfect images the first time.
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3. Compare your final figure to the Target Digital-Imaging Results listed later.
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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.