

Measuring levels of self-awareness in pediatric traumatic brain injury

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ABSTRACT

Impaired self-awareness following traumatic brain injury (TBI) in adults has been linked to affective and behavioural disturbances. This study extended the study of self-awareness in TBI to a pediatric population, and attempted to elucidate neuropsychological mechanisms of self-awareness. A neuropsychological model of self-awareness states that higher-order executive processes of self-monitoring and cognitive TD are closely linked to self-awareness, particularly given that all of these processes depend on the integrity of the frontal lobes. Some researchers have therefore suggested that metacognitive and Theory of Mind (ToM) measurements might be effective indicators of self-awareness. The hypothesis of this study, therefore, was that low scores on neuropsychological measures of metacognition and ToM would be associated with affective and behavioural disturbances. In a pediatric TBI population, metacognition was measured using the Behavior Rating Inventory of Executive Function (BRIEF) and ToM was assessed using NEPSY II subtests. Social behaviour and affect were assessed using the Child Behavior Check List (CBCL). Results showed that social behaviour and affect were highly correlated with each other and with metacognitive abilities, but not with ToM abilities. Thus, metacognitive abilities may be an effective indicator of self-awareness.

Key Words: pediatric TBI; self-awareness; awareness of deficits; behaviour; affect; metacognition; Theory of Mind.

This study broadly aimed to establish the relationship between self-awareness, metacognition, and theory of mind (ToM). These relationships will, in turn indicate whether neuropsychological measures of metacognition and ToM could be effective indicators of self-awareness.

The study was motivated by three main factors: (1) The high prevalence of TBI in South Africa. Although exact figures are not available, high levels of violence and motor vehicle accidents involving children suggest that a large number of South African children annually sustain TBI (Levin, 2004). (2) Self-awareness is an important factor in successful recovery from TBI (Jacobs, 1993). Before any rehabilitation program can be implemented effectively, patients should be aware of the fact that they are actually in need of and would benefit from the program. This awareness increases the patient's motivation and renders him more willing to fully participate in the program. (3) The limited data existing on the topic of self-awareness in children with TBI. Only a few studies (e.g., Beardmore, Tate, & Liddle, 1999; Hatten, Bartha, & Levin, 2000; Jacobs, 1993) dealing with this specific topic have been conducted, and none were conducted in South Africa. Furthermore the relationship between self-awareness, metacognition, and ToM has been suggested. No previous research has specifically investigated the exact nature of their interaction. Finally there are no effective measures of self-awareness in children.

This study will thus aim to contribute to South African literature on pediatric TBI with the hope of aiding children and families who have been affected by pediatric TBI. The proposed study is part of a larger study that will be implementing and evaluating the effectiveness of a neuropsychological rehabilitation service for children. Results obtained from this study concerning self-awareness will be further explored and used to establish what effect different levels of self-awareness has on rehabilitation.

DEFINING CONCEPTS

Before making any hypotheses or predictions about possible links and causal relationships between self-awareness, metacognition and ToM it is necessary to clarify what exactly we mean when referring to these concepts. Due to the complex nature of these concepts, it is difficult (if not impossible) to find universally accepted definitions for them. Such definitions are nonetheless necessary in order to obtain concise theoretical and empirical knowledge of these

concepts. Terms that are slack, imprecise and ambiguous are confusing and lead to unclear objectives for research and eventually to flawed research findings (Markova & Berrios, 2000).

Self-awareness

Self-awareness will be defined as the capacity to focus attention to oneself and thus to self-evaluate (Silvia & O'Brien, 2004). Traumatic brain injury (TBI) patients particularly struggle to appreciate the deficits that were caused by their accident and the effect these have on their daily functioning (Roberts, Rafal, & Coetzer, 2006). Self-awareness deficits have been reported as occurring in between 45% and 97% of all TBI patients (Sherer, Bergloff, Levin, Oden & Nick, 1998). These deficits in self-awareness are manifested by observable physical/motor problems, subjective cognitive deficits (e.g., poor memory) as well as behavioral disturbances (e.g., apathy, lack of inhibition, and inappropriate social behaviour; Flemming & Strong, 1999). Levels of self-awareness can, however, improve as the recovery time proceeds, especially in the first 6 months after the injury (Flemming & Strong, 1999).

Traumatic Brain Injury

TBI can be divided into two major categories: closed head injuries and open or penetrating head injuries. Because my research involved children who have sustained closed head injuries, this type of injury will be the primary focus of this section.

Closed head injuries (CHI) do not result in the exposure of the contents of the skull. This type of injury is primarily caused by blunt impact. The impact is caused by either rapid acceleration of the head following a physical blow from a relatively blunt object, or by rapid deceleration of the head as a result of contact with a blunt and relatively immovable object, or surface (Richardson, 2000). CHIs are likely to produce disturbances of consciousness and diffuse cerebral damage. More specifically, diffuse axonal injury is the most common form of brain damage caused by shearing forces which decrease in magnitude from the surface of the brain to the centre. The severity of the diffuse axonal injury is also the most important factor in predicting outcome following CHI (Richardson, 2000). Secondary brain damage refers to subsequent complications that follow the initial impact damage (cerebral contusions and diffuse axonal injury). Intracranial haematomas, brain swelling, raised intracranial pressure, ischaemic brain damage and post-

traumatic epilepsy are some of the more common forms of secondary brain damage (Richardson, 2000).

Although exact figures are not available, high levels of violence and motor vehicle accidents involving children suggest that a large number of children annually sustain TBI in South Africa (Levin, 2004). TBI affects physical, emotional, cognitive, and social functioning (Gainotti, 1993; Grieve, 2002; Hillier & Metzger, 1997). Useful information on the common symptoms of pediatric TBI were reported in a study involving 681 primary caregivers of pediatric TBI patients at 1, 4, and 10 months post-injury. The majority of the children were experiencing persistent symptoms at least until the 10-month follow-up. These symptoms included: headaches, impaired attention and memory, low frustration tolerance, sleep disturbances, personality changes and difficulties with school adaptation (Hooper et al., 2004).

Alteration in self-awareness is another common consequence of TBI. Children who have experienced a head injury frequently struggle to comprehend and recognize their own disabilities; this impaired self-awareness has negative effects on the child's social, emotional, educational and family life (Jacobs, 1993).

Impaired self-awareness

Impaired awareness of deficit has received much attention from both the brain injury and neurorehabilitation literature. This level of attention is understandable when considering the significant effect impaired awareness of deficit can have on post-injury recovery. Impaired awareness leads, for example to decreased levels of motivation as well as lower levels of engagement in the rehabilitation process (Roberts et al., 2006).

The exact relationship between impaired self-awareness and emotional distress has not been established. Some researchers suggest that impaired self-awareness results in the onset of depressed mood (Evans, Sherer, Nick, Nakase-Thompson, & Yablom, 2003; Flemming, Connol, Tooth, & Strong, 2002; Ownsworth & Oei, 1998). Patients who cannot appreciate their deficits tend to set unrealistic goals which are based on their abilities before the accident. Consequently

failure to reach goals, may in turn lead to feelings of frustration, aggression, and depression (Roberts et al., 2006).

There is, however, another school of thought that propagates the idea that lack of self-awareness is a coping mechanism and that the *return* of awareness leads to increased levels of emotional dysfunction (Gainotti, 1993; Gasquoine, 1992; Wallace & Bogner, 2000). This latter theoretical framework holds that emotional distress is a consequence of increased awareness that develops as the person begins to recognize their limitations and deficits following their accident (Gainotti, 1993). Most existing literature and research seem to support the first of these two positions, however (Roberts et al., 2006).

People with high levels of self-awareness will try to align their behaviour with their moral standards and value system (Silvia & O'Brien, 2004). Low levels of self-awareness, in turn, negatively affect behaviour – especially social behaviour (Stuss & Anderson, 2004). Self-awareness enables self-control, which underlies the ability to act and react in socially acceptable ways. Self-control is the ability by which individuals monitor their current behaviour to ensure that it is consistent with (1) social norms, (2) how they want to react, and (3) how other people expect them to behave. Self-control results in the generation of social emotions that are associated with the rectifying of social mistakes (Beer, John, Scabini, & Knight, 2006). People avoid making social blunders because particular physiological sensations guide them away from inappropriate behaviour and towards adaptive behaviour (Beer et al., 2006). Deficient levels of self-awareness thus lead to a lack of emotionally-based physiological sensations, which in turn result in inappropriate behaviour. Further, it has been suggested that individuals with frontal lobe damage often know what socially acceptable behaviour is, but struggle to connect this knowledge to their own behaviour (Beer et al., 2006).

Because my research focuses on children, self-awareness in young children is an area of specific interest. Children become aware of themselves as differentiated and unique entities in the world around them by the age of 18 months (Smith, Cowie, & Blades, 1998). This process develops gradually during the preschool period as the child moves from preconceptual to objective thought patterns. Elaboration of self-awareness continues throughout childhood development,

and perhaps throughout the entire lifespan (Smart & Smart, 1972). The years between 6 and 14 are particularly critical for development of the child's sense of identity. This period of development poses various psychological challenges that lead to further development of self-awareness, social comparison and self-esteem (Eccles, 1999). It thus seems that although the concept of self-awareness is still developing, it is definitely a trait that is present in young children.

Self-awareness implies a metacognitive representation of one's own mental states, beliefs, attitudes, and experiences (Stuss & Levine, 2002). This self-reflecting ability is also the basis for understanding the relationship between external events and one's own thoughts, as well as the mental states of others (i.e., Theory of Mind).

Metacognition

'Cognitions about cognitions' or 'thinking about one's own thinking' broadly define metacognition (Georghiades, 2004). Metacognition is multifaceted and can be divided into at least three main components: monitoring, knowledge, and control (Georghiades, 2004; Hatten, Bartha, & Levin, 2004). Metacognitive monitoring entails awareness and evaluation of current cognitive processes (Hatten et al., 2004). Metacognitive knowledge consists of the gradual process of gathering information regarding cognitive processes. Metacognitive control refers to the self-regulation and self-control of these processes (Otani & Widner, 2005).

Metacognition is necessary for the functioning of various forms of oral and linguistic communication and comprehension, memory, attention, problem-solving, social cognition and various levels of self-control and social instruction (Flavell, 1979). Metacognition allows the individual to recognize, evaluate and reconstruct existing ideas. It also involves hypothesis testing and evaluation (Georghiades, 2004). Although a large variety of definitions and understandings of metacognition followed John Flavell's (1979) initial introduction of the term, all these acknowledge the close relationship and dependence of metacognition on cognitive functions.

Literature regarding the question of whether children from birth to primary school age can experience metacognition is not unequivocal, although there are currently two dominant views (Brown & DeLoache 1978; Lipman, 1982, 1985). The first view is built on Piaget's theory, according to which formal operational thought is a prerequisite for reflection and thus also of metacognition. This function is believed to develop later in life. Metacognition is thus not something that can be attributed to young children (Georghiades, 2004). On the other hand, Flavell (1979, 1985) suggested that the ability to understand and react to metacognitive experiences is present in children, but will increase as they get older and gain "thinking" experience. He concluded that although children have some form of metacognition, it is limited. The latter view is accepted by the majority of current researchers and suggests that the difficulty does not surround children's ability to experience metacognition, but rather lies in finding effective methods that will help children to interpret and express their experiences (Garner, & Alexander, 1989). The large amount of research underway and the increasing interest in children's metacognition obviously supports this view (Amsterlaw, 2006; Cross, & Paris, 1988; Georghiades, 2004; Sperling, Howard, Miller, & Murphy, 2001).

Theory of Mind

The ability to predict mental state in others is essentially what Theory of Mind (ToM) entails. ToM is an umbrella term that covers various complex cognitive abilities (Griffin, Friedman, Ween, Winner, Happe, & Brownell, 2006). These abilities develop in increasingly complex and higher-level stages. The simplest of these stages is known as first-order ToM: the ability to ascribe feelings to other people (Bach, Happe, Fleminger, & Powell, 2000). The ability to infer a person's thoughts about another person's thoughts regarding an objective event is known as second-order ToM (belief about belief; Baron-Cohen, 1989). Faux Pas is the most sophisticated form of ToM. It involves the representation of two mental states and involves both cognitive and affective components (e.g., understanding that someone was not supposed to say something as well as understanding that the person hearing it might feel upset; Stone, Baron-Cohen, & Knight, 1998).

Although current literature provides no clarity regarding the cognitive mechanisms underlying ToM, the notion of chronological development does receive support from various sources (Bach

et al., 2000). The graded emergence of ToM is one such source. Evidence of joint attention arises when infants are around 18 months of age. Understanding (which does not necessarily include belief) of desire becomes evident at 2 years. The ability to understand false belief only emerges around the age of 4 years. Second-order ToM is usually acquired around the age of 7 years (Baron-Cohen, 1989). It is only when children reach the ages between 9 and 11 years that they become able to pass Faux Pas task. Boys generally tend to lag behind girls when it comes to the development of ToM ability (Stone et al., 1998).

NEUROANATOMIC SUBSTRATE OF SELF-AWARENESS

Increasing amounts of research have sought to establish exactly how the brain manages to form and maintain a sense of self (Zimmer, 2005). Executive models of self-awareness have been particularly helpful in clarifying the neuroanatomic substrates of self-awareness. Executive functions are general-purpose mechanisms of control that regulate the various dynamics involved in human cognition, including metacognition and ToM. This regulation occurs via modulation of the operation of the various cognitive sub-processes involved in human cognition (Miyake, Friedman, Emerson, Witzki, & Howerter, 2000).

Disruptions of higher-order executive processes of self-monitoring and self-control are the main focus of these executive models (Schacter, 1990; Stuss & Levine, 2002). Most of these models are linked to the integrity of the frontal lobes, particularly the prefrontal cortex (PFC). This integrity is disturbed following severe TBI, which is often associated PFC damage (Savage, Depompei, Tyler, & Lash, 2005). Executive models therefore advocate the involvement of the frontal lobe in self-awareness, metacognition, and ToM (Bach & David, 2006).

Solid evidence supporting the role of the frontal lobes in self-awareness derives from research on healthy subjects, which has shown that various cerebral areas are involved with introspective processes (Sherer, Hart, Whyte, Nick, & Yablon, 2005). These findings imply that no specific brain region is solely responsible for creating people's subjective sense of themselves. It has been theorized, however, that one specific brain region might be responsible for combining, in a meaningful way, all of the various perceptions and memories that originate in various areas of

the brain. This specific brain region, the medial prefrontal cortex, is therefore critical in creating a unitary feeling of who we are – a sense of self (Zimmer, 2005).

The medial prefrontal cortex also plays a role in ToM. Our sense of self, or how we think about ourselves, overlaps with how we think about others. Researchers have found that the brain regions activated when performing ToM tasks, including the medial prefrontal cortex, are similar to those activated when thinking about oneself (Zimmer, 2005).

Frontal lobe structures also play a role in metacognition. Research findings support the preeminent role of the right frontal lobe for self-reflective memory processes (Stuss & Levine, 2002). Auto-noetic (self-knowing) processes, which involve mental models and self-reflectiveness (and which underlie self-awareness), also depend on the integrity of the right frontal lobe (Tulving, 1985).

Finally, a close relationship between self-awareness, affect, and social behaviour is also supported by the role of the frontal lobes in human emotional and social behaviour and the integration of subjective experience (Stuss & Levine, 2002).

ToM AND METACOGNITIVE ABILITIES AS MEASURES OF SELF-AWARENESS

The exact nature of the relationship between self-awareness, behavior, affect, metacognition and ToM is not clear. The only study that has investigated this relationship (Bach & David, 2006) provided useful knowledge in my area of specific interest. These authors postulated that appropriate social behaviour is dependent on and predicted by the ability to comprehend other's thoughts, desires and intentions - ToM. The role of cognitive mechanisms that are sensitive to frontal damage was also investigated by that study.

The results of Bach and David's (2006) study indicated that patients with behavioral and personality problems consistently (in 80% of the cases) and significantly overestimated their level of psychosocial functioning competency and their ability to understand others' thoughts and feelings. Behavioral and emotional disturbances may thus be good indicators of low levels of self-awareness. They also found that poor mentalising abilities on ToM tasks were good

indicators of the overestimation of both general and social/mentalising competencies of individuals. Although the role of mentalising ability requires further investigation and remains somewhat unclear, this study suggests a definite role for ToM and metacognitive processing in self-awareness.

Building on the results of Bach and David's (2006) study and combining their findings with the knowledge that similar neuroanatomical substrates are involved in the processes of self-awareness, ToM, and metacognition, this study will assume that ToM and metacognitive neuropsychological measures will be good indicators of an individual's level of self-awareness.

SPECIFIC AIMS AND HYPOTHESIS

Impaired self-awareness following TBI in adults has been linked to affective and behavioural disturbances. This study aims to extend the study of self-awareness in TBI to a pediatric population, and attempts to elucidate neuropsychological mechanisms of self-awareness. The executive model of self-awareness states that higher-order executive processes of self-monitoring and cognitive control are closely linked to self-awareness, particularly given that all of these processes depend on the integrity of the prefrontal cortex. Some researchers have therefore suggested that metacognitive and Theory of Mind (ToM) measurements might be effective indicators of self-awareness. The overall hypothesis of this study, therefore, was that low scores on neuropsychological measures of metacognition and ToM will be associated with affective and behavioural disturbances, particularly in a pediatric TBI population.

DESIGN AND METHODS

Research Design

The study was an empirical cross-sectional study that used primary data that was collected using standardized tests. The study used two research groups – a pediatric TBI (pTBI) group and a matched typically developing group (TD).

Participants

The pTBI group consisted of 9 children, aged 7 to 10 years, with mild to moderate TBI and who were at least 1 year post-injury at the time of testing. Eight of the children in the TBI group had

mild TBI, while only one participant had sustained moderate TBI. The TD group consisted of 9 healthy children who matched the experimental group in terms of socioeconomic status (SES), language, education level, age range and sex, as far as this was possible. Table 1 shows the demographic characteristics of the groups.

Both groups were comprised of children who could fluently speak English. It was accepted that participants of both groups had low SES. It was presumed that those included in the pTBI group were from low SES backgrounds as most children admitted to RXH come from disadvantaged backgrounds. The TD group's SES was derived from the school the children in this group attended, which is classified as a government school. The area where the school is located is also generally seen as a poor community. This controlled for the effect that education and SES might have had on levels of self-awareness and on the test results. Children who had pre-morbid neurological, developmental, or psychiatric disorders (e.g., previous TBI, autism, schizophrenia) that might affect levels of self-awareness were excluded from the study (Fenwick & Anderson, 1999).

The pTBI group: Patients matching the abovementioned inclusion criteria were identified before the study began. This information was obtained by investigating RXH records and consultation with the attending medical team. After the most suitable children were identified, the parents or guardians were contacted and briefly informed about the study. The parents'/guardians' interested in having their child participate in the study were given a detailed verbal account of the study and appointments for testing the child were also scheduled telephonically. The tests and interviews that were administered to the children and their legal guardian in the experimental group required them to travel to the hospital and back. Participants were thus compensated for the total amount of their traveling costs.

The TD group: As the participants in the patient group were recruited, matched TDs were sought. Both the school and the parents of the children who were suitable for the research were informed about the procedure of the study. The appropriate consent forms were completed by the parents. The dates on which the tests were conducting was communicated to both the school and the parents.

All the procedures used in the study were approved by the Ethics Committees of both the UCT Department of Psychology's and the UCT Faculty of Health Sciences.

Measures

Behavior and affect: The Child Behavior Check List (CBCL; Achenbach, 2001) is a questionnaire that provides information regarding the child's competencies and behavioral/emotional problems. It is designed to be answered by parents, other close relatives or guardians of the child. This test is suitable for children between the ages of 6 and 18 years.

The CBCL takes 15 minutes to complete. It consists of 118 items describing specific emotional or behavioral problems and two additional open-ended items in which any specific problems not addressed in the questionnaire can be mentioned. Each item names a particular behavior and demands one of three possible responses – *very often true, somewhat or sometimes true, or never true*. Three major behavior scales are produced by the questionnaire: (1) Internalizing scales – measure depression/withdrawal, anxiety and other somaticizing behaviors; (2) Externalizing scales – determine the presence of cruel, aggressive, or delinquent behaviors; (3) Mixed scales – pick up on any other problem behaviors like immaturity or hyperactivity (Achenbach & Rescorla, 2001). In the current study the internalizing scale was used to determine levels of affect, while the externalizing scale measured behaviour. This test has been successfully implemented in a South African research study (Loffell, 2000)

The CBCL is a reliable and widely used instrument with established psychometric properties. Mean test-retest reliabilities have been reported to range from 0.78 to 0.97. The content validity of the CBCL has been supported by four decades of research, consultation, feedback, and revision, as well as findings that all items discriminated significantly ($p < 0.01$) between demographically matched referred and non-referred children (Achenbach & Rescorla, 2001).

Metacognition: Assessment of metacognition was done by using the Behavior Rating Inventory of Executive Functions (BRIEF; Malloy & Grace, 2005). This test is useful in evaluating children ages 5 to 18 years with TBI. It consists of parent and teacher questionnaires, and gives insight into the child's executive functions at school and at home. These questionnaires take between 10 and 15 minutes to complete. Each questionnaire contains 86 items in eight non-

overlapping clinical scales and two validity scales, which together form two broader indexes: Behavioral Regulation (3 scales) and Metacognition (5 scales). The Metacognition Index measures the child's ability to sustain future-oriented problem-solving in their working memory. It also measures the child's ability to initiate, plan, and organize behaviour. This index portrays the child's ability to cognitively self-manage tasks and gives a good indication of children's ability to monitor his/her own behaviour. High scores indicate greater degrees of dysfunction.

High internal consistency and test-retest reliability of the BRIEF has been reported. Validity of the BRIEF has also been reported (Malloy & Grace, 2005). No knowledge of previous use in South Africa was obtained.

Theory of Mind: The Social Perception subset of the NEPSY II (Korkman, Kirk & Kemp, 2007), which assessed children's ability to understand mental functions such as belief, intention, deception, emotion, imagination, and pretending. The subtest was designed to assess whether children have the ability to understand that other people have thoughts, ideas, and feelings that are different/separate from their own. The Verbal sub-task of this test requires that the child answers questions based on picture or stories. To answer these correctly children need to have knowledge of the fact that different people may perceive similar situations differently. The Contextual sub-task is comprised of pictures that assess the child's ability to understand the relationship between social context and emotion, as well as the ability to identify appropriate feelings in different social contexts. Low scores on this scale indicate poor comprehension of other's perspectives, experiences, and beliefs.

Procedure

The pTBI group: These participants were tested at the Red Cross War Memorial Children's Hospital (RXH). Parents/guardians were asked to complete the informed consent form and the child was requested to complete the assent form. The measures and tests that required input of the parents/guardians (viz., the CBCL and BRIEF) were given to them and they were required to complete these measures while the Theory of Mind section of the NEPSY was administered to the child.

The TD group: After the child completed the assent form the ToM section of the NEPSY was administered to the child at a government school in the Western Cape. The measures and tests that required input of the parents/guardians (viz., the CBCL and BRIEF) was given to the child to take home. The parents/guardians were required to complete these and return it to their child's teacher. The forms were subsequently collected from the teachers.

Data Analysis

The BRIEF was scored manually. Individual raw scores for the Metacognition Index were obtained and subsequently transferred to *T* scores.

The CBCL was scored electronically. Individual raw scores were transferred to *T* scores. The *T* scores of the Internalizing and Externalizing scales were used for further statistical analysis.

The NEPSY II only provides percentile ranks and raw scores for the ToM scale. As statistical analyses cannot be done with percentile ranks, the raw scores were used. Scores range from 0 to 28, with lower scores indicating more impaired ToM ability. Some data for the ToM measure was missing because of difficulties experienced with administration of the NEPSY II Social Perception subtest. Due to the missing data for two participants from the experimental group and one participant from the TD group, the data of these specific participants were excluded from subsequent statistical analyses.

All statistical significance decisions were based on an alpha level of 0.05.

RESULTS

Between-group comparisons: Descriptive statistics were obtained for both the pTBI and TD groups (see Table 2). Visual comparison of the two groups suggests that the TBI children performed worse on all the measures used in the study (see Figure 1; as mentioned before, high scores on the metacognition scale of the BRIEF indicate greater degrees of dysfunction). It is interesting to note that although the participants in pTBI group performed worse than those in the TD group, the former group's mean *T* score was not in the clinical range (i.e., ≥ 65). The pTBI

also performed worse than the TD group on the ToM measure and on both the CBCL Internalizing and Externalizing scales.

A one-way ANOVA is a possible way to establish whether these differences were statistically significant. Levene's test was not significant for any of the results of the measurements (Metacognition: $p = 0.99$; Affect: $p = 0.53$; Social behaviour: $p = 0.39$; ToM: $p = 0.49$), indicating that the variances are homogeneous. The probability plots of these results indicate normal distribution. Independence of observation was also attained as the two groups were comprised of different individuals. Seeing as all the assumptions were upheld, one-way ANOVAs were conducted on the results of the various measures. Between-group differences were generally not statistically significant (see Table 2). It was only on the ToM measure that the results indicated a significant difference, $F(1, 13) = 8.35, p = 0.01$. It thus seems that pediatric TBI leads to statistically significant levels of impairment in ToM abilities.

The adjusted R^2 , which is the equivalent to eta-squared, indicated that 9.5% of the variance in metacognition scores, 7.6% of the variance in the affective and social behaviour scores, and 34.4% of the variance in the ToM scores can be explained in terms of the effect of the group of the participant.

The participants' range of scores on the CBCL Internalizing and Externalizing scales indexes are shown in Table 3. These results are also visually represented in Figures 2 and 3. A chi-square test of contingency for scores on the CBCL Internalizing scale produced significant results, $\chi^2(1, N = 18) = 0.90, p = 0.34$. This result suggests that the number of scores in the clinical range for the Internalizing problems did depend on the group of the participant. In contrast, a similar chi-square test of contingency for scores on the CBCL Externalizing scale produced insignificant results, $\chi^2(1, N = 18) = 5.84, p = 0.02$, indicating that the number of scores in the clinical range for the Externalizing problems did not depend on the group of the participant. It is, however, clear that there were consistently more pTBI than TD participants in the clinical range. The TD group, however, had a surprisingly high number of participants in the clinical range for Internalizing problems.

Inter-correlation of scores: Scores of the CBCL Internalizing and Externalizing scales, BRIEF Metacognitive Index, and NEPSY II ToM subtest were correlated to determine whether there is any significant relationship between them (see Table 4). Separate correlation matrixes for the two groups presented no significant results. The presented correlation matrix thus includes the combined data from the pTBI and TD participants. It is argued that if there is any relationship between these characteristics, this will be evident in both healthy children as well as children who have sustained a TBI. This decision also increased the statistical power of the analysis.

Results suggest that affect (as measured by the CBCL Internalizing scale) and social behaviour (as measured by the CBCL Externalizing Scale) are significantly correlated. Additionally, a weak and insignificant correlation was found between the NEPSY II ToM subtest and the BRIEF Metacognitive Index. ToM scores were not significantly correlated with either affect or behaviour. Metacognition, on the other hand, showed significant correlations with both affect and behaviour.

DISCUSSION

The results obtained from this study showed that there are no significant differences in metacognitive, ToM, behavioural, and affective capabilities between normal, uninjured children and children who have sustained mild TBI. Results from the correlation matrix supported only parts of the original hypotheses. The statistical analyses indicated and supported the notion that metacognition might be an effective measure of self-awareness. On the other hand the relationship of ToM to metacognition, ToM to behaviour, as well as ToM to affect, did not support the hypothesis that ToM might be a good indicator of self-awareness. The various results are discussed in more detail below.

The pTBI vs. TD group's performance scores: Statistical analysis of the data clearly indicated that children who have been affected by TBI do not perform significantly worse than the TD group in areas of behaviour, affect, metacognition, or ToM. These findings support the literature on the effects of mild pediatric TBI (Hooper et al., 2004; Savage et al., 2005). The fact that most participants in the pTBI group sustained only mild injuries, and at the time of testing were at least 1 year post-injury, is a likely explanation of the results of this research. Although mild

pediatric TBI is symptomatic during the first 1-3 months following injury, it is generally accepted that most of these children show very good long-term neurobehavioural recovery. On the other hand, long-term cognitive and psychosocial sequelae are much more likely following more severe head injuries (Donders, 2007).

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An interesting result was obtained when comparing the scores of the CBCL Internalizing and Externalizing scales of the two groups. Although the participants in the pTBI group consistently performed weaker than the participants in the TD group, the participants in the TD group had a particularly large amount of participants who performed in the clinical range for Internalizing problems.

Relationships between behaviour, affect, Metacognition & ToM: The close relationship between social behaviour and affect observed in this study seems to be in agreement with current literature. It has been postulated that deficient knowledge of emotional systems account for impaired social behaviour (Beer et al., 2006). People who have been affected by TBI struggle to interpret their own emotions (which also points to a lack of self-awareness) which results in them having difficulties making decisions in interpersonal contexts. This relationship has been explained in terms of the effect that awareness of social norms has on emotions and how these

emotions subsequently affect an individual's physiological system. People who are aware of social standards would immediately experience emotional responses like embarrassment or regret. These emotions will, in turn, if the person is aware of their own emotions, have a physiological effect on the individual. These physiological changes will then guide the individual toward socially adaptive behaviour and away from socially maladaptive behaviour (Beer et al., 2006; Stuss & Anderson, 2004).

The results obtained from the correlation matrix, particularly concerning the relationships between ToM and metacognition, ToM and behaviour, as well as ToM and affect were contrary to what was expected. ToM and metacognition showed a very weak correlation. ToM scores were also not significantly correlated with either affect or behaviour. These results do not support the predictions made by Bach and David (2007) or by the hypothesis of this study. There are several possible interpretations for these results. One interpretation is that although similar neuroanatomical substrates are involved in both ToM and metacognitive processes, their key processes are housed in separate brain modules or networks. A second, and more likely, possibility is that the NEPSY II, which is a relatively new measure, might not effectively measure the specific aspects of ToM in which we are interested and which correlate with metacognition. (As noted above, ToM is an umbrella term for several different cognitive processes; Baron-Cohen, 1989)

Metacognition, on the other hand, showed significant and positive relationships with affect and behaviour. This result seems to support my hypothesis that metacognition could be an effective indicator of self-awareness. Literature has shown that low levels of self-awareness leads to disturbances in affect and social behaviour (Bach & David, 2007; Beer et al., 2006; Evans et al., 2003; Flemming et al., 2002; Ownsworth & Oei, 1998; Roberts et al., 2006; Stuss & Anderson, 2004). The fact that metacognition is also significantly positively correlated with both of these characteristics indicate that the relationship between metacognition, affect, and social behaviour shows a similar pattern to the relationship between self-awareness and these characteristics.

Limitations and Directions for Future Research

One of the main shortcomings of the research is the limited sample size. Limited opportunity to increase the number of participants in the pTBI group resulted from heavy time constraints, having to rely on a clinical population group, as well as the strict inclusion criteria applied by the study. We were only able to approach the few children who met the inclusion criteria; from that group, only a few agreed to participate. Inference from the data will thus have limited use. Future studies should not only aim to increase the sample size, but also to increase the number of pTBI participants with moderate and severe head injuries.

The fact that the measures were used in a TBI-specific context also created some difficulties. It has been reported that the CBCL has low sensitivity to behavioral disturbances following TBI, and there are suggestions that interview procedures would be more reliable and preferable (Fletcher & Ewing-Cobbs, 1991). Due to time constraints this was unfortunately not a viable option for this project. Future research might include a supplementary interview that can validate the responses obtained from the CBCL.

Multitrait-multimethod (MTMM; Campbell & Fiske, 1959) is a methodological technique by which the validity of research results can be established. MTMM suggests that more than one trait and more than one method should be employed when measuring psychological characteristics. As mentioned before, metacognition, social behaviour, affect, and ToM are multi-faceted constructs. Applying an MTMM approach in this domain of research might therefore not only enable the measurement of the various aspects of these characteristics, but also provide more than one measure of similar aspects of the constructs. This process will make it possible to compare the scores of different measures of the same construct, which will lead to more accurate results. It will also provide a broader representation and thus a better understanding of metacognition, social behaviour, affect, and ToM, and their relationships to self-awareness.

The reliability of self-report measures such as parent questionnaires and behavior checklists have been questioned. This is largely because these measures depend on the parents' subjective judgment, which might lead to data that is imprecise, exaggerated or underrated. Parents'

sensitivity surrounding their child's injury might lead them to ignore other factors that might contribute to the child's difficulties (Ward, Shum, Dick, Mckinlay, & Baker-Tweney, 2004). Once again, MTMM might be an effective way to overcome this difficulty in future research.

Measurements of self-awareness in children are very scarce. The only test we found is the Knowledge Interview for Children (KIC; Beardmore et al., 1999). The KIC is based on a checklist used by Nockelby and Deaton (1987) that has been adapted for use in pediatric TBI studies. This test claims to measure self-awareness in pediatric TBI populations using discrepancy scores (see Appendix for KIC test items). No knowledge on the validity and reliability of the KIC items and scoring system has been found. Other researchers, apart from the creators of the test, have not used this test. Initially the KIC was part of the battery of this study, but we found that it did not produce satisfactory data. Many items require the child to provide subjective information ("Do you know what a coma is?", "Where is the brain?", "What does the brain do?"). The parents we tested simply agreed with their children's responses on most of the questions of the KIC, which led to very high self-awareness scores for most of the participants. This might explain why the test is not widely recognized and used in the field of pediatric TBI.

This lack of effective measures of self-awareness in pediatric populations highlights a serious gap in the literature. The Patient Competency Rating Scale (PCRS; Prigatano & Fordyce, 1986) has proved to be a particularly helpful measure in adult TBI populations. The PCRS produces particularly useful discrepancy scores and studies employing this instrument indicate that TBI patients often overrate their own abilities of social and emotional competencies. It would be very useful if future researchers adapted the PCRS for use in a pediatric population.

As mentioned above, my study is part of a larger study that will test the implementation of a neuropsychological rehabilitation service for children. The results obtained from the current study could be built upon to develop an effective measure of self-awareness. Children's self-awareness could then be measured before they enter the proposed neuropsychological rehabilitation program. Once they have completed the program the effectiveness of the rehabilitation for each participant could be established. Subsequently, the effect that different levels of self-awareness have on rehabilitation following TBI could be established.

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Appendix

Knowledge Interview for Children (KIC) Items

A. Knowledge of TBI

Story of the accident

1. Orientation (when the accident occurred)
2. Story of the accident (where it was it, what happened)

Hopitalisation

3. Name of hospital/s
4. Length of time in hospital
5. Knowledge of hospital procedures, or operations

Brain Injury

6. Understanding of term head injury
7. Knowledge of brain functioning
8. Knowledge of what happens to the brain in TBI

Coma

9. Correct discription of coma
10. Duration of coma

Long-term effects of TBI

11. Common problems occuring after TBI
12. Knowledge of personal deficits, difficulties, disabilities

B. Awareness of Deficit Checklist

1. Attention/concentration
2. Fatigue/getting tired
3. Memory
4. Slowness/keeping up with the rest of the class
5. Planning/getting organised
6. Motor/physical: lower limbs (e.g., walking)
7. Motor/physical: upper limbs (e.g., writing)
8. Language (expression)
9. Language (comprehension)
10. Behaviours (e.g., frustrated/angry)

Table 1
Demographic Characteristics of the Participants

	pTBI (n = 9)	PD (n = 9)
Sex		
Males	5	3
Females	4	6
Age		
Range	7-9	7-10
Mean (SD)	8.22 (1.09)	7.88 (1.05)
Education		
Grade 1	1	2
Grade 2	5	1
Grade 3	1	3
Grade 4	2	3

Table 2
Descriptive Statistics for RXH & Silverlea

Variable	pTBI (n = 9)	TD (n = 9)	F	P	Effect Size
BRIEF: Metacognition	60.67 (11.89)	51.11 (10.75)	2.48	0.139	0.095
CBCL					
Internalizing Problems	59.11 (16.24)	56.00 (12.92)	0.01	0.942	0.076
Externalizing Problems	58.77 (13.63)	55.00 (10.51)	0.01	0.942	0.076
NEPSY II: ToM ^a	16.00 (4.28)	21.62 (3.24)	8.35	0.012	0.344

Note. Means are presented with standard deviations in parentheses.

^aValid *n* for the NEPSY II is 7 for the pTBI group and 8 for the TD group.

Table 3

Frequency Table indicating range of scores obtained for both behavioural & emotional difficulties for RXH & Silverlea

Range	<u>Internalizing problems</u>		<u>Externalizing problems</u>	
	TD	pTBI	TD	pTBI
Non -clinical	3	5	3	8
Clinical	6	4	6	1

Table 4
Intercorrelation between all scales for both RXH & Silverlea (N = 15)

Spearman's Rank Order Correlations
 Marked correlations are significant at $p < 0.5$

Scales	Metacognition	Affect	Social Behaviour	ToM
1. Metacognition	-	0.7	0.6	-0.1
2. Affect		-	0.7	0.2
3. Social Behaviour			-	-0.1
4. ToM				-

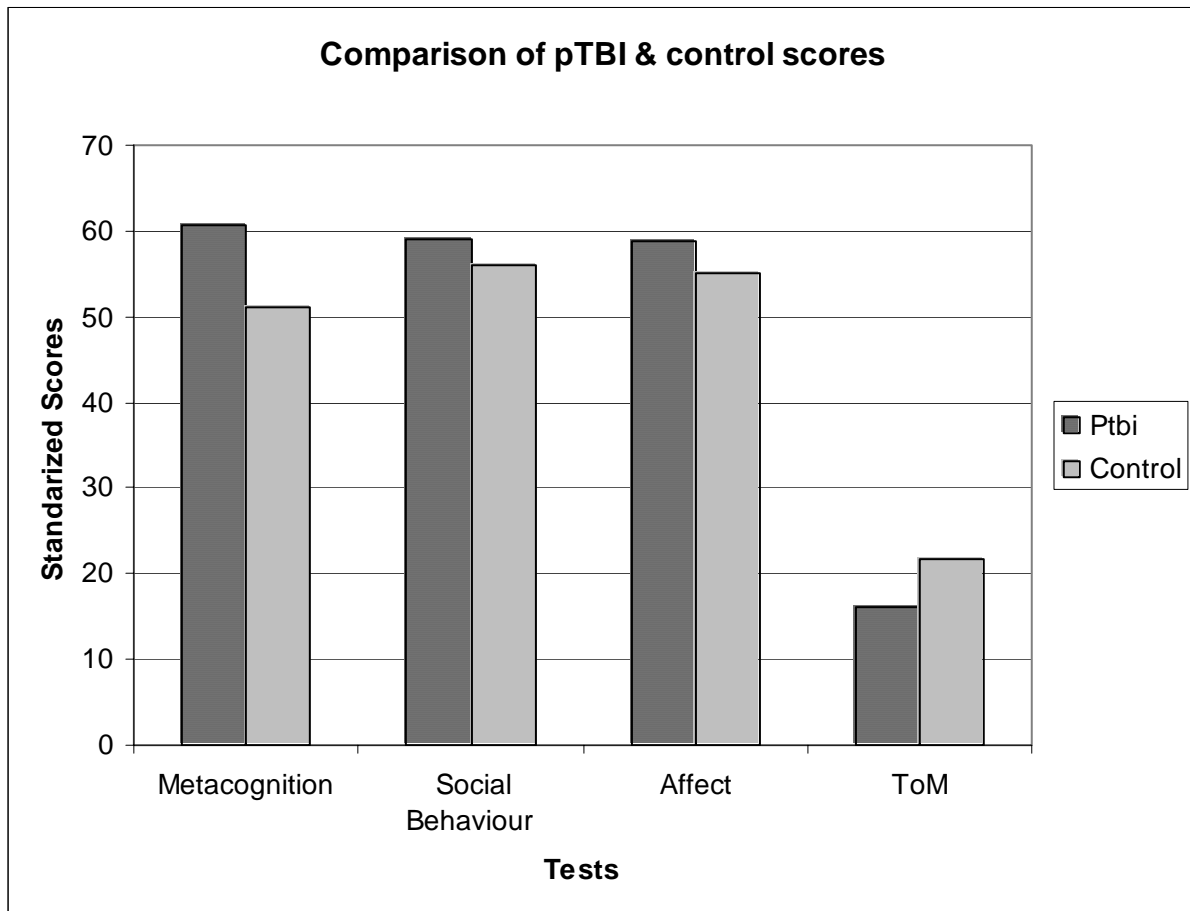
Figure 1. *Between-group comparison of Scores*

Figure 2. *Between-group comparison of CBCL Internalizing Problems Range*

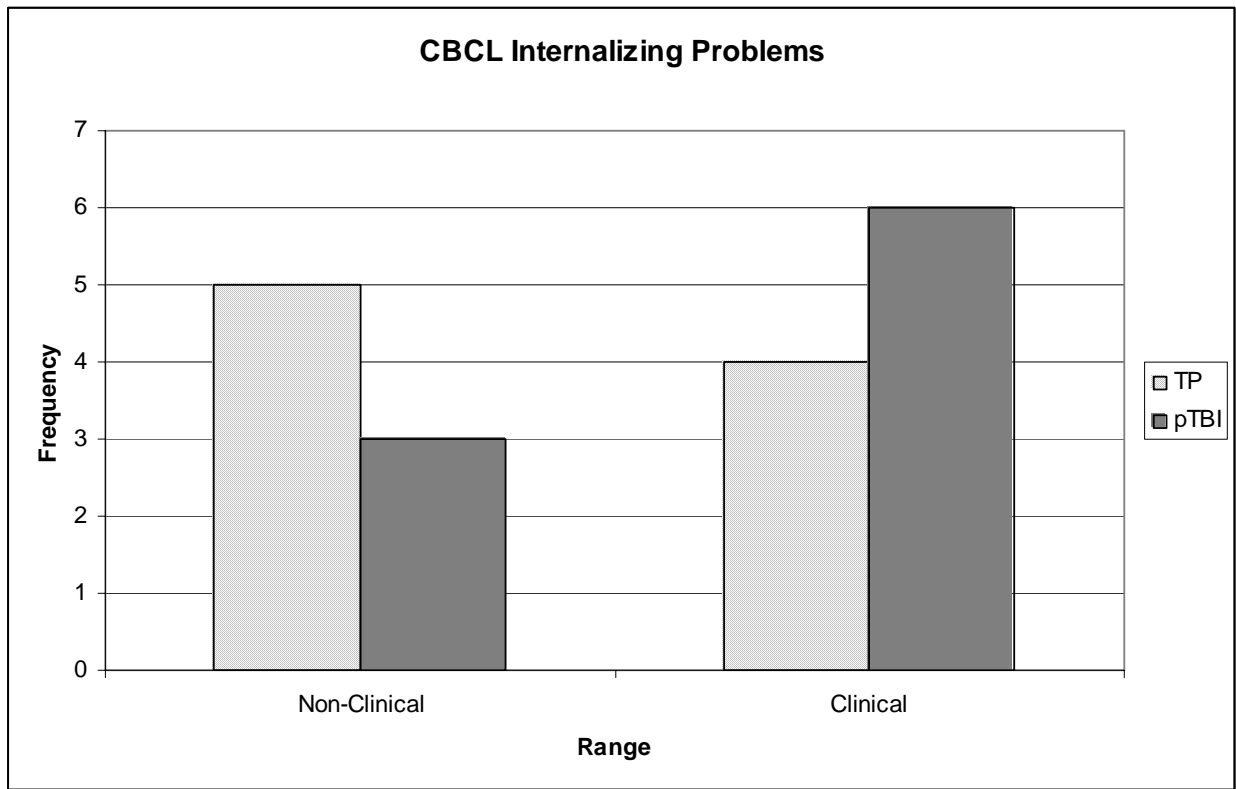


Figure 3. *Between-group comparison of CBCL Externalizing Problems Range*