Rehabilitation of executive functioning following paediatric traumatic brain injury: A Goal Management Training intervention.

Claire Corbett
ACSENT Laboratory
Department of Psychology
University of Cape Town

Supervisors: Leigh Schrieff, M.A.
Kevin G. F. Thomas, Ph.D.

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ABSTRACT

Executive functions, which might be defined as a set of interrelated skills and behavioural competencies necessary for independent, purposeful, goal-directed activity, are commonly impaired following traumatic brain injury (TBI). Literature focused on the rehabilitation of executive dysfunction in paediatric populations is scarce. This study details the adaptation of a Goal Management Training (GMT) intervention to children, which was originally developed for the remediation of executive dysfunction in adults. The intervention is evaluated in three cases of varying severity: a 10-year-old child with mild TBI, a 13-year-old child with moderate TBI, and a 12-year-old child with severe TBI. Neuropsychological tests, reports by parents and teachers, as well as clinical observations, were used to assess the effectiveness of the intervention. Changes in levels of executive functioning were detected by neuropsychological tests and by behavioural observations made during the intervention. These changes were not, however, reported by either parents or teachers, suggesting they might not have manifested in everyday functioning. Moreover, preliminary results suggest that although the GMT programme can be effective in the rehabilitation of executive dysfunction in pediatric TBI, its success relies heavily on school and familial involvement and support. It is thus ideally suited to children from a structured school and family environment.

Keywords: Goal Management Training; executive function; traumatic brain injury; paediatric; rehabilitation; case studies.

This study focused on the rehabilitation of executive dysfunction in children with a traumatic brain injury (TBI). There is a dearth of research focusing on executive dysfunction following TBI, and even less centring on the paediatric population. Although both cognitive and behavioural interventions have been found to be effective for rehabilitation of neuropsychological deficits in the domains of memory and attention in paediatric TBI (pTBI), minimal published research has addressed the rehabilitation of executive dysfunction following pTBI. The Goal Management Training (GMT) programme, a cognitive intervention that focuses specifically on rehabilitating everyday behaviour, has been used with success, in neurorehabilitation programs for executive dysfunction in TBI adults in North America and Europe. It has not, however, been adapted for or evaluated with children. The specific aims of this study were to (a) adapt GMT for South African children with head injuries, and (b) evaluate that adapted GMT programme.

LITERATURE REVIEW

TBI refers to injury of the brain resulting from physical forces placed on the neurons (Bauer & Fritz, 2004). Damage to the brain can result from either penetration of the brain, or from a blow to the head and consequent rapid acceleration or deceleration of the brain (closed head injury).

TBI results in lifelong interrelated deficits in academic, social and emotional functioning (Lord-Maes & Obrzut, 1996). Head injuries were the most frequently reported explanation for admission to hospital for children younger than 13 years of age in South Africa (Cywes et al., 1990).

In terms of neuropsychological performance, typically reported impairments following TBI are in the interdependent domains of attention, memory and executive function (Limond & Leeke, 2005; Verger et al., 2000). Only the domain of executive function will be addressed in this study.

Executive Function

Executive function (EF) is an umbrella term that encompasses a number of interrelated sub-skills and behavioural competencies necessary for independent, purposeful, goal-directed activity (V. Anderson, 1998). These skills and competencies include planning; sequencing; resistance to interference; utilisation of feedback; the ability to co-ordinate simultaneous activity; cognitive flexibility and the ability to deal with novelty (Crawford, 1998).

Several models have been proposed to organize these skills and competencies into sub-groups, and to explain the developmental trajectory of executive functioning. One such model, developed by Peter Anderson (2002), conceptualizes EF as having four components: attentional control; cognitive flexibility; goal-setting and information processing - all of which integrate to enable executive control (Figure 1). The integrity of these functions is important in a child's behaviour, emotional control, social interactions and cognitive functioning (Anderson, 2002).

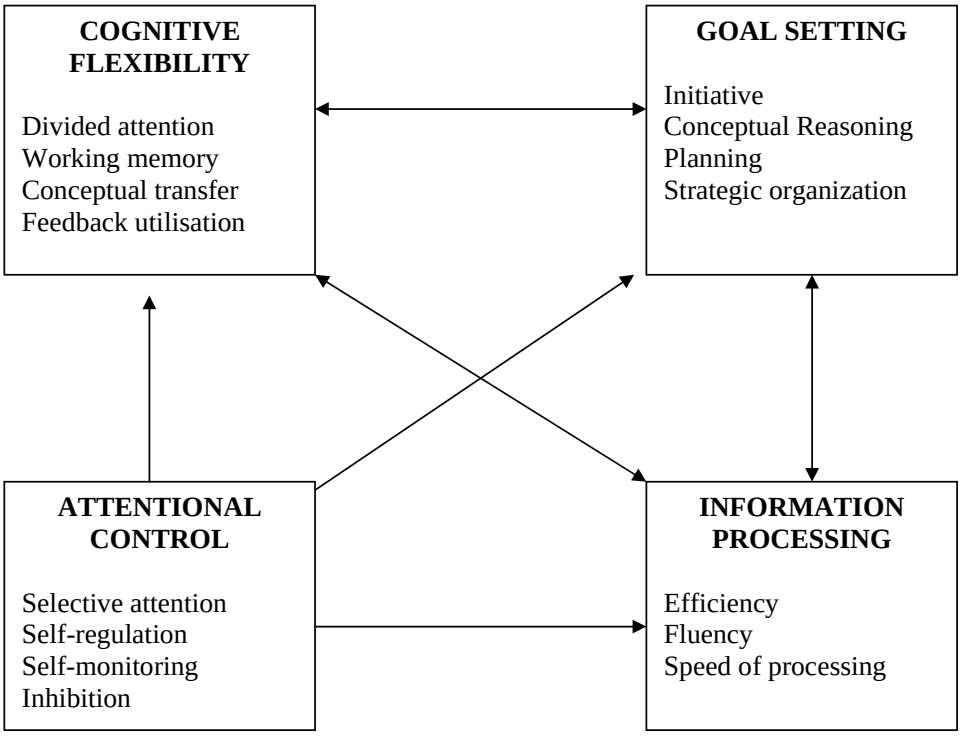

Figure 1. Anderson's (2002) Executive Function Model

As shown, four discrete domains are involved in an integrative manner to enable executive function. Together they can be considered a multi-process, inter-related and overall supervisory system. Attentional control processes influence the functioning of all the other executive domains. The domains of information processing, cognitive flexibility and goal-setting are inter-dependent and receive input from various sources involving an integrated cognitive process.

According to Anderson's EF model, the developmental trajectory of EF proceeds as follows. In the domain of *Attentional Control*, most infants can inhibit certain behaviours and shift to a new response set by 12 months. Instinctive behaviours can be inhibited by 3 years

of age, and improvements in speed of impulse control are seen until 6 years of age. Children can regulate and monitor their actions by 9 years of age.

In the domain of *Information Processing*, response speed and verbal fluency increase significantly between 3 and 5 years, and continue to improve into middle childhood. Processing speed increases dramatically between 9 and 11 years of age. Improvements in generative fluency occur in adolescence but are minimal after 15 years of age.

In the domain of *Cognitive Flexibility*, the ability to switch between simple response sets emerges between 3 and 4 years. The facilities that help to cope with switching between complex multi-dimensional response sets improve considerably between 7 and 9 years. The ability to learn from one's mistakes and subsequently devise alternative strategies emerges in early childhood and continues to develop into middle childhood. Perseveration (continuously making the same mistake) is common in early childhood, declining through middle childhood and rare in adolescence.

In the domain of *Goal-Setting*, the ability to organize simple actions as well as simple conceptual reasoning emerges at 4 years of age. Between 7 and 10 years there is a considerable increase in planning and organizational skills. This increase continues more gradually as the individual progresses into adolescence. Between 12 and 13 years regression from conceptual strategies to piecemeal strategies occurs, suggesting a developmental period of more cautious and conservative strategies.

In summary, attentional control is relatively mature by middle childhood. Cognitive flexibility, information processing and goal setting follow different developmental trajectories but all become relatively mature by the age of 12, although not being fully established until early adulthood.

Damage to the frontal lobes, typical following TBI, may stunt the development of these trajectories in children. The resultant executive dysfunction is shown on neuropsychological tests and in everyday life by perseveration; impulsivity; rigid thought processes; poor planning, reasoning and organization; difficulty generating, implementing and moderating strategies for problem solving and poor utilisation of feedback (P. Anderson, 2002; V. Anderson, 1998; Brenner et al., 2007). Executive dysfunction often incorporates emotional dysregulation such as disruptions in mood, affect, initiative, and energy levels and behavioural disturbances such as aggression and hyperactivity (Anderson, 2002; Kehle, Clarke, & Jenson, 1996). These deficits not only create difficulties in themselves, but affect other cognitive deficits, and treatments aimed at them (Limond & Leeke, 2005).

The neural systems underpinning Anderson's (2002) EF model lie in the prefrontal cortex and are extensively interconnected with numerous other cerebral areas (Crawford, 1998; Anderson, 2002). The pathology underlying executive dysfunction is thus not only associated with damage to the prefrontal cortex, but with network disconnections as well. In short, intact EF relies on the integrity of the entire brain, and developmentally appropriate maturation of function reflects morphologically appropriate maturation of the whole brain.

As many network connections are still forming in children the "Kennard Principle" held the view that children could "bounce back" from brain injury as they are still on the developmental pathway (Verger et al., 2000). Currently, the view holds that children are more vulnerable to head injury than adults. Early injury has cumulative effects on ongoing development resulting in deficits emerging through childhood and adolescence, a phenomenon termed "growing into deficits" (V. Anderson, 1998). As executive functions continue to develop into late adolescence, the impact of earlier brain insults on this domain may not be realized until later - when emerging skills should become functional but do not have the necessary foundations. Thus, although recovery in pre-adolescent individuals often appears to be complete, symptoms may surface only months or years post-injury due to the "latent" effects of TBI on the developing brain (Brenner et al., 2007).

Paediatric Rehabilitation of Executive Dysfunction

Due to cognitive deficits perhaps only becoming apparent years after brain injury, there is a need for monitoring the long-term development of children following TBI. As the abilities of children can vary dramatically at different ages, different rehabilitation strategies may be effective at different developmental stages. Perhaps due to these complexities there is a black hole of literature on the rehabilitation of EF.

Before neuropsychologists implement any rehabilitation strategies, the brain displays its own internally generated mechanisms of recovery. These mechanisms can be grouped into two classes (Catroppa & Anderson, 2006). Restitution mechanisms of recovery refer to the spontaneous physiological recovery that often occurs following damage. Substitution mechanisms on the other hand, refer to restoration by the transfer of cognitive function to healthy sites.[1] At the acute phase of recovery these two mechanisms overlap, but by 6 months post-injury, only the substitution mechanism continues as long as there is learning potential.

With regard to the involvement of neuropsychologists and other clinicians implementing rehabilitation strategies following pTBI, the general consensus in the field appears to be that practitioners should follow one or more of three lines of attack. These are

(a) direct retraining of deficits, (b) utilisation of the child's strengths to compensate for injury-related deficits, and (c) modification of the child's environment (Limond & Leeke, 2005).

The four rehabilitation strategies that have focused on paediatric executive dysfunction are summarized below.

The first involves specific techniques that emphasize an individually tailored behavioural approach to cognitive remediation. Crowley and Miles (1991) reported that the use of this strategy with an adolescent male resulted in improved accomplishment of goals and some generalisation of math skills. The methods used in their case study included charting progress to raise self-awareness and training and practicing of self-executed cues and checking procedures. Not all outcomes were positive: there were non-significant improvements on math test scores and on accuracy of daily homework assignments.

The second involves direct instruction techniques. Glang, Singer, Cooley, and Tish (1992) implemented a programme in an effort to rehabilitate three TBI children between the ages of 6 and 10 years. Their programme included task analysis, modelling and shaping to target reasoning and problem-solving strategies. In addition, practice, corrections and cumulative reviews of skills were incorporated into the intervention to aid problem-solving strategies. Progress was reported in the assessment areas of language, reasoning, mathematics, and reading; this generalized to school function. The use of self-monitoring techniques significantly reduced the aggressive outbursts of one child. In this case, direct instruction rehabilitation techniques applied to pTBI patients yielded improvements in both academic and behavioural domains.

The third is a multi-component programme that integrates self-instruction training, self-regulation training, metacognition training, attribution training and reinforcement; such programmes mirror the rehabilitation strategies used in adult TBI. Suzman, Morris, Morris, and Milan (1997) implemented such a multi-component programme in an effort to rehabilitate 5 TBI children between the ages of 6 and 11 years. The researchers reported large and rapid improvements on trained tasks, as well as on two of four post-intervention problem-solving tests.

The fourth behavioural rehabilitation that focuses on executive dysfunction following pTBI makes use of external aids. Wilson, Emslie, Quirk, and Evans (2001) implemented a paging system in an attempt to reduce everyday failures of memory and planning. Their participants were 143 TBI individuals between the ages of 8 and 83 years who, along with their caregivers and the researchers, identified areas of difficulty in memory and organization.

The intervention involved implementing a system of reminders, signaled by a tone and short message on a pager. The researchers reported positive results for all ages and all severities of injury.

Executive dysfunction interventions have been shown to be imperative for the rehabilitation of other cognitive functions. However, in remediating executive dysfunction an emphasis should be placed on everyday behaviours (Limond & Leeke, 2005). The involvement of the family is also imperative in paediatric rehabilitation (Braga, Da Paz Junior, Ylvisaker, 2005). The cognitive studies have not considered these two crucial aspects.

Goal Management Training (GMT)

GMT, developed by Robertson, Levine, and Manly (2005), is a relatively unique rehabilitation strategy because it is directly based on a specific theoretical framework, the theory of "Goal Neglect" (Duncan, Emslie, Williams, Johnson, & Freer, 1996). Goal neglect refers to a task requirement that is disregarded despite having been understood and remembered. This phenomenon is consistent with executive dysfunction as EF involves goal-setting. A particular advantage of GMT is that it places emphasis on everyday behaviour such as focusing on the planning and execution of an everyday activity, such as getting ready for school in the morning, in order to train the participant in goal management.

Thus far, GMT has only been implemented in the cognitive neurorehabilitation of adult populations. Because normal aging is associated with declining executive functioning, two studies have used GMT in older adult populations. In the first the intervention was found to significantly decrease anxiety while improving management of executive failures while the second showed significant improvement in real-life goal attainment and executive functioning.[2]

With regard to GMT implementation in clinical populations, two successful interventions were documented by Levine et al. (2000). The first, a case study of a postencephalitic participant, resulted in significant improvements on two paper-and-pencil tasks measuring goal neglect, as well as positive reports by the patient and trainer regarding increased efficiency in meal-preparation (a classic task reliant on EF). The patient also reported generalisation of GMT to other aspects of life, such as completing a mountaineering experience. The second intervention documented by Levine and colleagues (2000) involved 30 adults with TBI who were divided into two groups. One group underwent GMT and the other motor skills training. The GMT group showed significant gains on paper-and-pencil tasks sensitive to goal neglect.

Cerebellar lesions that have typically been associated with motor functions such as coordination and balance have recently been implicated in executive and attentional dysfunction. Schweitzer and colleagues (2008) documented the case of a 41-year-old male with focal damage to the cerebellum and consequent complaints of slowed information processing and difficulties in organization, resulting in the inability to return to work. After the implementation of GMT, the patient showed improvements on neuropsychological tests of attention and executive function, and reported subjective improvements in everyday executive tasks, verified by a significant other. 1 month post-intervention the patient returned to his previous (and intellectually challenging) occupation.

SPECIFIC AIMS

Damage to the frontal regions of the brain as a result of TBI often leads to executive dysfunction and, as executive function (viz., the ability to plan, organize and problem solve) is an essential requirement for successful development through childhood and adolescence, rehabilitation following TBI should thus include programmes focused on EF. The literature available on the rehabilitation of executive function is practically nonexistent in child and adolescent populations. Thus GMT, a successful intervention in the rehabilitation of adult executive dysfunction, might prove just as useful if adequately adapted for children. This study aimed to, first, develop such an adaptation, and, second, evaluate its use in three children who had experienced a TBI and consequent executive dysfunction.[3]

DESIGN AND METHODOLOGY

Research Design and Setting

The proposed study is part of a larger PhD research project that aims to examine rehabilitation strategies for children with TBI. Case-study investigations on 3 children were undertaken to determine whether a GMT-based rehabilitation intervention could be adapted for children with TBI. The intervention was conducted in a private room at the Red Cross War Memorial Children's Hospital (RXH) and/or in the UCT psychology department.

Ethical approval from the University of Cape Town's Psychology Department's Scientific Review and Research Ethics Committee and the Faculty of Health Sciences Research Ethics committee were obtained, as well as approval from the relevant Red Cross Children's Hospital authorities.

Sample

Three children, aged 11-13 years, each of whom was more than 1 year post-injury, were recruited from the RXH records. Each of the children had sustained either a mild, moderate or severe TBI.[4] Exclusion criteria included a previous history of TBI (other than the current injury), as well as co-morbid mental retardation, learning disabilities, epilepsy, attention-deficit/hyperactivity disorder, and any other psychiatric or neurological conditions.

Pre- and Post-Intervention Measures

General intellectual functioning and neuropsychological functioning in the domains of attention, memory and executive function were measured using the neuropsychological tests detailed below and listed in Table 1. All these tests have been utilized in Africa standardised for children and have proven reliability and validity. Reports from parents and teachers on the child's behaviour and affect were obtained from the relevant Behaviour Rating Inventory of Executive Function (BRIEF; Malloy & Grace, 2005) and Child Behaviour Checklist (CBCL; Achenbach, 2001) forms. Specific GMT questionnaires were administered to the child and teacher or parent before the intervention.

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General Intellectual Functioning

General intellectual function was estimated from the two Performance IQ (PIQ) subtests of the *Wechsler Abbreviated Scale of Intelligence* (*WASI*; Wechsler, 1999). The *Block Design* subtest requires the participant to replicate, within a time limit, modeled or printed 2D geometric patterns using two-colour cubes, thereby measuring perceptual organization. The *Matrix Reasoning* subtest measures non-verbal fluid reasoning. In this test the participant is required to indicate the missing piece from a choice of five possibilities to complete a series of incomplete gridded patterns.

Verbal and Visual Memory

Verbal memory was assessed through two subtests from the *Children's Memory Scale* (*CMS*; Cohen, 1997). The *CMS Stories* subtest measured recall of meaningful and semantically-related verbal material. In the first part (immediate recall), the participant listened to two stories told by the examiner, and was then required to retell the stories from memory. In the second part (delayed recall), the participant had to retell the two stories after a 30-minute delay and then answer related factual questions.

The *CMS Word List* subtest measured recall of a set of semantically unrelated words. In the first part (immediate recall), the participant listened to an initial presentation of the list and then immediately recalled as many words as possible. In the 3 trials following, the participant was reminded only of those words that he/she forgot, and was then asked to recall as many words as possible. After presentation and free recall of a distractor list, the participant was asked to again recall as many of the words from the original list as possible. In the second part (delayed recall), the participant had to recall as many of the words from the original list as he/she could remember after a 30-minute delay and then had to complete a standard-type recognition task based on the original list of words.

Visual memory was assessed using the *CMS Dot Locations* subtest and the *Rey-Osterrieth Complex Figure test* (*RCFT*; Osterrieth, 1944). The *CMS Dot Locations* subtest measured spatial-location learning. In the first part (immediate recall), the participant was presented a picture of an array of dots for 5 seconds, after which he/she had to recall the arrangement using a grid with chips. After three such trials, and the presentation of a distractor array, the participant had to recall the original array. In the second part (delayed recall), the participant was required to recall the initial array after a 30-minute delay.

The *RCFT*, a widely-used and well-standardized neuropsychological test of visuoconstructional, visuospatial, and visual memory ability, is comprised of 3 parts. Firstly, the participant was required to directly copy a complex figure presented to them. After removal of the model and copy, the participant was asked to re-draw the figure from memory. Finally, after a delay of 30 minutes, the participant was again asked to re-draw the figure from memory.

Working Memory and Attention

Working memory was assessed using the *CMS Numbers* subtest. In the first part, the participant was required to repeat a sequence of digits in the same order read by the examiner. In the second part, the participant was required to repeat the sequence of digits read by the examiner in reverse order.

Four subtests from the *Test of Everyday Attention for Children* (*TEA-Ch*; Manly, Robertson, Anderson, & Nimmo-Smith, 1999) were used to measure various aspects of attentional functioning. The *TEA-Ch Sky Search* subtest provided a measure of selective attention by requiring the participant to find as many “target” spaceships as possible on a sheet filled with both target and distractor ships. The *TEA-Ch Score!* subtest provided a measure of sustained attention by requiring the participant has to keep count of the number of

"scoring" sounds heard on a soundtrack with variably long pauses between sounds. The *TEA-Ch Creature Counting* subtest provided a measure of attentional control by requiring the participant to respond to arrows pointing in different directions by switching from counting in ascending order to counting in descending order. Finally, the *TEA-Ch Sky Search Dual Task* subtest provided a measure of divided attention by requiring the participant to complete the Sky Search and Score! tasks simultaneously.

Executive Function

The various aspects of EF, the domain of focus, were assessed by 6 instruments.

The *Tower of London* (*TOL;* Culbertson & Zillmer, 2001) test measured problem-solving and planning skills, which within Anderson's (2002) EF model are a part of the Goal-Setting domain. The test consists of two boards with pegs and several colored beads. The examiner presented the participant with an arrangement of the beads on the pegs of one board, and then asked the participants to reproduce, that arrangement on the other board, from a standard starting position and in as few moves as possible. Participants were given 2 minutes in which to complete each problem-solving task while adhering to specific rules: how many beads could be moved at a time and how many beads could be held on particular pegs.

The *Color Trails Test* (*CTT*; D'Elia, Satz, Uchiyama, & White, 1996) measured flexibility and switching, which within Anderson's (2002) EF model are a part of the Cognitive Flexibility domain. The CTT is a culturally fair equivalent of the Trail Making Test (Lee, Cheung, Chan, & Chan, 2000). In the first part of the CTT the participant was instructed to draw lines between numbers scattered around a single sheet of paper, going from 1 to 2, 2 to 3, and so forth. The second part of the test was identical except that two series of numbers were presented on the page, each series in a different colour. The participant therefore had to join the numbers with alternate colours (e.g., blue 1 to red2, red 2 to blue 3, etc.).

The *Controlled Oral Word Fluency* (COWA; Spreen, Sherman, & Strauss, 2006) test measures supervisory processes, verbal retrieval and recall, self-monitoring and inhibition, which within Anderson's (2002) EF model are part of the Attentional Control and Information Processing domains. In this test, participants were asked to generate as many words as possible within a time limit. The phonemic fluency part of the test required the participant to generate words beginning with a specified letter, whereas the semantic fluency part required the generation of words within a specific category (e.g., animals).

The Inhibition, Clocks and Design Fluency subtests from the NEPSY-II were used (Korkman, Kirk & Kemp, 2007). The *NEPSY-II Inhibition* subtest measured the inhibition of automatic responses, which in Anderson's (2002) EF model are part of the Attentional Control domain. In this test the participant looked at a series of black and white shapes and arrows and named either the shape or direction or gave an alternate response, depending on the colour of the shape or arrow.

The *NEPSY-II Clocks* subtest measured planning and organization, which in Anderson's (2002) EF model are part of the Goal-Setting domain. In the first part of the test the participant was required to draw, over several trials, the face of a clock and then to add the hands following either instructions from the examiner or the model from a digital clock. In the second part the participant was required to read, over several trials, the time on clocks either with or without numbers. In the third part the participant was required to copy two clock drawings.

Finally, the *NEPSY-II Design Fluency* subtest measured behavioural generativity, which in Anderson's (2002) EF model is part of the Information Processing domain. In this test the participant was required to generate, within a time limit, as many unique designs as possible by connecting up to five dots (presented in either a symmetric or an asymmetric array) in as many different ways as possible.

Behavioural and Affective Questionnaires

The BRIEF, for both parents and teachers, is designed to assess the executive functioning of children, between the ages of 5 and 18 years, in the home and at school (Malloy & Grace, 2005). The questionnaire consists of 86 items of non-overlapping clinical scales that produces two indexes composed of several subscales and takes 15 minutes to complete. The Behavioral Regulation Index is made up of the Inhibit, Shift, and Emotional Control subscales. The Metacognition Index is made up of the Initiate, Working Memory, Plan/Organize, Organization of Materials, and Monitor subscales. There is also a Global Executive Composite score incorporating all scales, recommended to be used when there is little variability in subscales. High internal consistency and test-retest reliability has been reported for the BRIEF, low inter-rater reliability was attributed to expected behavioural differences across settings.

The Child Behavior Checklist (CBCL; Achenbach, 2001) is suitable for ages 6-18 and allows a child's problem behaviours and competencies to be rated by a parent or individual who knows the child well. The first section of the CBCL consists of 20 items on the child's

competence and the second section of 120 items on the behavioural or emotional problem's of the child. A particular behaviour is described per item and scored on a Likert type scale consisting 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 somaticising 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). The CBCL is a reliable and widely used instrument with established psychometric properties.

An adapted pre-GMT questionnaire focusing on executive dysfunction in everyday life was administered to the participant. A separate and similar questionnaire was administered to a close relative or teacher (Appendix A).

Procedure

An initial pool of subjects were identified and recruited from RXH records. I then made telephonic contact with the parents of the identified children in order to explain the study and to request participation. The nature of the proposed study, confidentiality throughout the study, and the number and duration of sessions were detailed during this call. Additionally, the parent was informed we would provide compensation (R50) for travel expenses, as well as a completion bonus of R150.

If the parent agreed to allow his/her child to participate in the study, I scheduled and conducted an initial semi-structured interview with the children and parents in order to assess the child's behaviour. During that interview, we identified specific everyday areas of dysfunction upon which the GMT intervention could focus. The assent and consent forms (Appendices B and C respectively) were presented to the participants and parents, the voluntary nature of the study and the confidentiality of the parents and children was guaranteed by only using information that protected privacy. The BRIEF and the CBCL were administered to the parent whilst the battery of neuropsychological tests was administered to the children. After the completion of this initial interview, I conducted a semi-structured interview with the child's teacher in order to assess the child's functioning at school. The teacher BRIEF was completed during that session. The battery of neuropsychological tests was re-administered immediately post-intervention and a follow-up semi-structured interview with the parent and subsequently the teacher conducted.

The Intervention

The intervention was adapted from the original Goal Management Training Programme (GMT; Robertson, Levine, & Manly, 2005) with permission from one of the developers (B. Levine, personal communication, May 20, 2008). Adaptations to the intervention were made to ensure that children could identify with the examples, engage with the exercises and understand the language. In making the adaptations, I attempted to ensure that the concepts taught within the intervention remained intact. Upon completion of the adaptation, I obtained feedback and approval from one of the developers (B. Levine, personal communication, June 16, 2008). A summary of these adaptations can be found in Appendix D.

The 7-module programme was split into 5 modules due to time constraints. As in the original version, each module discussed a component of executive dysfunction, included exercises to illustrate the points made, and concluded with homework assignments that were to be recorded in a workbook.

More specifically, Module 1 provided an overview of the programme, and introduced concepts such as goals, slips and absentmindedness. Module 2 presented the concept of 'automatic pilot' and how to stop it and the 'mental blackboard' Module 3 focuses on stating goals and remembering them, and present-mindedness practice is introduced. Module 4 dealt with conflicting goals and indecision and taught the splitting of tasks into sub-goals. Module 5 concluded the programme with discussion about how to check goals and how to make stopping a habit. Appendix E provides a complete outline of the programme modules and tasks.

All modules were presented on MSPowerPoint slides. The sessions were interactive discussions rather than lessons, as it was imperative to receive feedback from the participant as to how the programme could be applied to their daily activities. The workbook was a fun and colourful space for the child to express his/her understanding of the programme; it was also a way for the child to remember the programme's content. Interaction and participation during training and successful completion of homework assignments were rewarded with stars and chocolates.

Data Analysis

As each GMT programme was individualised for the participants at different EF developmental levels. The results and observations for each participant were treated as case studies. The results from the neuropsychological tests pre- and post-intervention for each individual were descriptively compared for changes in neuropsychological function. The

efficacy of the GMT intervention was evaluated by investigator observations, the children's self-reports, and parent and teacher reports on general functioning and in the specific area targeted by the intervention

RESULTS

Three cases are presented below to illustrate the implementation of GMT in children with mild, moderate and severe TBI. The information presented in all of the case studies was garnered from medical files, questionnaires and interviews with the family and teachers of participants, neuropsychological test administration and investigator observations. References to neuropsychological domains herein refer to Anderson's (EF) model.

Case 1- Name: CZ

Date of birth: 12 November 1997
Date of injury: 06 August 2007 (aged 9 years 10 months)
Date of first examination: 13 September 2008 (aged 10 years 9 months)
Severity of injury: Mild; GCS: 14/15

Background Information

CZ is an English-speaking female currently enrolled in a mainstream school in Grade 5. She is the older of 2 children. Her mother is unemployed and father incarcerated. CZ, her mother and sister live with CZ's grandmother.

The medical record indicates that CZ was involved in a pedestrian MVA and taken to the hospital by paramedics. She vomited on arrival but had no loss of consciousness. There was no focal neurology or other injuries. CZ was discharged the same day.

Pre-Intervention Observations

Academic performance. CZ was ranked by her teacher to be in the bottom 10% of the class. He attributed her lower performance to be "not because she can't but because she doesn't". He stated that her difficulty lay in finishing assignments, often completing only 20 to 30 percent of her tasks. He reported that she could get frustrated during class and often gave up. CZ's mother did not report much as to academic performance, stating only that CZ did her homework everyday and that she was doing well.

Behavioural and affective functioning. CZ's mother reported that she did not have any significant behavioural problems and was a well behaved daughter, she cried and screamed

more than other children her age, but this was considered unproblematic by her mother. CZ's teacher indicated that she fought physically with other children at school quite regularly but was otherwise a well-mannered and pleasant child.

These patterns of behavioural and affective functioning were confirmed by the *CBCL*, where CZ exhibited externalising behaviours in the borderline clinical range (Table 1).

Executive functioning. CZ's mother indicated that CZ was disorganised at home, often late for the school bus as she would take a long time preparing for school, having to "go back and forwards getting stuff". Her mother indicated that she did not complete her chores, only finishing half the task before getting distracted. For instance she would wash some of the dishes, but forget the cutlery and not dry the dishes unless reminded. Her room was disorganised and she often forgot her books and jersey for school. CZ's teacher indicated that she was forgetful and messy, scattering her things, often needing to go back and fetch items left on the field during recess. CZ's teacher identified that she compensated for her forgetfulness by asking him to keep items such as her pens at school so she would not loose them. Her teacher also indicated that she was frequently late for class and did not plan her time well for assignments.

BRIEF. The parent BRIEF indicated that CZ was functioning in the normal range. The teacher BRIEF however indicated that CZ's executive functioning was severely impaired. The teacher BRIEF indicated a highly elevated negativity scale. This discrepancy between the teacher and parent BRIEF (Table 2) does not allow for a definitive understanding of CZ's functioning. The interview with the parent and teacher however, both show executive dysfunction. The discrepancy may result from CZ's difficulties arising in complex tasks that rely on splitting and checking within tasks that the mother may not be aware of in the home environment but becomes apparent in school.

Pre-GMT Questionnaires. The parent Pre-GMT questionnaire indicated that CZ had executive dysfunction with most responses lying in the range of 7 and 8/10. In the participant Pre-GMT questionnaire was inconclusive, CZ indicated she felt she had both problematic functioning (26%) and no dysfunction (29%). The most problematic areas were indicated to be time management, forgetfulness and absentmindedness.

Parental involvement. CZ's mother was in contact with the school and willing to participate in GMT. Her grandmother monitored her homework completion. CZ's father had an antagonistic relationship with CZ's mother, and uninvolved with CZ's rehabilitation progress.[5]

Target Behaviour for the Intervention

CZ's mother decided to assess executive function through completion of chores (cleaning her room and finishing the dishes) and time management (getting ready for school at home). CZ's teacher decided to assess CZ's completion of tasks and ability to achieve a number of steps in an assignment to gauge a change in executive functioning at school.

Observations During the Intervention

The number of 'absentminded slips' reported did not notably change through GMT. However, in the third session CZ reported that "stopping" was challenging and that she often only remembered to "stop and think" once an absentminded slip had occurred. This shows insight into her behaviour as well as the use of the intervention terminology. Exercises during the intervention, such as a clapping task, sensitive to absentminded errors, were performed with ease by CZ. The first 2 modules that covered the identification of absentminded slips and stopping the automatic pilot were easily understood by CZ. The completions of intervention tasks and homework for the first 2 sessions were done well and easily. The first two modules were completed in half the designated time. The subsequent 3 modules involving complex tasks, the splitting of tasks into sub-tasks and checking were more pertinent to CZ's problems. In the first three splitting tasks CZ had great difficulty and was not able to complete the tasks successfully, the fourth task she managed well. This ability to split tasks generalised to exercises within the intervention; a birthday planning task and Jelly-Tot sorting task. A complex task, the goal of which is to attempt a certain proportion of each of 5 sub-tasks showed marked improvements. In the first task CZ attempted 3 sub-tasks scoring 26 points, in the second task she attempted all 5 sub-tasks and scored 43 and in the last task attempted all 5 tasks scoring 200. At the post-intervention neuropsychological test session, CZ spontaneously reported the help of the checking exercise in her school activities.

Family involvement during the intervention. CZ's mother expressed interest in attending the programme at the initial interview and attended the first two sessions. Thereafter she was absent despite confirmation of her attendance in the confirmatory calls before the session.

Changes in Neuropsychological Performance Following the Intervention

The neuropsychological test data for CZ are presented in Tables 4 to 7. The qualitative descriptions of the *WASI*, *Tower of London*, *CMS* and *NEPSY- II* are presented in Tables 8 to 11. Regarding the *WASI*, the only notable change was a significant improvement on the

Matrix Reasoning subtest (from a scaled score in the low average to the high average range). This change is particularly interesting because the abilities tapped by the Matrix Reasoning subtest (non-verbal reasoning and problem-solving) fit within the Goal Setting domain, this is consistent with other observations of CZ (see below).

Regarding *verbal memory*, CZ's performance was consistent from pre- to post-intervention. Regarding *visual memory*, the Dot Locations subtest showed consistent performance. A noteworthy increase in the Delayed RCFT from 12 to 23.5 could be attributed to a carry over effect as there was no change on CZ's Copy RCFT performance. Regarding *working memory* there was consistent performance.

Regarding *attention*, CZ's performance on the TEA-Ch was fairly consistent from pre- to post-intervention, with mild improvements shown on some subtests likely due to practice effects rather than to any substantial change in functioning.

Regarding *executive functioning* there were significant increases in the Goal-Setting and Attentional Control domains. This was shown by the Verbal Fluency test, a measure of the Attentional Control domain which showed significant changes in Total Fluency from 1 to 4 standard deviations from the mean. The TOL (Goal-Setting domain) improved significantly from 98 to 110. The Color Trails (Cognitive Flexibility domain) showed an improvement in performance.

The neuropsychological results are depicted in Anderson's (2002) EF model, figure 2. In domains of Attentional Control and Goal-Setting (GMT focus) there was general improvement in functioning. There appears to be a generalisation of this improvement to the Cognitive Flexibility domain although inconclusive due to the decline in the *CMS* Numbers performance. There was no improvement in functioning in the Information Processing domain.

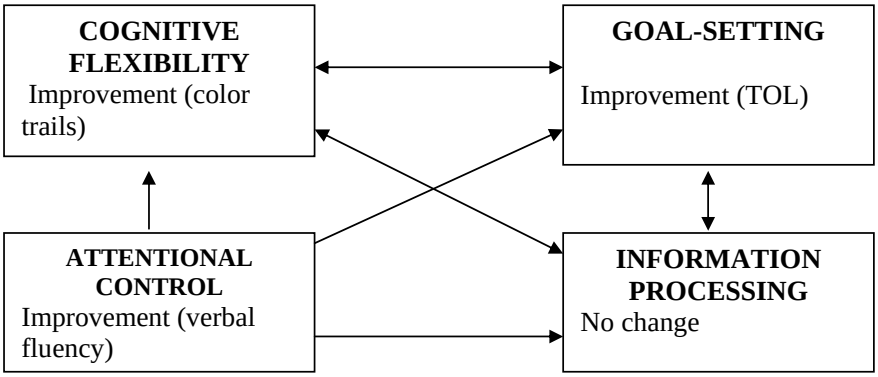

Figure 2. CZ's test performance summarised in Anderson's (2002) EF model.

Post-Intervention Observations

Academic performance and behavioural and affective functioning. CZ's teacher reported a change in affect, she had less "nervous tension" and had "cooled down a bit". An increase in completion of tasks had improved her academic performance. These academic and behavioural improvements had promoted her to class monitor.

Executive Functioning. Both CZ's mother and teacher reported an improvement in CZ's forgetfulness. CZ's teacher reported only one occasion in which CZ had been late for class. CZ's teacher also reported an improvement in her completion of multi-step assignments, illustrating that when she would have typically finished 1 of 5 steps she would now finish 3 or more. CZ's mother reported that her room was better kept, resulting in her not being late for the bus as much.

Target Behaviour

There were reported changes in the assessment areas of completion of chores and time management in the home. CZ's teacher reported improvement in the assessment areas of completion of tasks and ability to achieve a number of steps in an assignment.

In summary the GMT programme appeared to have generalised to CZ's school and home environments, the neuropsychological results suggest improvement in executive function although inconclusive.

Case 2 – Name: MJ

Date of birth: 14 August 1995
Date of injury: 06 July 2005 (aged 9 years 11 months)
Date of first examination: 04 July 2008 (aged 12 years 11 months)
Severity of injury: Moderate; GCS: 11/15

Background Information

MJ is an English-speaking male currently enrolled in a mainstream school in Grade 6. His father is an artist and his mother a dressmaker. MJ is the second youngest of 6 siblings, 4 of which are dependant on the family.

The medical record indicates that MJ sustained his injury by jumping off a moving vehicle. No focal injuries were sustained. The CT scan indicated mild brain swelling. MJ lost

consciousness at the scene of the accident. Apart from a swollen right eye no other injuries to his body were sustained. MJ was hospitalised for three days.

Pre-Intervention Observations

Academic performance. MJ had repeated Grade 5 the year following the injury. His mother indicated that he performed above average academically compared to other children his age but she did not know his school grades. The interview with MJ's teacher was contradictory. His teacher was concerned as to his academic performance and ranked him as a low-performing student, she stated that at that stage (mid-year) she was unsure as to whether he would pass the year. Before the intervention had commenced, MJ had been absent from school 10 days. MJ's teacher attributed his poor performance to his lack of concentration. She indicated that when multiple steps were involved in assignments he struggled and his writing organisation was poor. She indicated that MJ often left his books at home, did not hand in homework and did not deliver letters to his mother. His teacher demonstrated his lack of motivation to work by an example of MJ being called into the principal's office and when sent back to class, wondered around the school for two hours.

Behavioural and affective functioning. MJ*'s* mother was most concerned as to his moody and aggressive behaviours post-injury. She explained that he lacked self-control, was more withdrawn and was very forgetful. She indicated that his interactions with other children were normal. MJ's teacher indicated that he integrated and communicated well with his classmates that were two years younger than him and that he was friendly with many students. She noted that he often smiled and laughed inappropriately (such as when told he was doing something wrong) and was regarded by many classmates as "weird" due to this. She indicated he had angry outbursts and his mood was easily influenced and changed.

The parent *CBCL* indicated functioning in the Clinical range for internalising, externalising and total problems, supporting the above observations (Table 12).

Executive functioning. MJ's mother indicated that he had trouble initiating a task even when willing and required supervision to complete tasks. Reports on executive functioning at home were confounded by MJ's home environment which was very disorganised. The one room which all four siblings shared had no lighting or cupboards, the family's belongings were piled on the floor, dining-room table and lounge, so providing no space for the children to do their homework. MJ had no routine, chores or bed-time and spent most afternoons playing at his neighbour's house.

The global executive composite on the parent and teacher *BRIEF* (Table 13) indicated severe executive difficulties, scoring 2 standard deviations above the mean.

Pre-GMT questionnaires. The parent Pre-GMT questionnaire indicated that MJ had significant problems in all executive functioning areas from planning to inhibition. The participant Pre-GMT questionnaire indicated that MJ identified he had some difficulties in attention and completion of tasks but on the whole reported low executive dysfunction. This lack of insight is typical of executive dysfunction.

Family involvement. Parental involvement in MJ's activities appeared minimal. MJ's teacher reported he received no help regarding homework despite recommending to MJ's parents that he required help. MJ's mother indicated in the first interview her willingness to participate in GMT but excused herself at each session assuring her attendance at the next one.

Target Behaviour

As there was more structure to MJ's schooling than home life (he has no chores or daily routine) it was decided to assess a change in executive functioning at school. MJ's teacher decided to monitor MJ's completion of tasks during class and to monitor if MJ brought all his books to school.

Observations During the Intervention

Increased awareness into MJ's problems was indicated by increased recording of 'absentminded slips' each week. In the first week he recorded 10, the second week 15 and both the third and fourth week 25. MJ had significant difficulties relating stories, integral to the intervention. There was no marked improvement in this area. MJ exhibited the use of the programme terminology, such as "I was on automatic pilot when…" whilst participating in GMT. Exercises during the intervention such as a clapping task, sensitive to absentminded errors, indicated an improvement in MJ's performance. Exercises splitting tasks into sub-tasks indicated an improvement in MJ's performance which generalised within GMT such as dividing Jelly-Tots among children with a range of requests and the steps involved in organising a birthday party. This did not appear to generalise to activities outside the intervention. A complex task, the goal of which is to attempt a certain proportion of 5 sub-tasks showed marked improvements. In the first task MJ attempted 2 sub-tasks scoring 18 points, in the second task MJ attempted 4 sub-tasks and scored 45 points and in the last task MJ attempted all 5 tasks and scored 60 points. MJ's organisation at home appeared to

improve as when picked up from home by the investigator MJ took less time (from 30 min to less than 5) to find his homework assignments and get a jacket.

Change in Neuropsychological Performance

The Neuropsychological data for MJ are presented in Tables 14 to 17. Regarding the *WASI* there was a significant improvement in fluid reasoning as shown on the Block Design subtest.

Regarding *verbal memory* there were significant increases from impaired functioning to average. Regarding *visual memory* there were noteworthy increases in the *CMS* Dot Locations sub-test and RCFT. The latter result could be attributed to carry-over effects. Regarding working memory there was consistent performance pre- and post-intervention.

Regarding *attention* there were consistent results on the *TEA-Ch* pre- and post-intervention, apart from the Sky Search Dual Task subtest which showed a marked decline post-intervention which is most likely due to the questionable efforts and motivation on this particular sub-task.

Regarding *Executive functioning* there were marked improvements in the domain of Attentional Control measured by the Inhibition subtest which was supported by the Verbal Fluency test, a measure of the same domain. The TOL, a measure of the Goal Setting domain, showed a noteworthy improvement.

The neuropsychological results are depicted in Anderson's (2002) EF model, figure 3. There were changes to the Goal-Setting and Attentional Control domains (the focus of GMT) which did not generalise to the other domains.

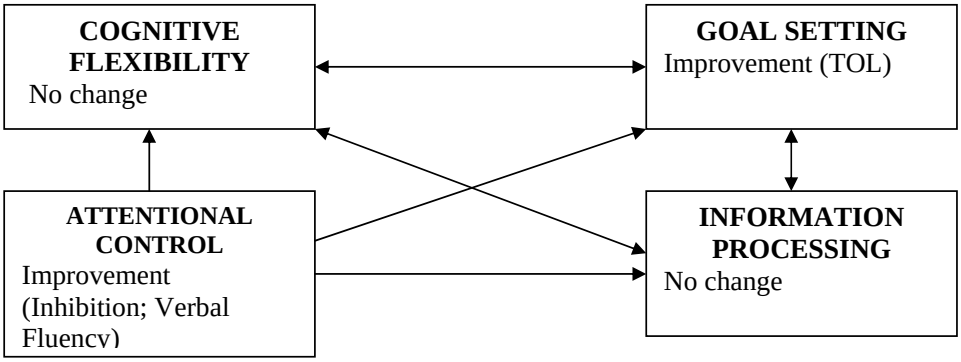

Figure 3. MJ's test performance summarised in Anderson's (2002) EF model.

Post-Intervention Observations

Academic performance. MJ's academic performance declined post-intervention. MJ's mother expressed her concern regarding his academic performance. MJ's teacher was highly concerned as to his performance as he had not completed sufficient assignments to graduate and would have to repeat the grade. During the 54-day term MJ had been absent from school 33 days (61% absenteeism). MJ's teacher said that he was not going to repeat the year due to inability but because he was lazy and was not attending school.

Behavioural and affective functioning. MJ's mother was still most concerned as to MJ's frequent mood changes and aggressive behaviour towards his siblings. Reports from MJ's teacher indicated that he became apathetic towards school activities and frequently stated that he was not enjoying school. MJ justified his absenteeism by being "stupid". MJ's teacher reported that his classmates had distanced themselves from him, which she attributed to his absenteeism.

Executive functioning and target behaviour. There were no reported changes in forgetfulness, inattention and planning by the parent or teacher. The indication of changes of EF by monitoring completion of school tasks and remembering to bring books to school became invalid due to absenteeism.

In summary the investigator observations suggest changes in executive functioning during the programme. These changes did not generalise to MJ's daily life and due to his absenteeism his academic performance had worsened.

Case 3 – Name: SN

Date of birth: 15 January 1996

Date of injury: 16 April 2006 (aged 10 years 3 months)

Date of admittance to hospital: 20 April 2006.

Date of first examination: 16 July 2008 (aged 12 years, 6 months)

Severity of injury: Severe; GCS: 3/15 (recorded 20th April 2006)

Background Information

SN is an Afrikaans-speaking male currently enrolled in special schooling. The class comprises of 13 students of a range of abilities but of all the same age. SN is completing a Grade 1 equivalent. His father and mother are unemployed. SN is the second youngest of 4 siblings. He lives with his parents, aunt, uncle and 12 children.

The medical records indicate that SN sustained a penetrating brain injury to the left frontal lobe when the frame of a paintbrush hit him. SN did not loose consciousness initially but became drowsy and began to vomit everyday. Four days after the injury was sustained SN's mother admitted him to the hospital. SN remained in ICU and subsequently the recovery unit for one month, during which, he had multiple CT scans and EGG recordings. The abnormal EEGs showed a decreased level of consciousness and generalised slowing. The medical records reported decreased higher functions and behavioural changes since the injury. He had become emotionally labile, showed obsessional behaviour, unsettled sleep and decreased cognition, memory and speech.

Pre-Intervention Observations

Academic performance. SN's teacher felt he lacked the motivation to improve, not the ability. She felt that he could progress to Grade 2 work if he "felt like it". She said he did not enjoy schoolwork and became moody when pressed to participate in class. SN's teacher felt his lack of motivation and laziness were the cause of his poor academic performance. SN's mother did not comment on his academic performance.

Behavioural and affective functioning. SN had severe behavioural problems. He constantly suffered from headaches and his injury had resulted in severe somatosensory problems. He itched constantly causing great discomfort and agitation. SN presented with a pungent smell, which could be attributed to his incontinence. SN was highly sensitive to sounds and reacted badly, covering his ears and shouting, when the chips from the Dot Locations sub-test dropped on the desk. SN's mother reported that he had frequent mood-swings. He became aggressive and hot-tempered, specifically when agitated by loud noise. SN disliked his siblings, attributed by his mother to their noisiness. SN's teacher reported that he had no friends and was disliked by his peers due to his hot-temper, screaming when they made a noise and "manipulative behaviour" (SN frequently made other children, of a similar level of functioning, clean up after him and carry his school bag).

These behavioural problems were confirmed by the parent *CBCL* that indicated functioning in the Clinical range for internalising and total problems (Table 18). The externalising problems were reported by the teacher and thus not reflected on the CBCL.

Executive functioning. Regarding executive function the parent and teacher BRIEF (Table 19) indicate severe executive dysfunction.

Pre-GMT questionnaires. The parent Pre-GMT questionnaire indicated severe executive dysfunction in all areas, scoring a 9 or 10/10 for all questions except those that

asked if SN worried about his coping where he scored 2/10. SN initially refused to answer the participant pre-GMT questionnaire and when pressed to answer gave a typical response set of "fine" and is considered invalid.

Parental involvement. Parental involvement in SN's activities appeared minimal. SN's teacher criticised his families' lack of involvement as his "mother left everything for the teachers to do". SN's mother is illiterate and thus uninvolved in his academic work. SN's mother stated during initial telephonic contact that she would be interested in accompanying SN to GMT but declined involvement when we met for the interview. Neither SN nor his mother commented on his father's involvement.

Neuropsychological Performance

The Neuropsychological data for SN are presented in Tables 20 to 23.

Regarding the *WASI*, SN's PIQ was in the borderline range. SN's *verbal and working memory* were impaired, his *visual memory* regarding the RCFT was severely impaired, however the *CMS* Dot Locations subtest showed low average functioning. Regarding *attention* SN's average scores were 3 standard deviations from the mean. Regarding *executive functioning* the TOL showed poor performance and the *NEPSY –II* Inhibition subtest was well below the expected level. The Clocks was below the expected level. The Color Trails and Verbal Fluency showed severe impairment. Overall this indicates that in PIQ, attention memory and all domains of executive function, SN showed impaired and borderline performance.

In summary, due to SN's poor performance on the neuropsychological tests, behavioural difficulties and disinterest of his mother the intervention was terminated.

DISCUSSION

The GMT intervention, adapted for a South African pediatric population, was implemented in three pTBI cases, with varying levels of success. In the case of CZ, a 10-year-old girl who experienced a mild TBI when 9-years-old, the intervention proved successful. For instance, in terms of academic performance her teacher reported significant increases in the ability to complete assignments. Regarding behavioural and affective functioning her conduct had improved to such an extent she was promoted to class monitor. Regarding neuropsychological change there was noteworthy improvement in the domains of GMT focus and some generalisation to the Cognitive Flexibility domain.

In the case of MJ, a 13-year-old boy who had experienced a moderate TBI when 9-years-old, the efficacy of the intervention was inconclusive as there were changes in executive functioning within the programme but this did not generalise to other areas. Within the intervention there were changes regarding the participants' insight into his behaviour and the ability to split tasks into more manageable sub-tasks. Regarding academic performance there was a decrease in functioning, attributed to absenteeism of 61%. Regarding behavioural and affective functioning there were no reported changes. The neuropsychological tests indicated improvement in the domains targeted by GMT, this improvement did not generalise to the other domains of EF.

Finally, in the case of SN, a 12-year-old boy who experienced a severe head injury at when 10-years-old, the intervention could not be implemented.

Two major factors contributed to the varying levels of success we experienced with implementing GMT. Each of those factors is discussed in turn below.

Severity of Injury

The most prominent changes in executive functioning were seen in the mild participant. This may be due to her increased insight and better foundational skills compared to the other cases. The first 2 modules did not seem as pertinent to her difficulties as the later modules. This may be due to these later modules relying on piecemeal strategies, such as splitting tasks, which are still developing at this age in the participant (Brenner et al., 2007). Although the later modules were more relevant to the participants' difficulties, the success of the intervention may have been founded on the good grounding of the initial 2 modules.

All modules appeared pertinent to the moderate participant, the success of the intervention, however, was inconclusive. The lack of insight of the participant into his difficulties may have contributed to this as well as the effects of the absenteeism and lack of familial involvement.

The original intervention has been implemented with severe adult TBI patients. This suggests that the paediatric intervention could expect the same success. The severe participant, showed poor performance on the neuropsychological tests and severe behavioural problems that would have made the implementation of GMT problematic and in light of the mother's disinterest as well, the intervention was terminated.

Family Involvement Resulting in Structure at School and at Home

Families are profoundly affected by a child's brain injury. The support and involvement of the family can play a critical role in the child's recovery (Wade, Borawski, Taylor, Drotar, Yeates, & Stancin, 2001). Rehabilitation has been found more effective when set within the routines of everyday academic, social and familial life. This requires the involvement of the family in the rehabilitation process. Braga et al. (2005) found that children following TBI experienced superior outcomes following an indirect family-supported rehabilitation intervention than those in a direct clinician-delivered programme not involving the family. It was also found that the efficacy of the parents training was independent of their education level.

The intention of GMT is to utilise participants' existing executive skills more effectively in everyday life. To make these acquired skills more applicable to everyday activities and to reinforce GMT ideas outside the intervention, the involvement of the family is imperative. Loss of insight into behaviour results from executive dysfunction. This renders self-report an unreliable measure. The involvement of the parents in GMT to bring EF difficulties to light is thus essential.

Familial involvement is crucial to the structure of a child's schooling (attendance and homework), a foundation from which the intervention operates. As evident in the moderate case, MJ's absenteeism was unmediated by the parents, resulting in no possible generalisation of the intervention to the school environment. Similarly the participants' home environment is important, if the child has a daily routine, this can be utilised as the everyday framework on which to base the programme.

Familial involvement is thus a crucial aspect to the success of the GMT programme in all levels of severity.

The effect of age, gender and time post-injury has been shown to influence cognitive outcome and may thus impact on rehabilitation (Anderson, Northam, Hendy, & Wrennall, 2001). In this small sample, these effects could not be identified.

Adaptation of the Intervention

The Goal Management Training programme is a fun, interactive and colourful intervention that is appropriate and engaging for children of a range of ages. Children of the ages 10-13 participated in the programme and it would be suitable for children in their teens as well. The phrasing and emphasis on written exercises may need to be adapted for 7 or 8 year-old children.

The original intervention had been shortened by 2 modules, by combining the modules, with successful results (Levine et al., 2000). Due to time limitations the paediatric intervention was adapted to the shortened version. The authors indicated, when reviewing the adaptations, that the shortened version was not advisable. The sessions became rushed and not as much time could be spent on problem areas that arose and suggested eliminating some material. Some complex tasks were eliminated to compensate but the intervention was nonetheless too hurried. Children with TBI also have attentional difficulties and the longer sessions were problematic in this regard. Future interventions should allow time for the 7-module intervention.

The first module, focussing on identification of slips through the participants' narratives, is vital to the success of the programme as the focus of the intervention is on identifying where, when and which types of slips occur and developing strategies to compensate. It has been found that following frontal lobe lesions, children display disorganisation in the process of expressing ideas (Ponsford, 2004), which can make this part of the intervention challenging. If the children display low self-awareness as well, this module could be implemented over two sessions. As Robertson, Levine and Manly (2005) noted, dysexecutive patients can be among the most challenging to rehabilitate. Insight into one's problems, being able to flexibly adapt to and take into account one's new situation and being motivated to do so – the very stuff of the executive function – is important to rehabilitation.

The original intervention was designed to be used in groups. This would allow interaction between participants experiencing similar problems, ideas on how to overcome difficulties could be shared between peers rather than in a patient-therapist manner. Group sessions have the attributes of support and learning from colleagues and aiding more people in one session. This would be problematic in the paediatric population, as the engagement, comprehension and interactions of the child are crucial in the efficacy of the programme. The children could also feel intimidated by age or better functioning of other children. The parents' participation is hoped to compensate for the group interactions by lending support and encouragement and aiding in the identification of slips and creating strategies relevant to the child's life. As each intervention "step" is demonstrated pictorially and the majority of the intervention involves discussion, the literacy of parents is not imperative but advisable to assist in homework assignments. The programme is not costly and can be implemented in a range of settings, as it is run off a laptop, reducing travel inconvenience to the family.

Recommendations for Improving GMT Programmes for Children

The GMT intervention has been shown to be effective on moderate and mild TBI participants. The involvement of the family and implementation of GMT on a severe participant could not be completed. From the literature on adult GMT interventions it appears that it could be implemented in severe children, dependant on the involvement of the family. As the involvement of the family is integral for the generalisation of the intervention to the child's life, future studies should require the participation of a parent on condition of monetary compensation. The disinterest of the parents may be resultant of incomprehension of the difficulties the child may experience following TBI, a more comprehensive explanation at the initial interview and a pamphlet explaining the difficulties that may arise following TBI, could be suitable to engage the parents.

This study found that large discrepancies between the parents' and teachers' understanding of the participant's academic performance. A combined interview with both these parties may bridge this understanding allowing improved identification and monitoring of executive dysfunction. This may also encourage future collaboration between the parties.

The 5-module GMT programme is adequate; however the 7-module programme would be advisable for future implementations. The adult GMT studies evaluated the efficacy of the intervention through everyday paper and pencil tasks that are sensitive to executive dysfunction, a paediatric version of these tasks could be constructed to assess GMT. The GMT participants may also be contrasted to a control group.

Conclusion

In two of the three cases presented here, changes in behaviour and executive function were recorded following the implementation of GMT programme. These results suggest that the adaptations were appropriate and that the intervention can be as successful in child as in adult rehabilitation. In children, however, the success of the intervention seems to rest, at least partially, on a firm basis of familial support. Furthermore, the motivation of the child and the parents to engage in the programme appears to impact greatly on the success of GMT. The current pilot study has laid the groundwork for further explorations focused on neuropsychological rehabilitation services offered to children who have sustained a TBI. Should our future research show that GMT-based neurorehabilitation strategies are effective, we would be making an important contribution to improving the quality of life and reducing the frustration experienced by head-injured children and their caregivers.

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APPENDIX A

The adapted participant and significant other Pre-GMT questionnaires assessing executive functioning

Participant Pre-GMT Questionnaires

This questionnaire is about problems that most people have from time-to-time. Please choose the number that best describes how much of a problem this has been for *you* in the *last two weeks.* The scale goes from 1 (not a problem at all) through to 10 (a big problem).

1	Finding that you don't finish everything that you want to in a day?	1	2	3	4	5	6	7	8	9	10
2	Walking into a room and forgetting what it was that you had come for?	1	2	3	4	5	6	7	8	9	10
3	Finding that you don't have time to stop and think?	1	2	3	4	5	6	7	8	9	10
4	Something that you needed to do just "slipped your mind" (e.g. forgetting to pack a school book, asking your parents to sign something for school)?	1	2	3	4	5	6	7	8	9	10
5	Not actually having a very clear idea of what you are trying to do?	1	2	3	4	5	6	7	8	9	10
6	Having to go back and re-read a paragraph because you didn't take the information in the first time	1	2	3	4	5	6	7	8	9	10
7	Not leaving enough time to finish things? (e.g. only leaving an hour to finish a project that will take 3 hours.)	1	2	3	4	5	6	7	8	9	10
8	Forgetting something that needed to be done at a certain time (e.g. a sports practice, a TV programme that you wanted to watch)?	1	2	3	4	5	6	7	8	9	10
9	Feeling like you aren't in control?	1	2	3	4	5	6	7	8	9	10
10	Trying to please everybody? Trying to make everyone happy?	1	2	3	4	5	6	7	8	9	10
11	Find that you haven't been listening to important information that someone is telling	1	2	3	4	5	6	7	8	9	10

	you?									
12	Making a mistake because you weren't thinking about what you were doing at the time?	1	2	3	4	5	6	7	8	9	10
13	Not remembering where you had got to in an assignment? (e.g. Not remembering whereabouts you had got to in a book.)	1	2	3	4	5	6	7	8	9	10
14	Worrying too much about things that you need to finish?	1	2	3	4	5	6	7	8	9	10
15	Find that you have done things in the wrong order (e.g. Getting dressed in smart clothes before washing the dog and then having to change again)?	1	2	3	4	5	6	7	8	9	10
16	Trying to do or think about too many things at once?	1	2	3	4	5	6	7	8	9	10
17	Taking too long to find things (e.g. homework diary, jersey)?	1	2	3	4	5	6	7	8	9	10
18	Not having what you need with you at the right time (e.g. swimming costume for practice or homework for school)?	1	2	3	4	5	6	7	8	9	10
19	Not remembering whether you had done an everyday activity or not (e.g. not remembering whether you had turned the light off, flushed the toilet)?	1	2	3	4	5	6	7	8	9	10
20	Feeling that others expect too much from you?	1	2	3	4	5	6	7	8	9	10
21	Taking too long to finish something? Not knowing how long you have been doing something for?	1	2	3	4	5	6	7	8	9	10
22	Getting distracted from an important activity by something that is less important?	1	2	3	4	5	6	7	8	9	10
23	Getting "carried away" with something, not stopping to think about it?	1	2	3	4	5	6	7	8	9	10
24	Avoided thinking about a problem because it just seems too difficult?	1	2	3	4	5	6	7	8	9	10

Significant Other Pre- GMT Questionnaire

This questionnaire is about problems that most people experience from time-to-time. Sometimes it is useful to get another person's view on these things. Perhaps we feel that we have more problems than other people are aware of – or perhaps others might be able to spot areas of difficulty of which we are less aware. It can be difficult to rate someone you know on things that sound very negative. Remember, however, that we *all* experience the types of errors described below – the question is how much of a *problem* it is for the person you are rating. With his or her permission, please rate how much of a problem the following descriptions have been for the person that you are describing over the *last two weeks.* The scale goes from 1 (not a problem at all) through to 10 (a really major problem).

1	Not achieving everything that s/he wants to get done in a day?	1	2	3	4	5	6	7	8	9	10
2	Walking into a room and forgetting what it was that s/he had come for?	1	2	3	4	5	6	7	8	9	10
3	Finding that s/he doesn't have time to stop and think?	1	2	3	4	5	6	7	8	9	10
4	Something that s/he needed to do just "slips the mind" (e.g. forgetting to pack a school book, asking your parents to sign something for school?)	1	2	3	4	5	6	7	8	9	10
5	Often not appearing to have a very clear idea of what s/he is trying to achieve?	1	2	3	4	5	6	7	8	9	10
6	S/he doesn't always seem to take in written information the first time?	1	2	3	4	5	6	7	8	9	10
7	S/he is not realistic about how long something will take to complete?	1	2	3	4	5	6	7	8	9	10
8	S/he forgets something that needs to be done at a certain time (e.g. watching a TV programme)?	1	2	3	4	5	6	7	8	9	10
9	S/he feels too busy, hassled, not in control?	1	2	3	4	5	6	7	8	9	10
10	S/he tries to please everybody?	1	2	3	4	5	6	7	8	9	10
11	S/he sometimes doesn't appear to listen to	1	2	3	4	5	6	7	8	9	10

	important information that someone is telling him or her?										
12	Makes mistake because of not thinking about what s/he was doing at the time?	1	2	3	4	5	6	7	8	9	10
13	Forgetting where s/he has got to in a task?	1	2	3	4	5	6	7	8	9	10
14	Worrying too much about things that s/he needs to achieve?	1	2	3	4	5	6	7	8	9	10
15	Doing things in the wrong order (e.g. checking something that is needed when *arriving* at a destination, rather than *before* leaving)?	1	2	3	4	5	6	7	8	9	10
16	Trying to do or think about too many things at once?	1	2	3	4	5	6	7	8	9	10
17	Often searching for things (e.g. book, jersey)?	1	2	3	4	5	6	7	8	9	10
18	Not having what is needed at the right time (e.g. going to swimming practice without a costume and towel)?	1	2	3	4	5	6	7	8	9	10
19	Not remembering whether an everyday activity has been done or not (e.g. not remembering whether s/he has turned off the light)?	1	2	3	4	5	6	7	8	9	10
20	Feels that others expect too much of him or her?	1	2	3	4	5	6	7	8	9	10
21	Loses track of the time?	1	2	3	4	5	6	7	8	9	10
22	Gets distracted from an important activity by something that is less important?	1	2	3	4	5	6	7	8	9	10
23	Gets “carried away” with something, not stopping to think about it?	1	2	3	4	5	6	7	8	9	10
24	Avoids thinking about a problem because it just seems too complicated?	1	2	3	4	5	6	7	8	9	10
25	Feels worried about how well s/he is coping?	1	2	3	4	5	6	7	8	9	10

APPENDIX B

Assent Form

ASSENT TO PARTICIPATE IN RESEARCH

We are inviting you to be in our research study because we would like to learn more about children with head injuries and ways to help them.

If you agree to be in this study we will ask you to come to the hospital a few times a month to do some activities with us and learn new ways to do things like getting ready for school. For example, we may ask you to try to remember things, to draw or read things. We will also ask your family to do the activities with you at home, and your teacher to do them with you at school.

These exercises and activities will not hurt you, but some of them may be long and you may feel tired at times. If you do, you can stop and rest at any time.

Signing this paper means that you want to be in the study. If you don't want to be in the study, don't sign the paper. No one will be cross if you don't sign this paper, and no one will be cross if you change your mind later and want to stop.

You can ask any questions that you have about the study. If you have a question later that you didn't think of now, you can call me on 074 171 9985 or ask me next time.

Signature of Participant _____ Date _____

Signature of Investigator _____ Date _____

APPENDIX C

Consent form

Informed Consent for you and your child to participate in research and authorization for collection, use, and disclosure of neuropsychological rehabilitation and cognitive performance, and other personal data

You are being asked to allow your child to take part in a research study. This form provides you with information about the study and seeks your permission for the collection, use and disclosure of your child's neuropsychological rehabilitation and cognitive performance data, as well as other information necessary for the study. The Principal Investigator (the person in charge of this research) or a representative of the Principal Investigator will also describe this study to you and answer all of your questions. Your child's participation is entirely voluntary. Before you decide whether or not to allow your child to take part, read the information below and ask questions about anything you do not understand. By allowing your child to participate in this study you will not be penalized or lose any benefits to which you would otherwise be entitled.

1. **Name of Participant ("Study Subject" – the child)**

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2. **Title of Research Study**

   Rehabilitation of executive functioning following paediatric traumatic brain injury: A Goal Management Training intervention.

3. **Principal Investigator(s) and Telephone Number(s)**

Kevin G. F. Thomas, Ph.D.	Leigh Schrieff, M.A.
Senior Lecturer	Doctoral candidate
Department of Psychology	Department of Psychology
University of Cape Town	University of Cape Town
021-650-3435	021-650-3435

Claire Corbett, B.Sc.
Honours Student
Department of Psychology
University of Cape Town
074-171-9985

4. Source of Funding or Other Material Support

None

5. What is the purpose of this research study?

The main purpose of this research is to investigate the effectiveness of the Goal Management Training (GMT) programme in the rehabilitation of executive functioning in children following traumatic brain injury. This research was undertaken as the efficacy of this intervention has not been established for children.

6. What will be done if you take part in this research study?

Firstly, a number of neuropsychological tests will be carried out with your child to find out his/her strengths and weaknesses, for example in the way he/she remembers, pays attention, or solves problems. You, as the parent/caregiver, will also be asked some questions so that the investigator can know more about your child's performance at home or at school. An interview about your child's behaviour will then be conducted by the principal researcher and supervisor to establish in which everyday tasks the GMT intervention will be most effective.

Once these strengths and weaknesses are determined and the area of focus for the intervention has been identified, the researchers will adapt a training programme to match your child's needs. For example, if your child has problems getting ready for school, then the training programme will teach your child to organise more goal-directed behaviour that will aid his/her ability to get ready for school in a systematic way. These strategies will be discussed with you, the parent/caregiver, as well as with the child.

Once the training programme has been implemented, a paper-and-pencil post-training assessment will be administered to your child, similar to the pre-training assessment. We will also request your permission to obtain a comprehensive report from your child's school teacher.

A follow-up assessment, using similar paper-and-pencil tasks as before, will be performed one (1) month after the intervention.

The principal researchers and/or research assistants will implement these rehabilitation strategies. However, some of the intervention strategies will require your involvement as the parent/caregiver, depending on what the intervention strategy involves.

The researchers will monitor your children's progress over a maximum period of 4 months.

7. **If you choose to participate in this study, how long will you be expected to participate in the research?**

In order to assess whether the interventions are effective, it will be necessary for some of the interventions to be monitored for at least 4 months. Thus, participation could last for up to 4 months.

However, if at any time during the research period you feel that you do not wish to continue, you are free to discontinue your participation without penalty.

8. How many people are expected to participate in the research?

3 children and their parents/guardians/caregivers.

9. What are the possible discomforts and risks for you or your child?

There are no known risks associated with taking part in this study.

During the testing period we may find that your child may need assistance in other areas of functioning not covered by the intervention service. If this happens, we will talk with you and give a referral for the necessary care.

If you wish to discuss the information above or any discomforts you may experience, you may ask questions now or call the Principal Investigators listed on the front page of this form.

10. What are the possible benefits to you and your child?

The general aim of the research is improvement in the quality of life for you and your child. More specifically, the intervention strategies chosen are aimed at improving specific areas of functioning for your child. As the aim of this study is to investigate how effective the GMT intervention will be for children, it is not guaranteed that the rehabilitation interventions will result in improved functioning or performance for your child.

11. What are the possible benefits to others?

Should the intervention strategies that are used prove to be effective, this will be an important contribution to future neuropsychological rehabilitation services offered to other children who have sustained traumatic brain injuries. In other words, this research can then be applied to other children, or families of children, who have experienced a traumatic brain injury.

12. If you choose to take part in this research study, will it cost you anything?

Participating in this study will not cost you anything financially. However, some of the intervention strategies that need to be conducted at home will require your involvement and supervision.

13. Will you and your child receive compensation for taking part in this research study?

You will receive financial compensation of R150 to cover travel costs.

14. Can you and your child withdraw from this research study?

You are free to withdraw your consent and to stop participating in this research study at any time. If you do withdraw your consent, there will be no penalty.

If you have any questions regarding you or your child's rights as a research subject, you may phone the Psychology Department, University of Cape Town on 021-650-3430.

15. If you withdraw, can information about you and your child still be used and/or collected?

Information already collected may be used.

16. Once personal and performance information is collected, how will it be kept secret (confidential) in order to protect your privacy?

Information collected will be stored in locked filing cabinets or on computers with security passwords. Only certain people have the right to review these research records. These people include the researchers for this study and certain University of Cape Town officials. Your research records will not be released without your permission unless required by law or a court order.

17. What information about you or your child may be collected, used and shared with others?

This information gathered from you will be demographic information, records of your responses, or your child's performance on the neuropsychological tests, and records of your child's progress in terms of the intervention strategies. If you agree to be in this research study, it is possible that some of the information collected might be copied into a "limited data set" (a computer file) to be used for other research purposes. If so, the limited data set may only include information that does not directly identify you or your child. For example, the limited data set cannot include you or your child's name, address, telephone number, ID number, or any other photographs, numbers, codes, or so forth that link you to the information in the limited data set.

18. How will the researcher(s) benefit from your being in the study?

In general, presenting research results helps the career of a scientist. Therefore, the Principal Investigators may benefit if the results of this study are presented at scientific meetings or in scientific journals. This study is being undertaken as part of honours and doctoral degrees being completed at the University of Cape Town.

Signatures

As a representative of this study, I have explained to the participant's (child's) parent the purpose, the procedures, the possible benefits, and the risks of this research study; and how the participant's performance and other data will be collected, used, and shared with others:

_____ _____

Signature of Person Obtaining Consent and Authorization Date

You have been informed about this study's purpose, procedures, possible benefits, and risks; and how your responses and your child's performance and other data will be collected, used and shared with others. You have received a copy of this form. You have been given the opportunity to ask questions before you sign, and you have been told that you can ask other questions at any time.

You voluntarily agree for you and your child to participate in this study. You hereby authorize the collection, use and sharing of your performance and other data. By signing this form, you are not waiving any of your legal rights.

_____ _____

Signature of Person Consenting and Authorizing Date

Authorization for _____ to participate in the study.

Relationship to child participating in the study: parent / legal guardian

_____

Please indicate below if you would like to be notified of future research projects conducted by our research group:

_____ (initial & surname) Yes, I would like to be added to your research participation pool and be notified of research projects in which I might participate in the future.

Method of contact:

Phone number: _____

E-mail address: _____

Mailing address: _____

_____

_____

APPENDIX D

Summary of Adaptations to the Goal Management Training Intervention.

Where changes were made to the text, pictures reflecting the adapted example replaced the original drawings. These are in the form of photos or cartoons. Any changes made to the PowerPoint presentations and workbooks are maintained throughout the modules.

Modules 2 and 3 have been joined as well as modules 4 and 5.
The PowerPoint presentations and workbooks have been renamed to reflect the condensed intervention thus module 2 is the original module 2 and 3. Module 3 is the original module 4 and 5. Module 4 is the original module 6 and module 5 is the original module 7.

Changes to the PowerPoint presentations:

Module 1:

1. The slide of introductions was removed as the intervention was administered individually to the child and parent, instead of in a group as with adults.
2. Professor Norbert Fertwinkle was changed to Teacher Fertwinkle and changed to a classroom scenario. Teacher Fertwinkle was distracted by the plants needing watering and a letter from a friend while he was tiding up the class for the children's arrival.
3. The example of consequences of slips was changed from the pilot example to that of a child absentmindedly riding his bicycle to school, not watching for the puddle he had been warned of, rides through the puddle and gets all his clothes wet.
4. The monitoring of slips assignment example (loosing keys in the fridge) was changed to a girl loosing her school lunch box because she put it in the wrong bag.

Module 2 and 3

1. The modules were merged onto one PowerPoint.
2. The card dealing task was adapted for one participant (no partner swapping).
3. The example of Roy Regals was changed to a Rugby match (similar to American Football) due to the South African context.
4. The automatic pilot error example was changed from a man misplacing his Boss's book in his briefcase to that of a girl misplacing her friend's sticker book in her school bag.

5. The Gus and Mertyl example was changed to Gus and Kelly walking back from the shops, Kelly telling a story of drawing a dinosaur in class so distracting Gus from dropping off a loaf of bread and his Grandmother's house.

Module 4 and 5

1. The example of Gilbert Rushdale getting a call about a car was changed to Gavin a boy being distracted by a TV game so making him late for a soccer game.
2. The phrase "get the files to the printer by 5pm" was changed to getting eggs from the shops by 5pm.
3. The goal conflict example of Nolan was changed to the conflict of needing to learn for a spelling test for the Friday, finishing a library book for Thursday and packing a bag for a sleep-over on Saturday.
4. The indecision example of Helen's conference was changed to Joe wanting to play soccer but not having his clothes with him and having to choose between going home to fetch clothes or going to a friend's to borrow clothes.
5. The scoring of the complex tasks has been changed to reflect the changes to the task in the workbook.

Module 6

1. The example of making a Beef Wellington was changed to making a sandwich.
2. The wedding task was changed to a birthday task.
3. The bookkeeping task is changed to a Jelly tot task.

Module 7

1. The example of Philip making a rabbit hutch was changed to Jen making a birthday card instead of a happy father's day card.
2. The second bookkeeping task was changed to another Jelly Tot task.
3. The example of having Frank over for dinner was changed to organising a picnic and cricket game in the park.
4. The third bookkeeping task was changed to another Jelly Tot task.

Workbook changes:

Module 1 workbook:

1. No changes.

Module 2 and 3 workbook:

1. Reflects the changes of Gus and Kelly (distracted by dinosaur story thus forgetting to deliver a loaf of bread) made to the PowerPoint presentation.

Module 4 and 5 workbook:

1. Complex task 1- word search- a more colourful word search that only requires 8 words replaced the original.

   Spot the difference- a colourful, child-friendly picture replaced the original.

2. Complex task 2- word search- a more colourful word search that only requires words replaced the original.

   Spot the difference- a colourful, child-friendly picture replaced the original. There are 4 differences.

3. The catalogue task was removed as too much was required from the children.

Module 6 workbook:

1. The tasks and subtasks exercise was changed to a sleep-over birthday party.
2. The Bookkeeping task was changed to a task that requires Jelly Tots (colourful sweets) to be divided among children according to their requests.
3. The second catalogue task was also removed.

Module 7 workbook:

1. The bookkeeping tasks were changed to Jelly Tot tasks.
2. The final Fertwinkle example was changed to reflect the initial changes to the example.

APPENDIX E

Goal Management Training Intervention Schedule and a breakdown of the modules

GMT	Key Concepts	Mental Laboratory Tasks	Homework
Module 1: Slip-ups	Introductions What are goals? Introduction to the Mental Laboratory Absentmindedness Slips & Intelligence Consequences of Slips What makes slips more/less likely? Optional-GMT overview Highlights to come in GMT	Clapping Task Clapping Task-revisited	Record Slips Remember workbook
Module II: Stop the Automatic Pilot and the Mental Blackboard	Automatic Pilot Automatic Pilot Errors Stopping the Automatic Pilot The Mental Blackboard Using "STOP!" to check the mental blackboard "STOP!"-Present-mindedness-check mental blackboard	Card-Dealing Task Clapping Task with "STOP!" Card-Dealing Task with "STOP!" by Trainer Card-Dealing Task with "STOP!" by Participant Card-Dealing Task with distraction	Record Slips 30-minute daily STOP Record Slips/things that went well

Module III: State Your Goal and Present-Mindedness	Being sidetracked from your goal How we remember things State your goal "STOP!"(present-mindedness)-STATE cycle	Complex Task I Complex Task II (state goal, present-mindedness)	Daily Present-mindedness practice Record Slips/things that went well 30-min daily STOP-STATE
Module IV: Making Decisions and Splitting Tasks into Subtasks	Goal Conflicts Emotional reactions to Conflicting Goals To-Do Lists To-Do Lists in the "STOP"-STATE cycle Combating indecision Getting overwhelmed Tasks and Subtasks Splitting the task up “STOP!"-STATE-SPLIT cycle	Complex Task with To-Do List Find the Letter Birthday Task Jelly Tot Task I	Get TO-DO list Daily Present-mindedness practice Log STOP-STATE-SPLIT scenarios Daily Present-mindedness practice
Module: Checking (STOP!)	Expect "STOP!"-STATE-SPLIT errors	Jelly Tot Task II	

	Clapping Task with
CHECK!	"STOP!"
Changing circumstances	
may cause errors	Jelly Tot Task III
Make STOPPING a habit	
GMT review	

Note. Information in this table is adapted from (Robertson, Levine & Manly, 2005)

FOOTNOTES

[1]Although the latter can refer only to transfer by anatomical system, it can also be extended to refer to transfer by behavioural compensation.

[2]In the former, van Horne et al. (2006) applied the programme in the cognitive rehabilitation of 69 healthy subjects over the age of 55. Second, Levine et al. (2007) applied a modified version of the original GMT programme to the cognitive rehabilitation of 49 healthy older adults aged between 71 and 87 years. Results from tabletop simulated real-life tasks, examiner-rated and self-rated executive function and a dysexecutive questionnaire all converged to the indicated results. Furthermore, these gains were maintained at a 6-month follow-up.

[3]The participants in this study were chosen to represent varying levels of severity in order not only to test the success of the adaptation of this intervention but also the extent of its applicability to different disorder intensities. Efforts were made to establish these results from a common stand-point to improve comparability. Thus controlling for socioeconomic status, age and duration of disorder.

[4]The definitions of mild, moderate, and severe TBI used here mirror those used in the larger research project. Specifically, grading of TBI severity was based on the Glasgow Coma Scale (GCS; Teasdale & Jennet, 1974) scores upon admission to the RXH trauma ward. Mild TBI was defined as a GCS of 13-15, moderate TBI as a GCS of 9-12, and severe TBI as a GCS of 3-8.

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[5]To clarify: the father was not involved in any positive impact on CZ's progress but rather inhibited progress through causing emotional anxiety for his daughter. This observation is not subjectively based as this author witnessed an attempt made on the mother's life by the father and in the company of CV which resulted in the cancellation of session 2. The father was subsequently incarcerated

Table 1

A summary the neuropsychological test battery and the corresponding domains of Anderson's (2002) Executive Function model

Measure	Domain
Wechsler Abbreviated Scale of Intelligence.(WASI)	General intellectual functioning
Block Design	Perceptual organization
Matrix Reasoning	Nonverbal fluid reasoning
Children's Memory Scale (CMS)	Verbal memory
Stories	Recall of meaningful verbal material.
Word List	List learning of unrelated words.
CMS	Visual memory
Dot locations	Spatial location learning
Rey-Osterrieth Complex Figure	Visual-spatial memory and constructional ability
CMS *Numbers*	Working memory
Test of Everyday Attention (TEA-Ch)	Attention
Sky Search	Selective and focused attention
Score	Sustained attention
Creature Counting	Attentional control/switching. Cognitive Flexibility domain of Anderson's (2002) EF model.
Sky Search Dual Task	Sustained-divided attention. Cognitive Flexibility domain of Anderson's (2002) EF model.
	Executive Function
Tower of London	Problem-solving and planning skills. Goal Setting domain of Anderson's (2002) EF model.
Color Trails	Flexibility/ Switching. Cognitive Flexibility domain of Anderson's (2002) EF model.
Verbal Fluency	Executive/ supervisory processes, verbal retrieval and recall, self-monitoring and inhibition. Attention Control domain of Anderson's (2002) EF model.
NEPSY- II	
Inhibition	Inhibition of automatic responses/ switching. Attention Control domain of Anderson's (2002) EF model.
Clocks	Planning and organization. Goal Setting domain of Anderson's (2002) EF model.
Design Fluency	Behavioural productivity. Information Processing domain of Anderson's (2002) EF model.

Table 2
Case 1: CZ- CBCL Parent Report of Behaviour

Measure	Problems		
	Internalising	Externalising	Total
Total Score	10	12	36
T Score	59	60 B	59
Percentile	81	84	81

Note: The three major scales of the questionnaire are presented. B indicates a score is in the borderline clinical range.

Table 3
Case 1: CZ- Parent and Teacher reports of Executive Function

Measure	Index	Score
BRIEF- Parent	Behaviour Regulation	53
	Metacognition	65
	Global Executive Composite	61
BRIEF- Teacher	Behaviour Regulation	103
	Metacognition	108
	Global Executive Composite	106

Note: Standard Score (M= 50; SD=10) Higher scores indicate a negative performance.

Table 4
Case 1- CZ: Neuropsychological Tests of General Intellectual Functioning

WASI Measure	Score	
	Pre-intervention	Post-intervention
Block Design	6	5
Matrix Reasoning	8	12
Performance IQ	84	92

Note: For Block Design and Matrix Reasoning, scaled scores are presented (M = 10, SD = 3). For Performance IQ, an index score is presented (M = 100, SD = 10). Higher scores indicate positive performance.

Table 5
Case 1- CZ: Neuropsychological Tests of Verbal, Visual and Working Memory

Measure	Subtest		Score	
			Pre-intervention	Post-intervention
CMS	Stories	Immediate	8	7
		Delayed	8	5
		Delayed Recognition	6	6
	Word Lists	Learning	8	15
		Delayed	9	15
		Delayed Recognition	10	11
	Dot locations	Total	13	15
		Long delay	12	13
	Numbers	Forwards	11	10
		Backwards	7	4
Rey-Osterrieth Complex Figure	Copy		26.5	26
	Delayed		12	23.5

Note: The scaled scores are presented for the CMS measures (*M= 10, SD= 3*). Higher scores indicate positive performance. The raw scores are presented for the Rey- Osterrieth Complex Figure.

Table 6
Case 1: CZ- Neuropsychological Tests of Executive Functions

Measure	Subtest		Score	
			Pre-intervention	Post-intervention
Tower of London	N/A		98	110
NEPSY-II	Inhibition	Name vs. Inhibition contrast	8	6
		Inhibition vs. Switch contrast	8	7
		Total errors	6	6
	Clocks		10	9
	Design Fluency		8	7
Color Trails	One		58	58
	Two		166	98
Verbal Fluency	Total FAS		21	54
	Animals		12	10
	Food		10	12

Note: The standard scores for the total move count are presented for the Tower of London as this is the primary measure of executive planning. The scaled scores are presented for the NEPSY-II tests (*M= 10, SD= 3*), higher scores indicate positive performance. Norms for this age were not available for the Color Trails thus the raw score in seconds are reported, lower scores indicate positive performance. The standard scores forVerbal Fluency are presented (Total FAS *M*=24; *SD*=6.5; Foods *M*=14; *SD*=3.7; Animals *M*=14, SD= 2.2)

Table 7
Case 1: CZ- Neuropsychological Tests of Attention

Measure	Subtest		Score	
			Pre-intervention	Post-intervention
TEA-Ch	Sky Search (Attention)		8	10
	Score		8	5
	Creature	Total correct	7	9
	Counting	Timing score	6	8
	Sky Search Dual Task		8	8

Note: The scaled scores for the TEA-Ch tests are presented (*M= 10*, *SD= 3*). Higher scores indicate positive performance.

Table 8
Qualitative Descriptions of WASI Scores

IQ Scores	Subtest Scaled Score	Classification
130 and above	16 – 19	Very Superior
120 – 129	14 – 15	Superior
110 – 119	12 – 13	High Average
90 – 109	8 – 11	Average
80 – 89	6 – 7	Low Average
70 – 79	4 -5	Borderline
69 and below	1 – 3	Extremely Low

Note. Taken from *Wechsler Abbreviated Scale of Intelligence* (Wechsler, 1999)

Table 9
Qualitative Descriptions of CMS Scores

Subtest Scaled Scores	Classification
16 and above	Very Superior
14 – 15	Superior
12 – 13	High Average
8 – 11	Average
6 – 7	Low Average
4 – 5	Borderline
3 and below	Impaired

Note. Taken from *Children's Memory Scale* (Cohen, 1997)

Table 10
Qualitative Descriptions of NEPSY-II Scaled Scores

Scaled Score	Classification
13 – 19	Above Expected Level
8 – 12	At Expected Level
6 – 7	Borderline
4 – 5	Below Expected Level
1 – 3	Well Below Expected Level

Note. Taken from *NEPSY-II* (Korkman, Kirk & Kemp, 2007).

Table 11
Qualitative Descriptions of the Tower of London Standard Scores

Standard Score	Executive Planning Classification	Number of SD's from the Mean	Percentile Rank
>130	Very Superior	> +2	> 98
120-129	Superior	+ 1 1/3 to +2	91 – 98
110-119	High Average	+2/3 to +1 1/3	75 – 91
90-109	Average	-2/3 to +2/3	25 – 75
80-89	Low Average	-1 1/3 to -2/3	16 – 25
70-79	Borderline	-2 to -1 1/3	2 – 16
<70	Poor	<-2	< 2

Note. Taken from *Tower of London: Drexel University* (Culbertson, & Zillmer, 2001)

Table 12
Case 1: MJ- CBCL parent report of behaviour

Measure	Problems		
	Internalising	Externalising	Total
Total Score	30	26	97
T Score	76[b]	69 C	75 C
Percentile	>98	97	>98

Note: The three major scales of the questionnaire are presented. C indicates a score is in the clinical range.

Table 13
Case 2- MJ: Parent and Teacher reports of Executive Function

Measure	Index	Score
BRIEF- Parent	Behaviour Regulation	87
	Metacognition	94
	Global Executive Composite	70
BRIEF- Teacher	Behaviour Regulation	69
	Metacognition	76
	Global Executive Composite	75

Note: Standard Score (M= 50; SD=10) Higher scores indicate a negative performace.

Table 14
Case 2- MJ: Neuropsychological Tests of General Intellectual Functioning

		Score	
Measure	Subtest	Pre-intervention	Post-intervention
WASI	Block design	6	10
	Matrix reasoning	8	8
	Performance IQ	84	93

Note: The Scaled-Scores are presented. Higher scores indicate positive performance.

Table 15
Case 2- MJ: Neuropsychological Tests of Verbal, Visual and Working Memory

Measure	Subtest		Score	
			Pre-intervention	Post-intervention
CMS	Stories	Immediate	3	13
		Delayed	4	13
		Delayed Recognition	4	11
	Word Lists	Learning	3	6
		Delayed	5	11
		Delayed Recognition	4	4
	Dot locations	Total	8	13
		Long delay	8	13
	Numbers	Forwards	4	5
		Backwards	5	7
Rey-Osterrieth Complex Figure	Copy		21	24
	Delayed		12.5	20

Note: The scaled scores are presented for the CMS measures (*M= 10, SD= 3*). Higher scores indicate positive performance. The raw scores are presented for the Rey- Osterreith Complex Figure.

Table 16
Case 2- MJ: Neuropsychological Tests of Executive Functions

Measure	Subtest		Score	
			Pre-intervention	Post-intervention
Tower of London	N/A		68	88
NEPSY-II	Inhibition	Name vs. Inhibition contrast	9	6
		Inhibition vs. Switch contrast	2	9
		Total errors	1	9
	Clocks		4	3
	Design Fluency		8	8
Color Trails	One		97	71
	Two		168	192
Verbal Fluency	Total FAS		26	34
	Animals		14	17
	Food		10	12

Note: The standard scores for the total move count are presented for the Tower of London as this is the primary measure of executive planning. The scaled scores are presented for the NEPSY-II tests (*M= 10, SD= 3*), higher scores indicate positive performance. Norms for this age were not available for the Color Trails thus the raw score in seconds are reported, lower scores indicate positive performance. The standard scores for Verbal Fluency are presented (Total FAS *M*=24; *SD*=6.5; Foods *M*=14; *SD*=3.7; Animals *M*=14, SD= 2.2)

Table 17
Case 2- MJ: Neuropsychological Tests of Attention

Measure	Subtest		Score	
			Pre-intervention	Post-intervention
TEA-Ch	Sky Search (Attention)		8	10
	Score		5	5
	Creature	Total correct	3	3
	Counting	Timing score	1	N/A
	Sky Search Dual Task		7	1

Note: The scaled scores for the TEA-Ch tests are presented (*M= 10*, *SD= 3*). Higher scores indicate positive performance.

Table 18
Case 1: SN- CBCL parent report of behaviour

Measure	Problems		
	Internalising	Externalising	Total
Total Score	22	13	79
T Score	70 C	59	71 C
Percentile	98	81	>98

Note: The three major scales of the questionnaire are presented.
C indicates a score in the clinical range.

Table 19
Case 3: SN- Parent and Teacher reports of Executive Function

Measure	Index	Score
BRIEF- Parent	Behaviour Regulation	53
	Metacognition	56
	Global Executive Composite	55
BRIEF- Teacher	Behaviour Regulation	96
	Metacognition	99
	Global Executive Composite	94

Note: Standard Score (M= 50; SD=10) Higher scores indicate a negative performace.

Table 20
Case 3- SN: Neuropsychological Tests of General Intellectual Functioning

Measure	Subtest	Score pre-intervention
WASI	Block design	6
	Matrix reasoning	5
	Performance IQ	77

Note: The T-Scores are presented (*M*=50, *SD*= 10). Higher scores indicate positive performance.

Table 21
Case 3- SN: Neuropsychological Tests of Verbal, Visual and Working Memory

Measure		Subtest	Score pre-intervention
CMS	Stories	Immediate	2
		Delayed	2
		Delayed Recognition	3
	Word Lists	Learning	1
		Delayed	2
		Delayed Recognition	2
	Dot locations	Total	6
		Long delay	6
	Numbers	Forwards	4
		Backwards	8
Rey-Osterrieth Complex Figure	Copy		12.5
	Delayed		1

Note: The scaled scores are presented for the CMS measures (*M= 10, SD= 3*). Higher scores indicate positive performance. The raw scores are presented for the Rey- Osterreith Complex Figure.

Table 22
Case 3: SN- Neuropsychological Tests of Executive Functions

Measure	Subtest		Score pre-intervention
Tower of London	N/A		90*
NEPSY-II	Inhibition	Name vs. Inhibition contrast	3
		Inhibition vs. Switch contrast	3
		Total errors	1
	Clocks		4
	Design Fluency		8
Color Trails	One		368
	Two		661
Verbal Fluency	Total FAS		5
	Animals		10
	Food		5

Note: The standard scores for the total move count are presented for the Tower of London as this is the primary measure of executive planning. SN made 4 time violations and 4 rule violations which would decrease his SS to <60.
The scaled scores are presented for the NEPSY-II tests (*M= 10*, *SD= 3*), higher scores indicate positive performance. Norms for this age were not available for the Color Trails thus the raw score in seconds are reported, lower scores indicate positive performance. The standard scores for Verbal Fluency are presented (Total FAS *M*=24; *SD*=6.5; Foods *M*=14; *SD*=3.7; Animals *M*=14, SD= 2.2)

Table 23
Case 3: SN- Neuropsychological Tests of Attention

Measure	Subtest		Score pre-intervention
TEA-Ch	Sky Search (Attention)		1
	Score		5
	Creature	Total correct	2
	Counting	Timing score	N/A
	Sky Search Dual Task		1

Note: The scaled scores for the TEA-Ch tests are presented (*M= 10*, *SD= 3*). Higher scores indicate positive performance.